

GREENING U.S. AVIATION



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Initiative (CAAIFI)*

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**ACT>>>
GLOBAL**

ICAO: UNITING AVIATION ON CLIMATE CHANGE

ICAO Colloquium on Aviation and Climate Change

GREENING U.S. AVIATION

The Challenge:

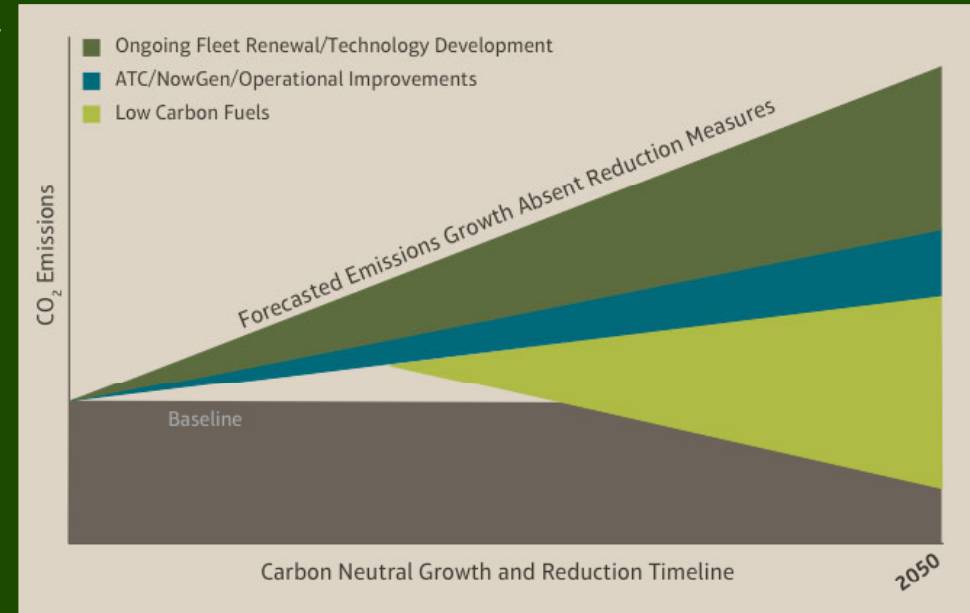
- *Enable increased mobility while reducing environmental impacts in absolute terms*

The Solution - U.S. five-pillar approach

- Mature New Aircraft Technology
- Accelerate Operational Changes
- **Develop Alternative Fuels**
- Examine Policies and Market Based Measures
- Advance Scientific Understanding, Improve Environmental Analysis Capability

Our Plans

- Aggressive efficiency improvements of at least 2% per year
- Carbon neutral growth by 2020, absolute reductions by 2050
- Aircraft and engine CO₂ and other emissions standards



Alternative Fuels



GREENING U.S. AVIATION

Can alternative fuels provide aviation with a sustainable source of energy to power both the fleet of today and that of tomorrow?

WHY AVIATION ALTERNATIVE FUELS?

- Aviation assured market for hydrocarbon liquid fuels
- Environmental need
- Concentrated airport distribution
- Aviation systems engineering/risk management experience
- Single ICAO regulatory environmental framework to ensure Global standards
- Committed industry and government investments to test and qualify viable alternative fuels candidates
- Strong leadership from the industry

WHAT HAVE WE ACHIEVED RECENTLY?

- Developed advanced biofuels that are safe for aviation and could be grown in a sustainable manner
- Approval of a new synthetic jet fuel specification (ASTM D7566) —
 - Fisher-Tropsch alternatives now approved
 - hydroprocessed renewable jet (HRJ) expected soon
- Multiple flights on these fuels

Commercial Aviation Alternative Fuels Initiative (CAAFI)

- Coalition of airlines, aircraft and engine manufacturers, energy producers, researchers, international participant, and U.S. government agencies
- Leading development and deployment of alternative jet fuels for commercial aviation



