The Commercial Aviation Alternative Fuels Initiative (CAAFI)

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Bonn, Germany

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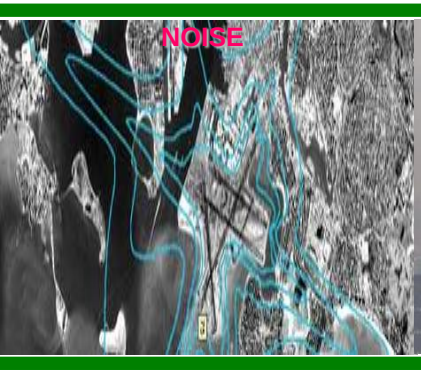
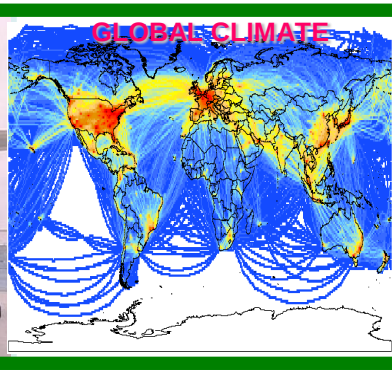
Aviation Environmental Drivers

- **Aviation impacts community noise footprints, air quality, water quality, energy usage and availability, and the global climate.**

- **Trends show environmental impacts from aircraft noise and aviation emissions will be a critical constraint on capacity growth.**

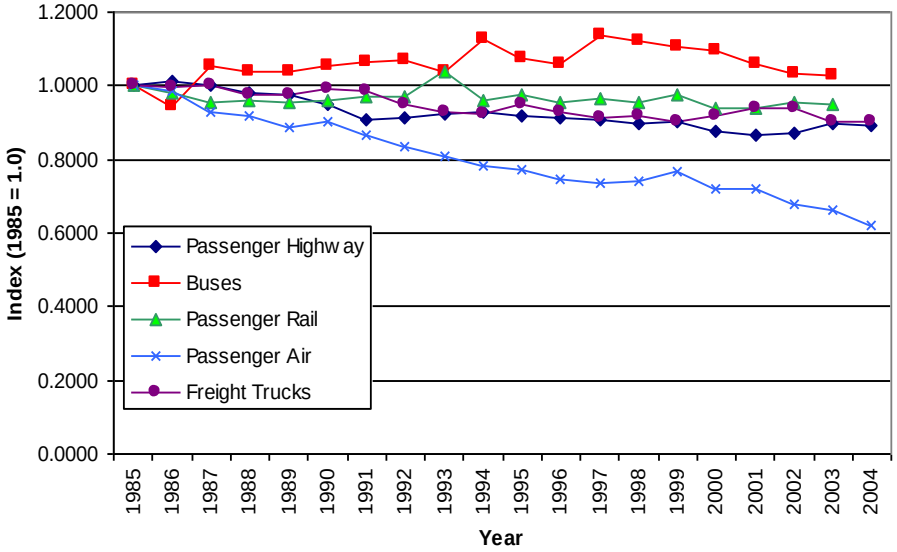
- **Fundamental changes ongoing from economic downturn, fuel costs, and financial turmoil.**





➢ ***The challenge is to ensure energy availability and affordability and reducing aviation's environmental footprint, even with projected aviation growth***

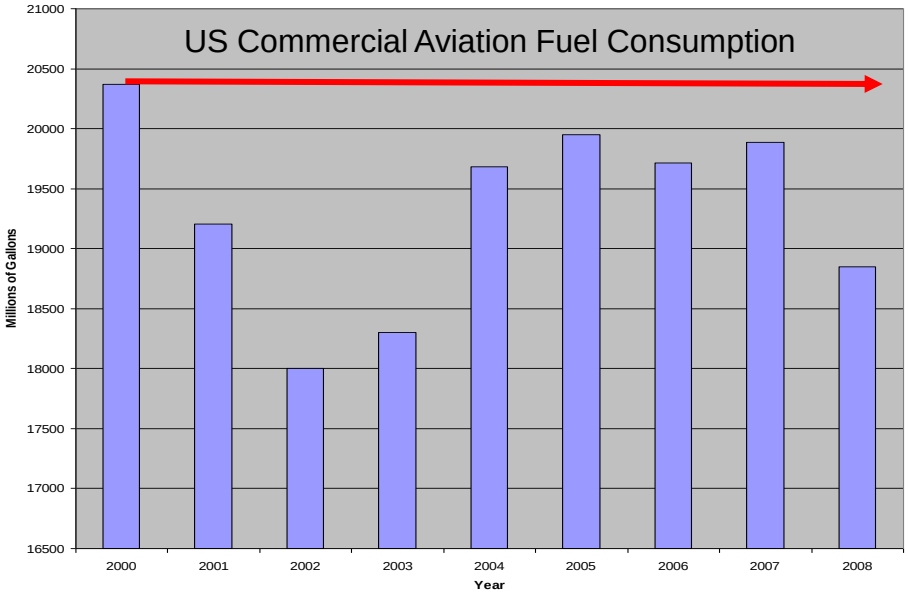
U.S. Experience: Aviation Emissions Performance