CAAIFI

Members

Consultants
Universities
Think Tanks

Aircraft OEMs

Aircraft Engine
OEMs

Aircraft
Equip Cos

NRC
Canada

ANP Brazil

Bauhaus

UK MoD

NIST

NASA

DESC

USAF

US Army

DARPA

USN

USDA

DOE

DOC

EPA

Energy
Companies

Bio-Fuels
Companies

Oil
Companies

CRC

ASTM

Airport
Operators

ALPA

Airlines

Air Cargo

NetJets

IATA

**Federal Aviation
Administration**

FAA

ATA

**Air Transport
Association**

ACI-NA

**Airports Council
International –
North America**

**Aerospace
Industries
Association**

AIA

CAAIFI

Sponsors



CAAFI COMPREHENSIVE APPROACH

Structure addresses challenges to adoption

Environmental Team

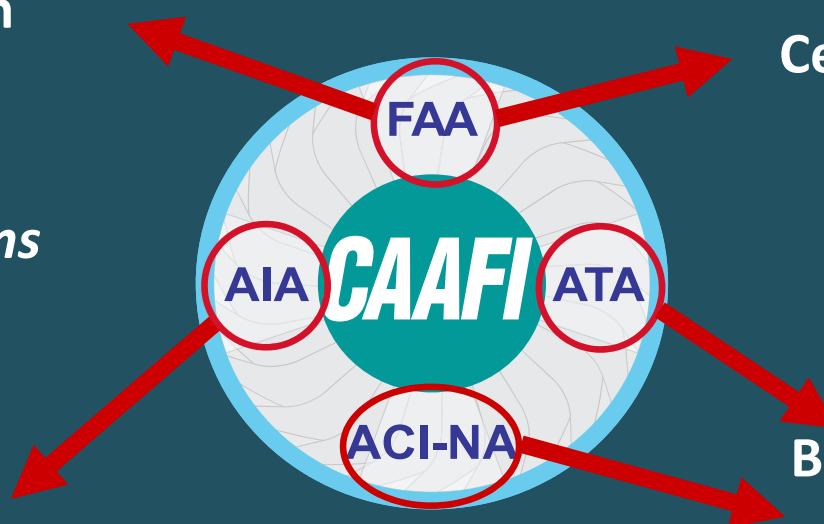


*GHG Life Cycle
Analyses, Emissions
Quantification*

R&D Team



*Multiple "Drop-
in" Solutions*



Certification-Qualification
Team



ASTM D7566

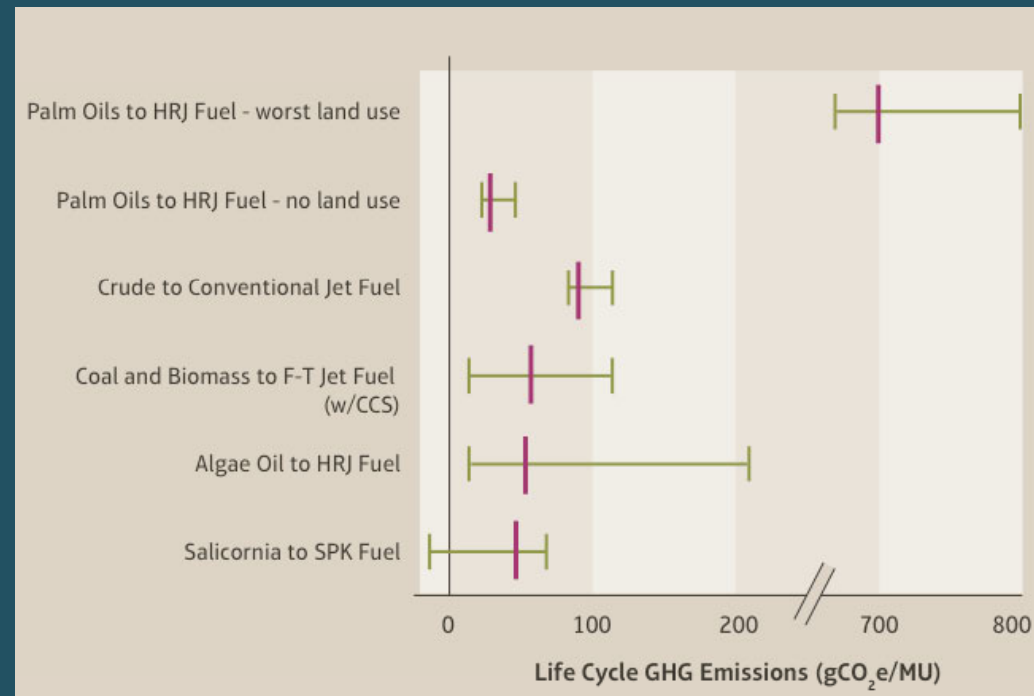
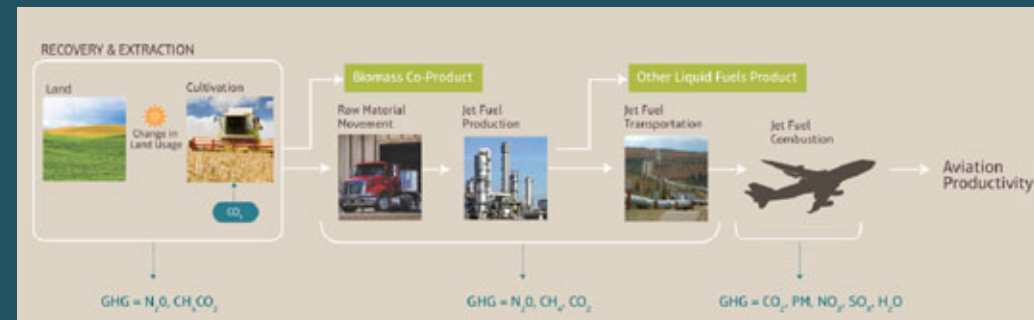
Business & Economics
Team



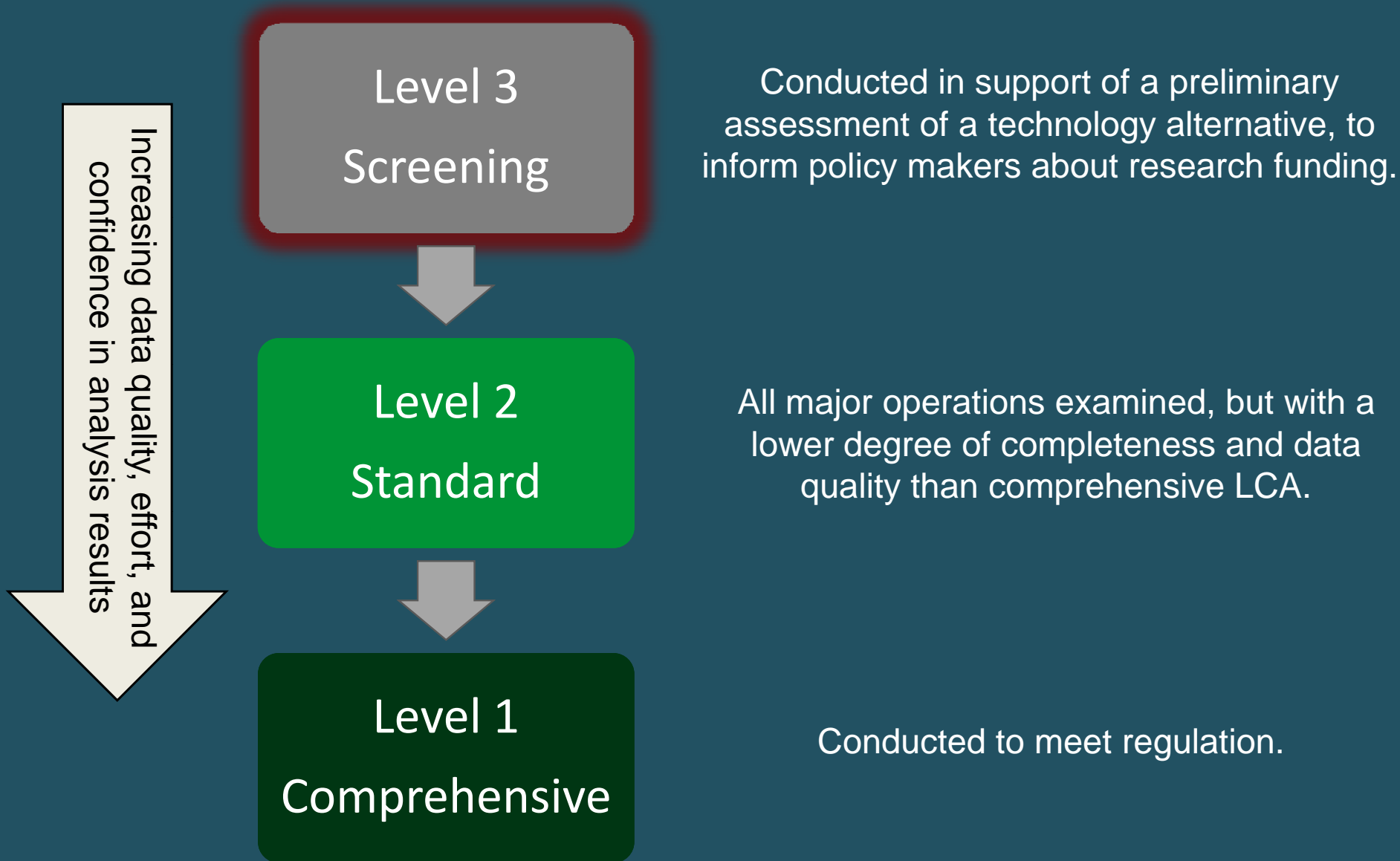
*Facilitating
Deployment,
Investment*

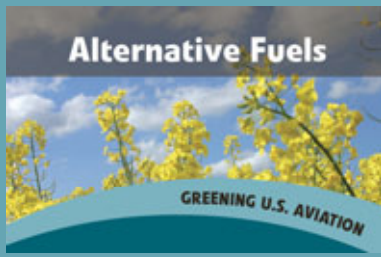
WHAT ARE WE DOING NOW?