Source: DOE

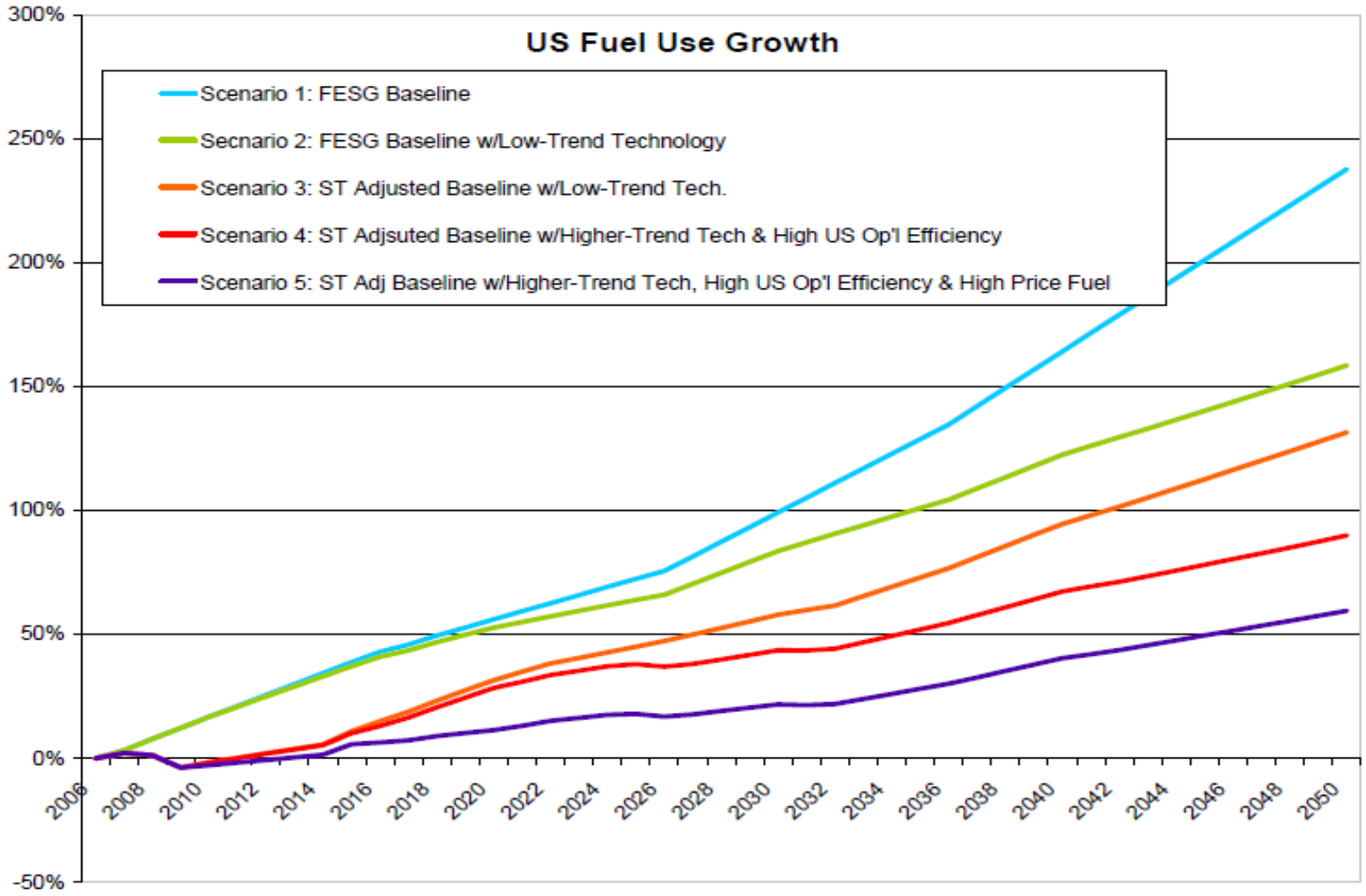
U.S. commercial aviation outpaces other modes in energy efficiency improvements…

…while absolutely reducing its carbon footprint since 2000.



Source: BTS

The Challenge - U.S. Aviation Fuel Use Scenarios



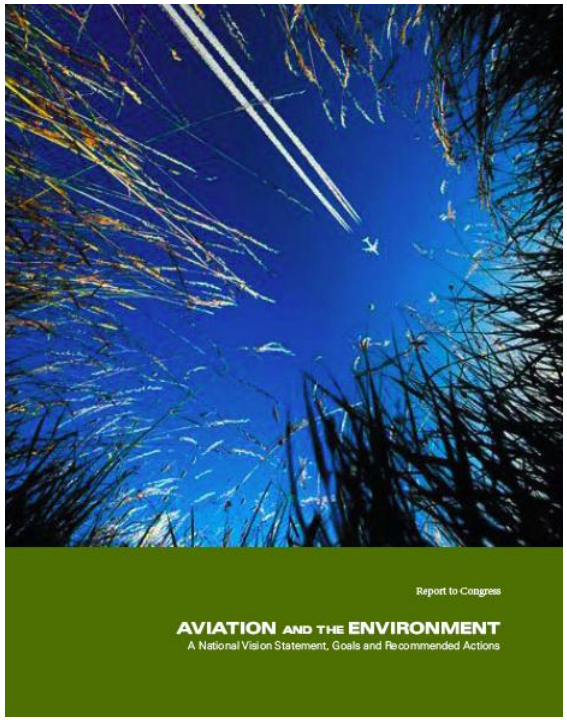
Source: FAA Preliminary Analysis

NextGen Vision

Provide environmental protection that allows sustained aviation growth

Key Initiatives:

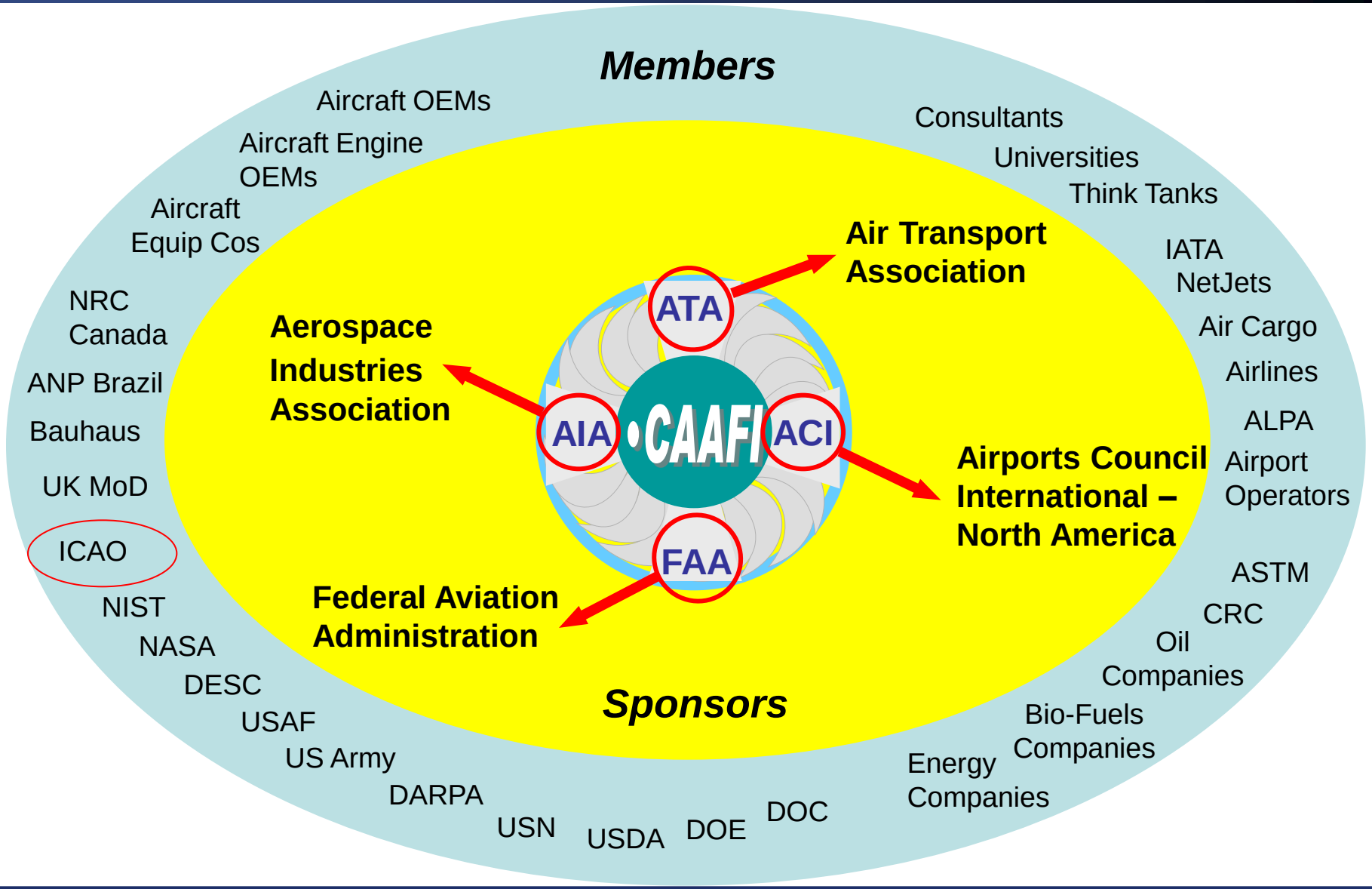
- Continued Local Mitigation
- Better Scientific Understanding
- Accelerate Operational Changes
- Mature New Aircraft Technology
- Develop Alternative Fuels
- Policy Options