- Researchers measuring “well-to-wake” lifecycle GHG emissions
- Purchasing of fuels from camelina and algae for more extensive testing
- Properties testing for early R&D fuels
- Considerable capital devoted to developing new biofuels
- Airline fuel purchasing agreements for renewable diesel, and alternative jet fuels

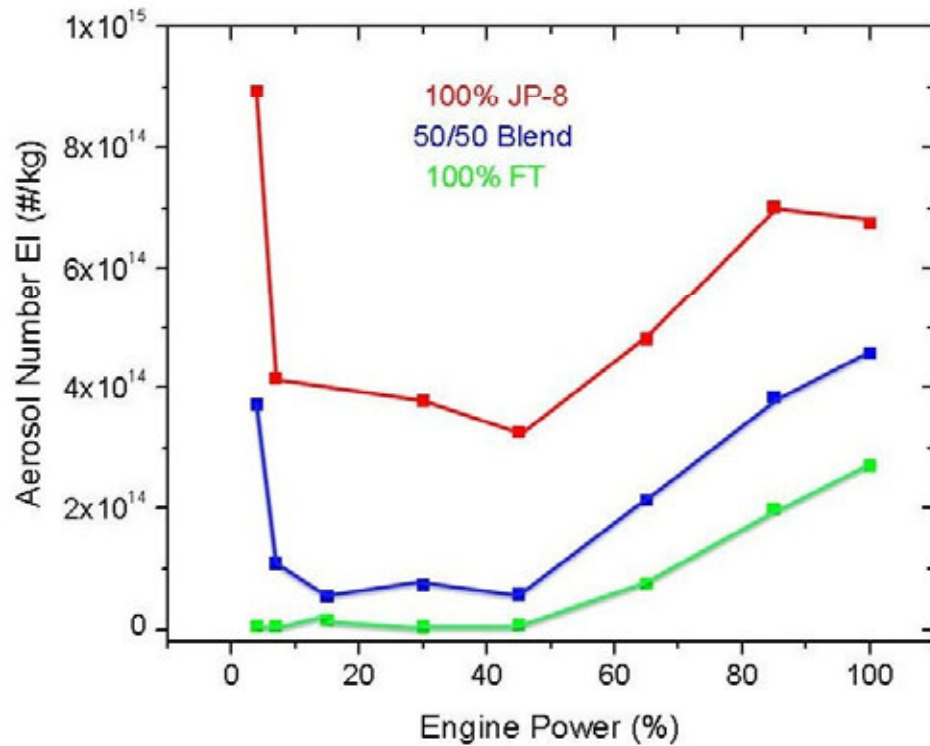


LIFE CYCLE ANALYSES RESOLUTION LEVELS

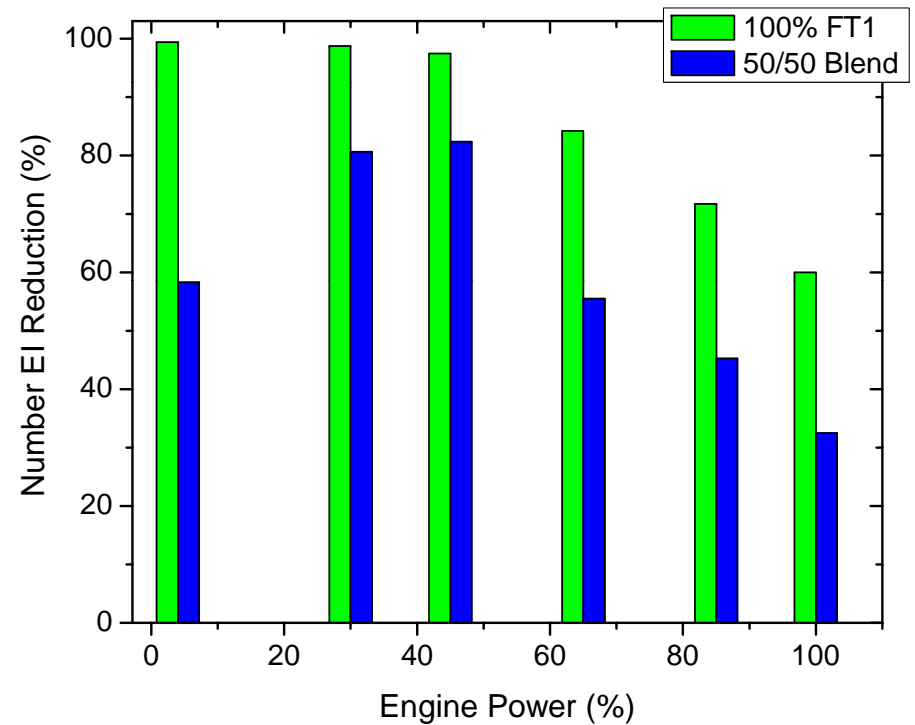




LIFE CYCLE ANALYSES ALSO INCLUDES AIR QUALITY BENEFITS (1)



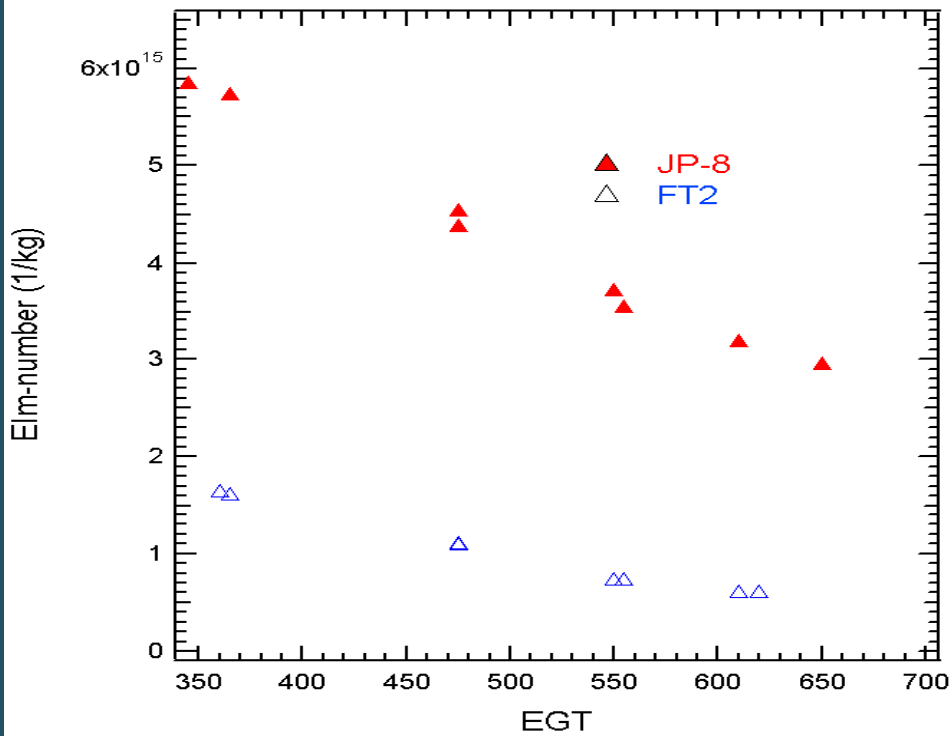
Differences in emissions greatest at idle, less at higher engine powers



Number emissions 98% lower at idle, 40% at takeoff power
Emission reduction

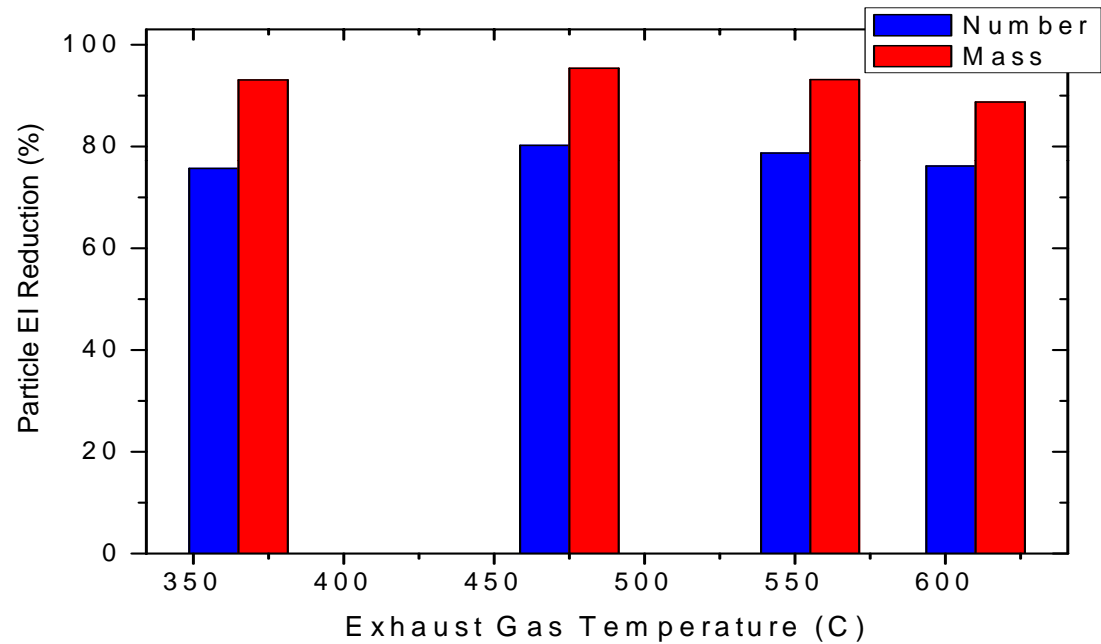


LIFE CYCLE ANALYSES ALSO INCLUDES AIR QUALITY BENEFITS (2)



- Mass emissions 90% lower when burning FT fuel
- Number emissions ~70% lower when burning FT fuel