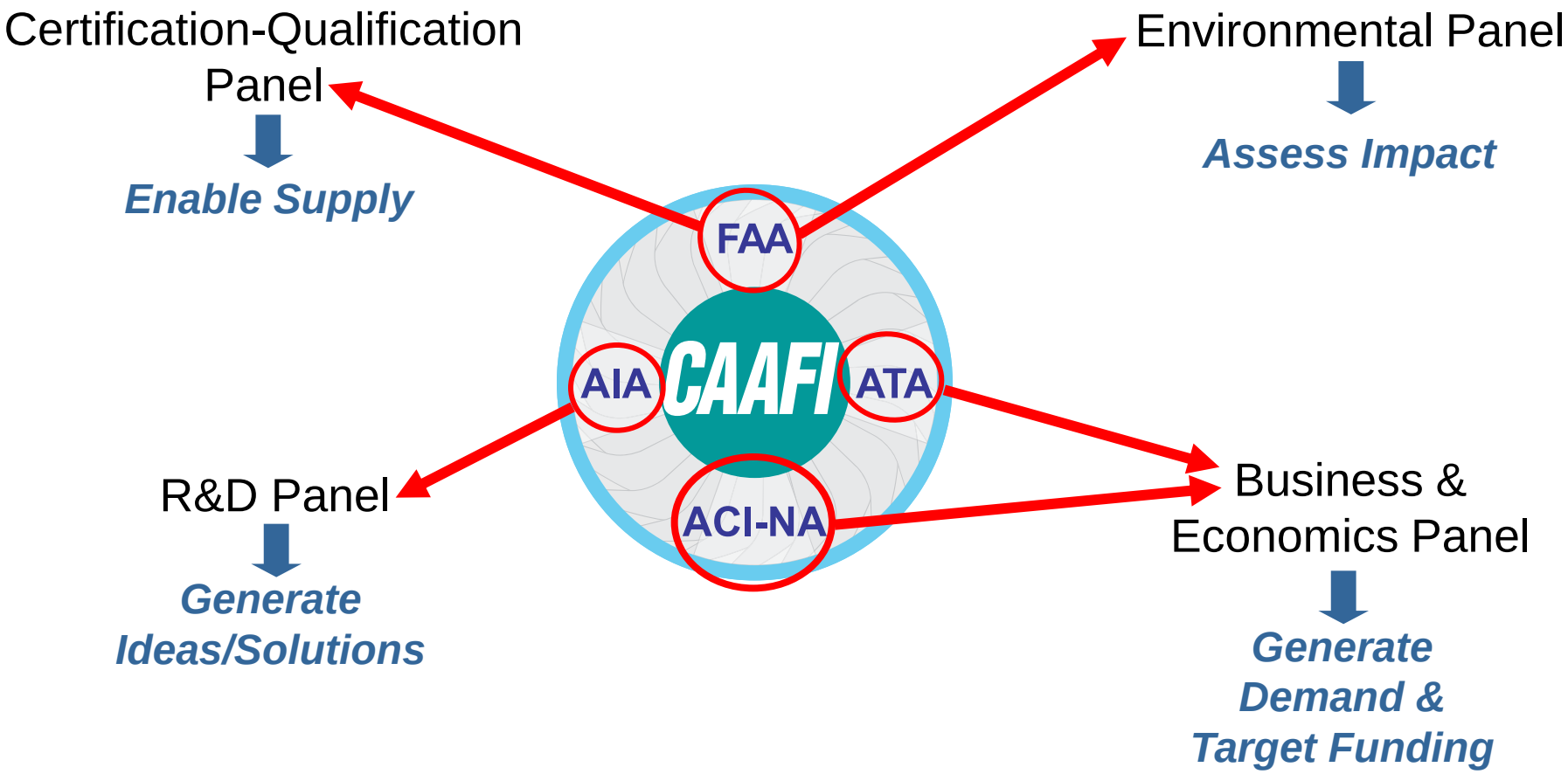
The Commercial Aviation Alternative Fuel Initiative

- ***A consortium*** *of government agencies, airlines, manufacturers, airports, and current and prospective fuel suppliers*
- ***Foster the development and deployment*** *of alternative jet fuels*
- ***Share Information and Coordinate research and development*** *of alternative jet fuels, including technical specifications, environmental assessment, production and distribution.*
- ***To enhance*** *energy security, aviation economics and environment*

Who is CAAFI?


Members
Aircraft OEMs
Aircraft Engine OEMs
Aircraft Equip Cos
NRC Canada
ANP Brazil
Bauhaus
UK MoD
ICAO
NIST
NASA
DESC
USAF
US Army
DARPA
USN
USDA
DOE
DOC
Energy Companies
Bio-Fuels Companies
Oil Companies
CRC
ASTM
Airport Operators
ALPA
Airlines
Air Cargo
IATA
NetJets
Think Tanks
Universities
Consultants
Air Transport Association
Airports Council International – North America
Federal Aviation Administration
Aerospace Industries Association
ATA
ACI
FAA
AIA
CAAFI
Sponsors