** FT2 = Sasol (coal)

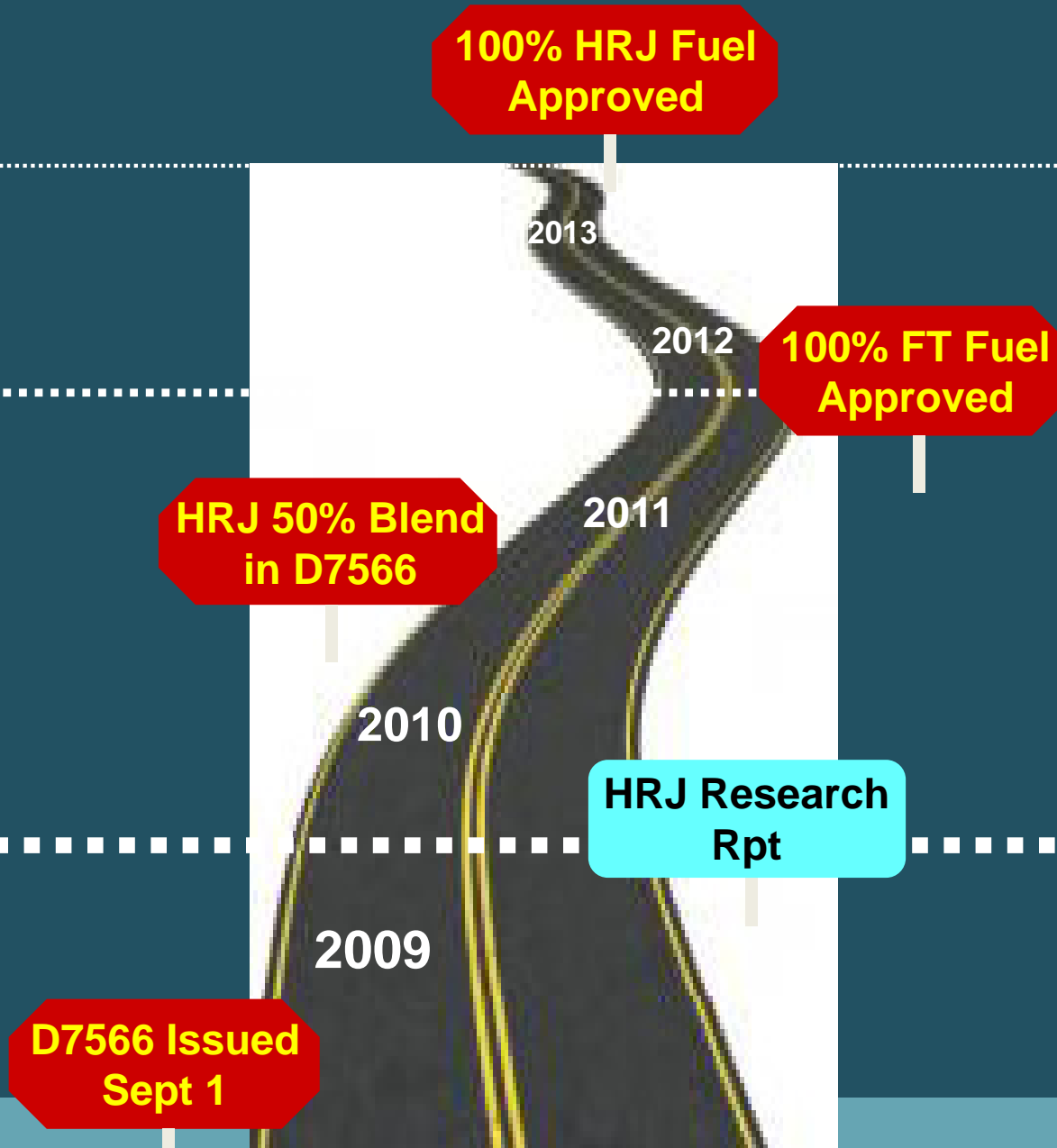


Recent Air Quality Results: APU Emissions

IMPORTANCE OF QUALIFICATION AND CERTIFICATION

- Establishes standardized specifications for control of aviation fuel properties and composition.
- Industry uses specifications for quality control of aviation fuel as it travels through the distribution system.
- Civil Airworthiness Authorities (CAAs) use fuel specifications to ensure the safety of aircraft operations.