CAAFI Structure and Strategy

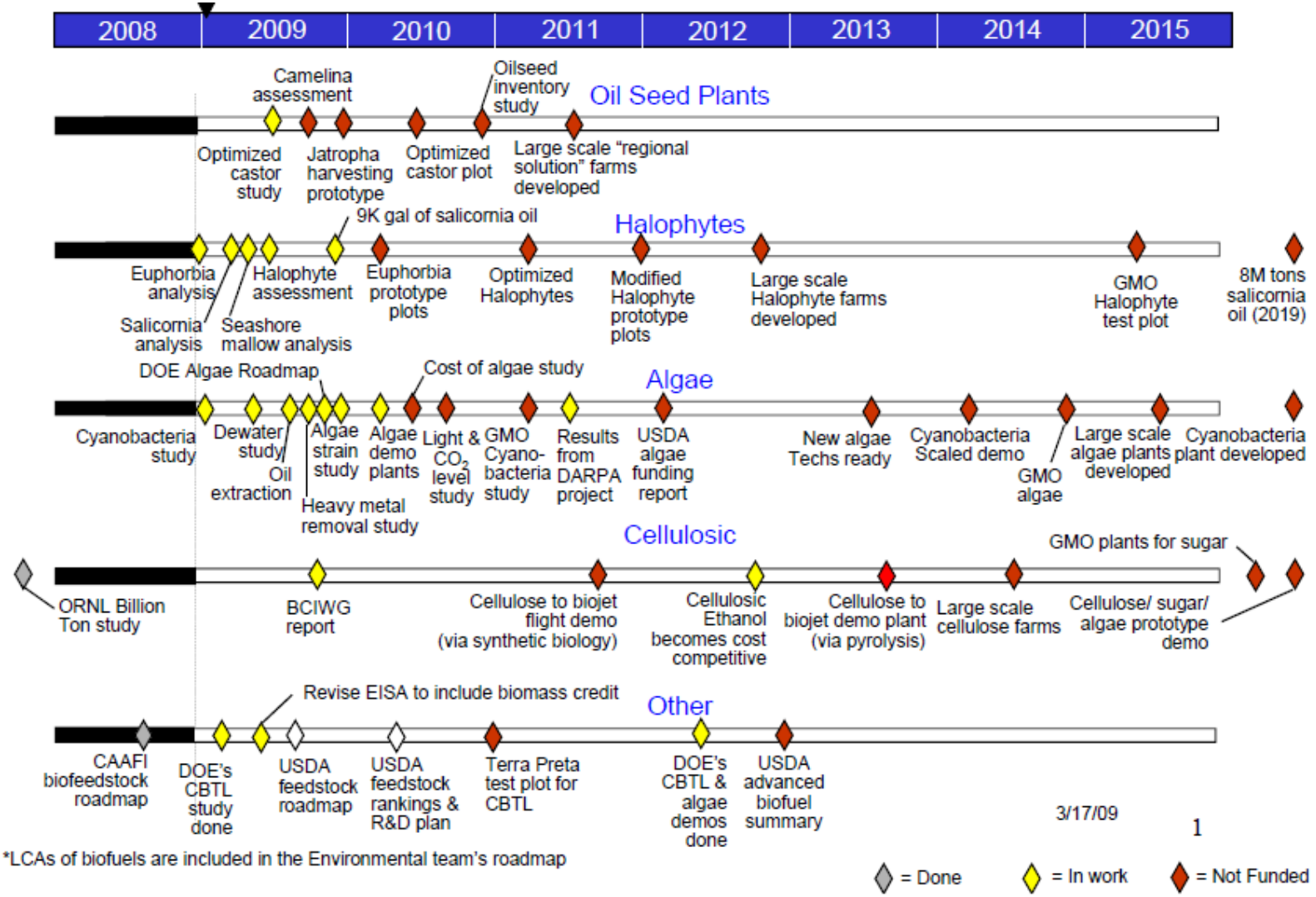


CQ: CAAFI Targeted* Certification Timing

YEAR	FUEL TYPE	STATUS
• 2009	- 50% FT generic blends including biomass/ coal / gas	- ASTM vote targeted for June '09 - Rapid Adjudication process with producers/ OEM's / USAF
• 2010	- 50% HRJ Blend - 100% FT generic including biomass	- Working with ASTM, FAA and engine/aircraft OEMS -Supporting low sulfur cost/benefit starting 4/08
• 2013	- 100% HRJ - Other Biofuel processes	- DARPA program complete. Fuels available for FFP tests - DARPA Algae program underway.

* Generic Targets based upon outcomes to date anticipated fuel availability for tests

R&D: Feedstocks Roadmap



R&D: Three Successful HRJ Biojet Flight Programs

* Graphics Courtesy J. Holmgren, UOP

BOEING® UOP A Honeywell Company

Feedstock: Jatropha oil

- **Successful ANZ Flight Demo Date: December 30 2008**

AIR NEW ZEALAND Rolls-Royce

BOEING® UOP A Honeywell Company

Feedstock: Jatropha and algal oil

- **Successful CO Flight Demo Date: Jan. 7 2009**

Continental Airlines cfm

BOEING® UOP A Honeywell Company n·d

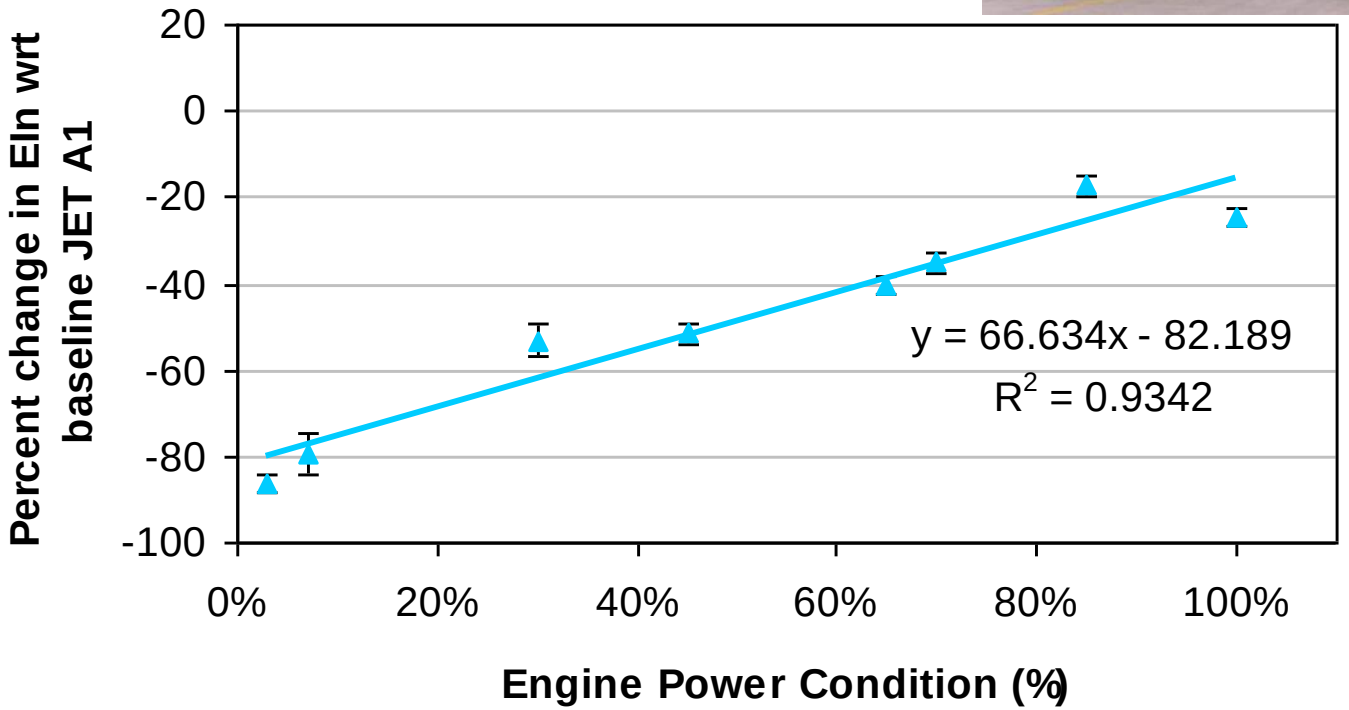
Feedstock: Camelina, Jatropha and algal oil

- **Successful JAL Flight Demo Date: Jan. 30 2009**

JAL Pratt & Whitney A United Technologies Company Sustainable Oils Your trusted energy growth partner.

Environment: Particulate Matter Emission Gains Measured

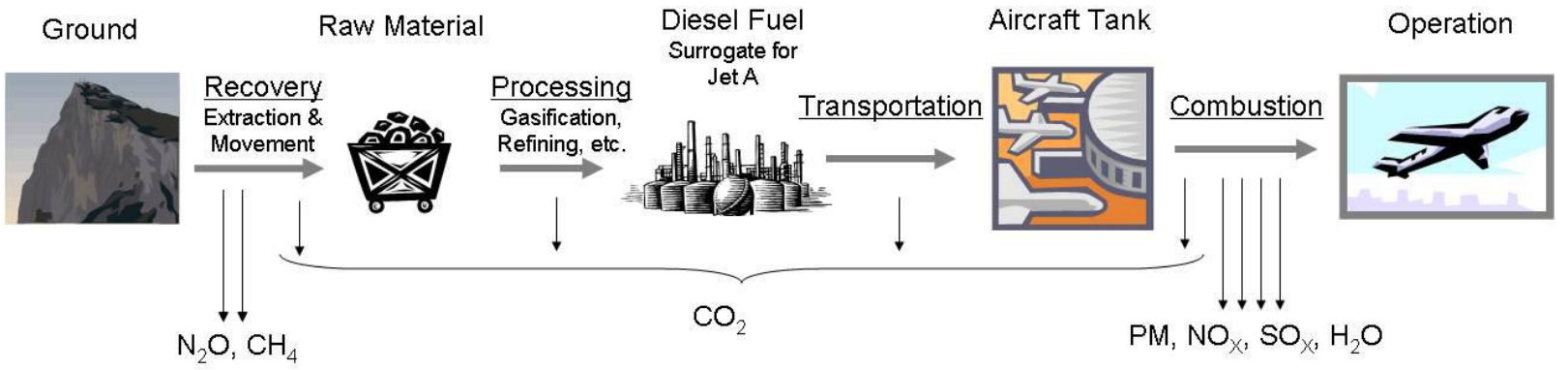
Results showing observed reductions in primary PM in a CFM56-7B engine burning a mixture of 50% F-T fuel and 50% Jet A-1 (PARTNER Center of Excellence)



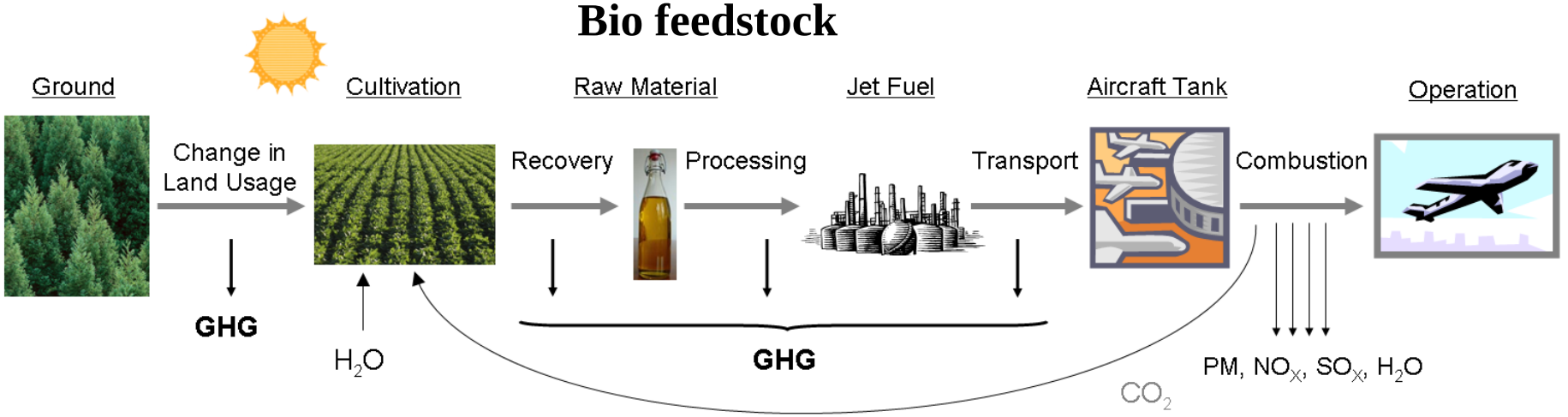
Environment: Life Cycle Analysis (LCA)