TARGETED QUALIFICATION TIMING

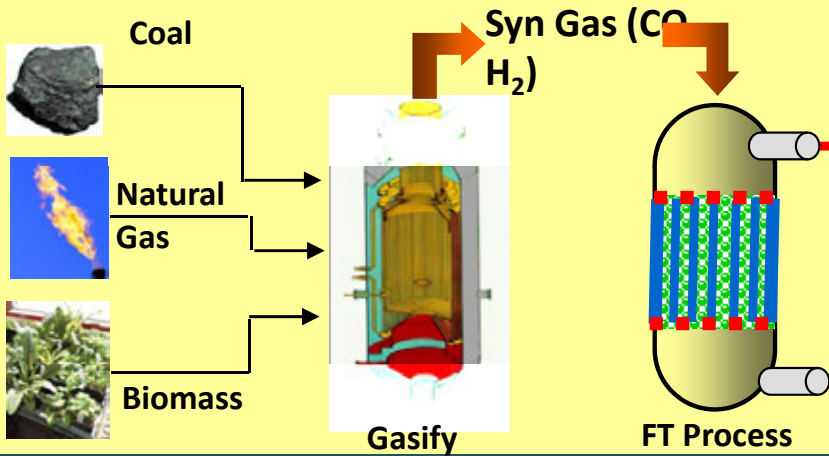


CURRENT ALTERNATIVE JET FUEL PROCESSING

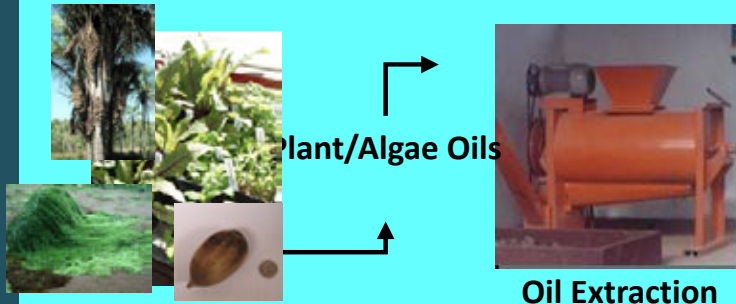
Petroleum



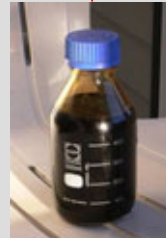
Fischer-Tropsch (FT)



Hydroprocessed Renewable Jet (HRJ) from Bio-Oils



Conventional Refinery Processes



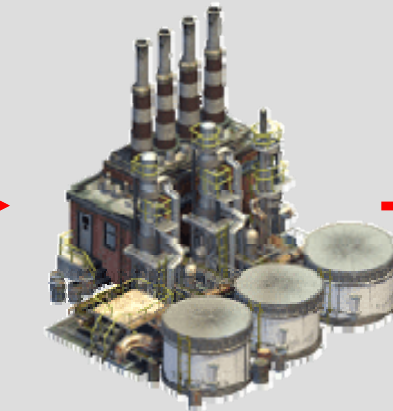
Crude Oil



Syn-Crude



Bio-Crude



Hydroprocessing

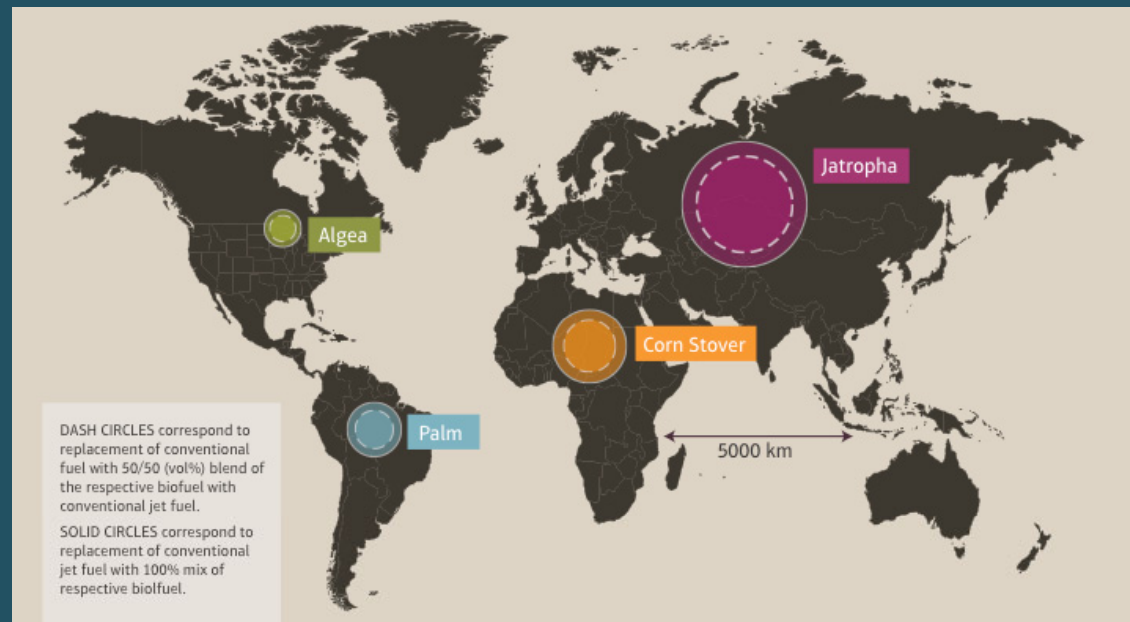


Jet Fuel

WHAT IS COMING NEXT?