Need to determine "well-to-wake" life-cycle emissions

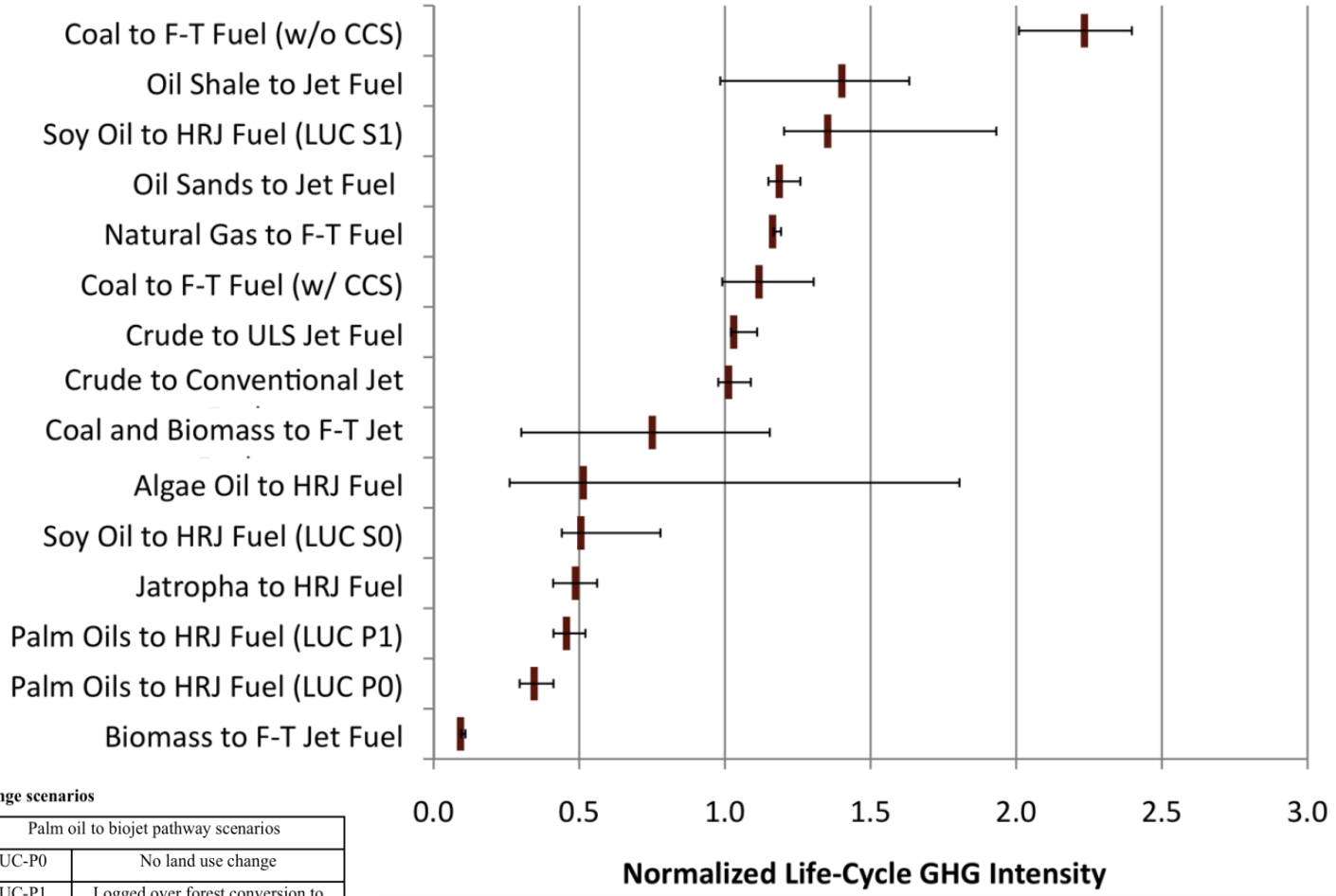
Fossil feedstock



Bio feedstock



Environment: Quantifying LCA Uncertainties



Land use change scenarios

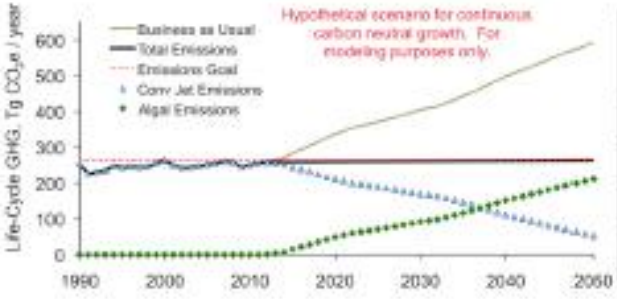
Soy oil to biojet pathway scenarios		Palm oil to biojet pathway scenarios	
LUC-S0	No land use change	LUC-P0	No land use change
LUC-S1	Grassland conversion to soybean field	LUC-P1	Logged over forest conversion to palm plantation field
LUC-S2	World wide conversion of non-cropland	LUC-P2	Tropical rainforest conversion to palm plantation field
LUC-S3	Tropical rainforest conversion to soybean field	LUC-P3	Peatland rainforest conversion to palm plantation field

Chart courtesy of J. Hileman, MIT

Environment: Biomass Needs for 2050 Carbon Neutrality

- Assessed potential for carbon neutral growth from 2000 to 2050.
- Palm and soy unable to meet needs for a carbon neutral growth.
- CBTL w/ CCS and 25% biomass usage unable to meet carbon neutrality past 2021.
- Algal biojet (HRJ) presents opportunity for carbon neutral growth past 2050.
- Expanding feedstock options to consider jatropha and multiple feedstock solutions.

Need feedstocks with high yield and low life-cycle emissions that do not require arable land.



Fuel Source	Alternative Fuel Use as % of Total Use	Percent of Target Emissions
CBTL[1]	100%	167%
Algae	91%	100%
Soybeans[1]	100%	109%
Palm[1]	82%	100%

Alternative Fuel Land Requirements Compared to the United States in 2050

Notes:

Assumed no land use change emissions with all of the feedstocks.