- Sustainable biofuels avoid competition for food and fresh water
- Advanced bio-based jet fuels from camelina, jatropha pave the way
- Bio-based synthetic fuels with coal and carbon capture and sequestration could reduce GHG emissions and be cost-competitive
- Salicornia to synthetic fuel could be grown in the desert with sea water
- Sugars/cellulose to synthetic fuels via advanced fermentation
- Algae holds tremendous potential

Technology exists to create alternative jet fuels compatible with today's aircraft; Fuel feedstocks being evaluated to determine their environmental sustainability.





ALTERNATIVE FUELS GLOBAL POTENTIAL

USA

camelina

Caribbean

jatropha

Brazil

*Macauba,
babassu,
sugarcane*

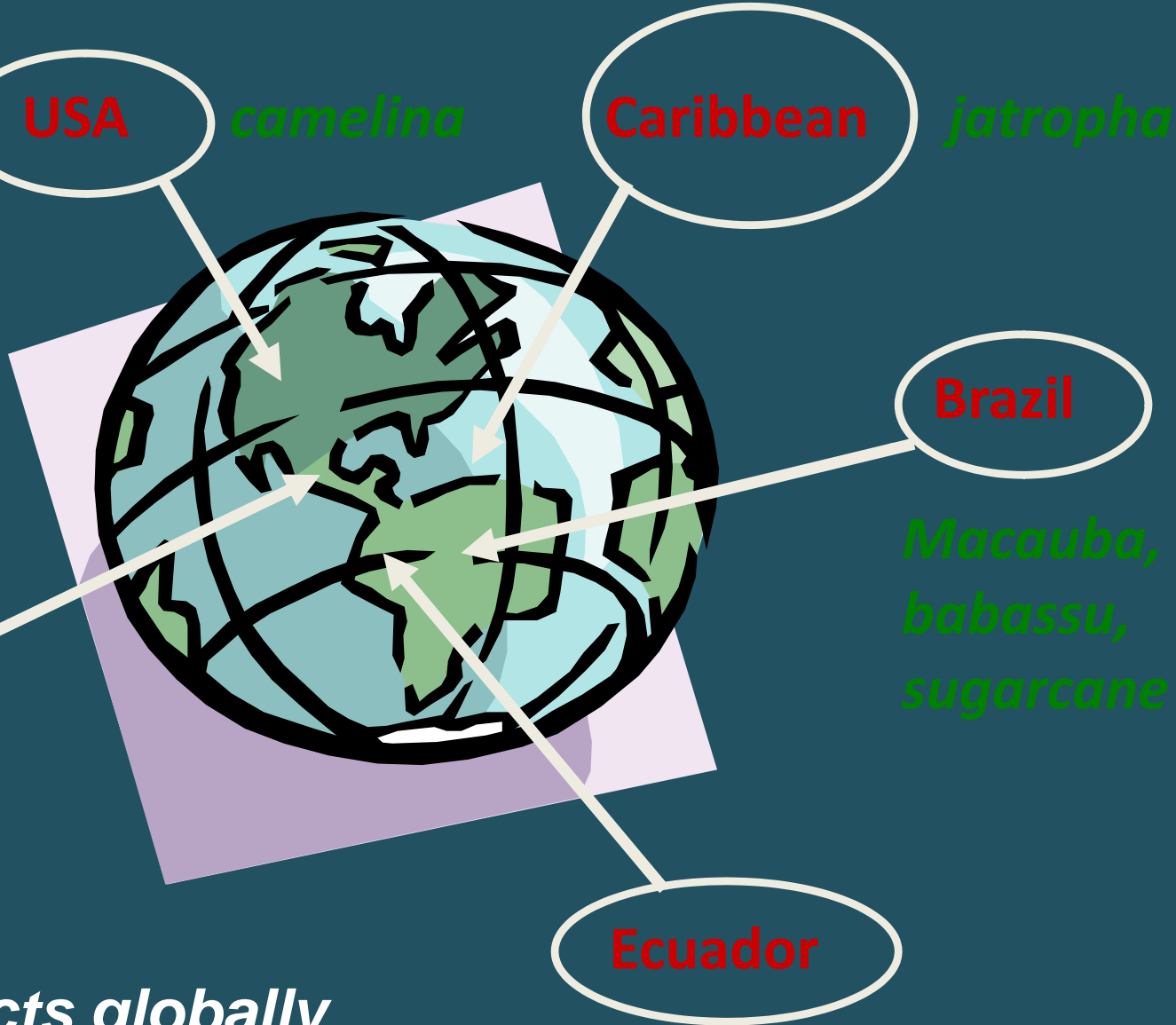
Mexico

*salicornia,
jatropha*

Ecuador

*For starter in
Latin America via
Inter-American
Development
Bank*

Target +10 projects globally



A NEW SUSTAINABLE FUEL DYNAMIC

...EMERGING, GROWING