Land areas are given relative to continental U.S. for illustrative purposes (e.g., palm trees do not grow in Illinois).

Source: GIACC/3-IP/4 (2009). Subject to modification.
Recall that corn stover is also used for diesel production.

Chart courtesy of J. Hileman, MIT

Business: Facilitating a Future Market

Morgan Stanley
OPIS (Oil Pricing)
Solarc (Taxes)

Colonial Pipeline
Magellan Pipeline
Kinder Morgan

Potential Funding Sources

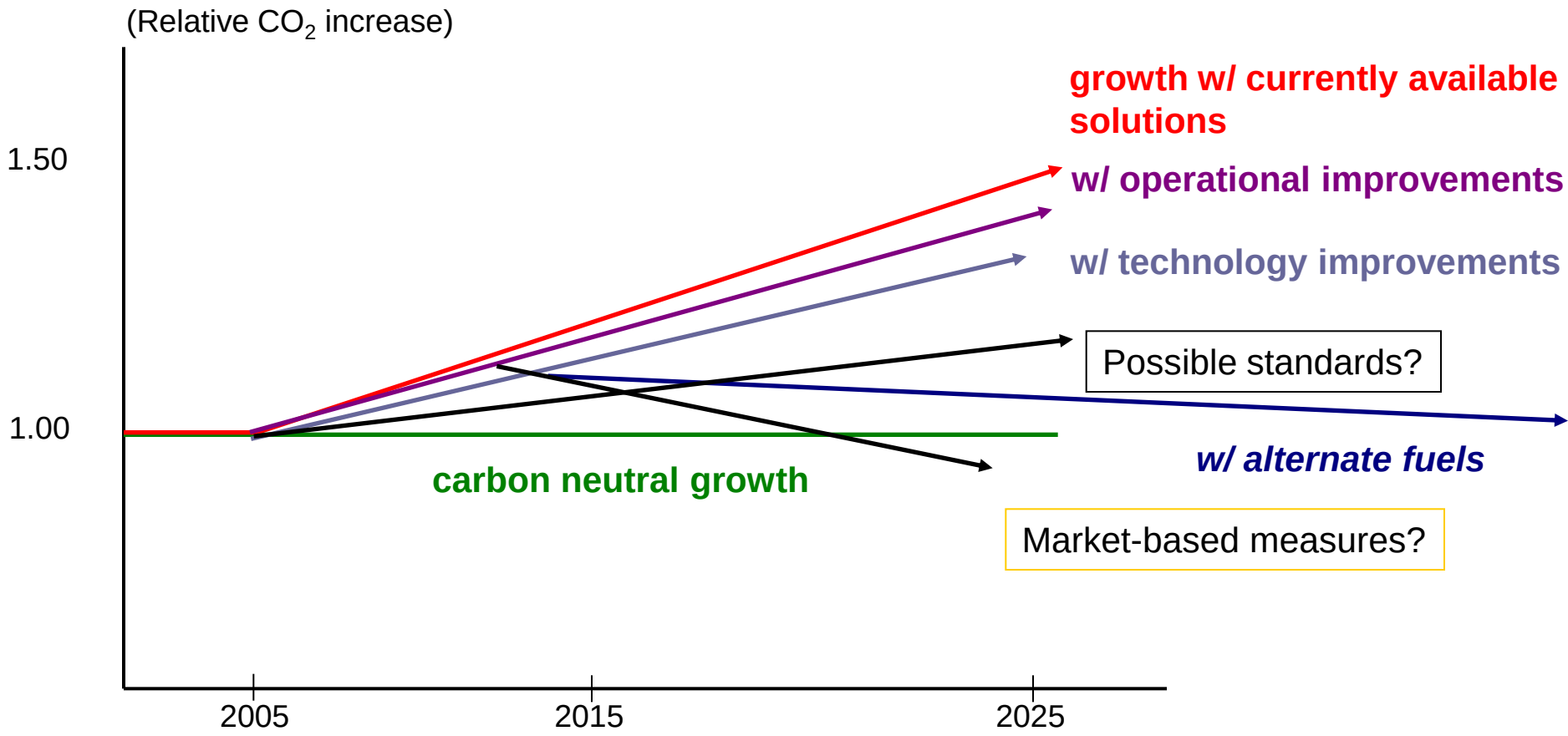
Alt Fuel Producers

A2BE Carbon Capture
Adv Bio-Energy Tech's
Agromass Biofuels
Air BP
Amyris Biotech
Baard Energy
Chevron
ConocoPhillips
Neste Oil
SASOL
Shell
Solazyme
SolArc
PetroSA
Syntroleum
UOP

Airlines & Operators

ATA
ALPA
Alaska
American
Continenta
Delta
FedEx
Airbus
Boeing
JetB
NetJ
Northwest
Southwest
Star Alliance
United
US Airways
UPS
Airbus
Boeing
GE
PW

U.S. Strategy to Reduce Aviation's Carbon Footprint



Closing Thoughts

- **Aviation dependent on hydrocarbon based liquid fuels**
- **Concentrated Airport Distribution allows rapid deployment (80% of fuel in 35 locations in U.S.)**
- **Timely Fuel Certification crucial for market**
- **Establishing GHG LCA crucial for decisions (policy and investment)**
- **Alternative fuels are technically feasible but need to get to deployment**
- **CAAFI helping to bring these pieces together**
- **ICAO key to global harmonization**