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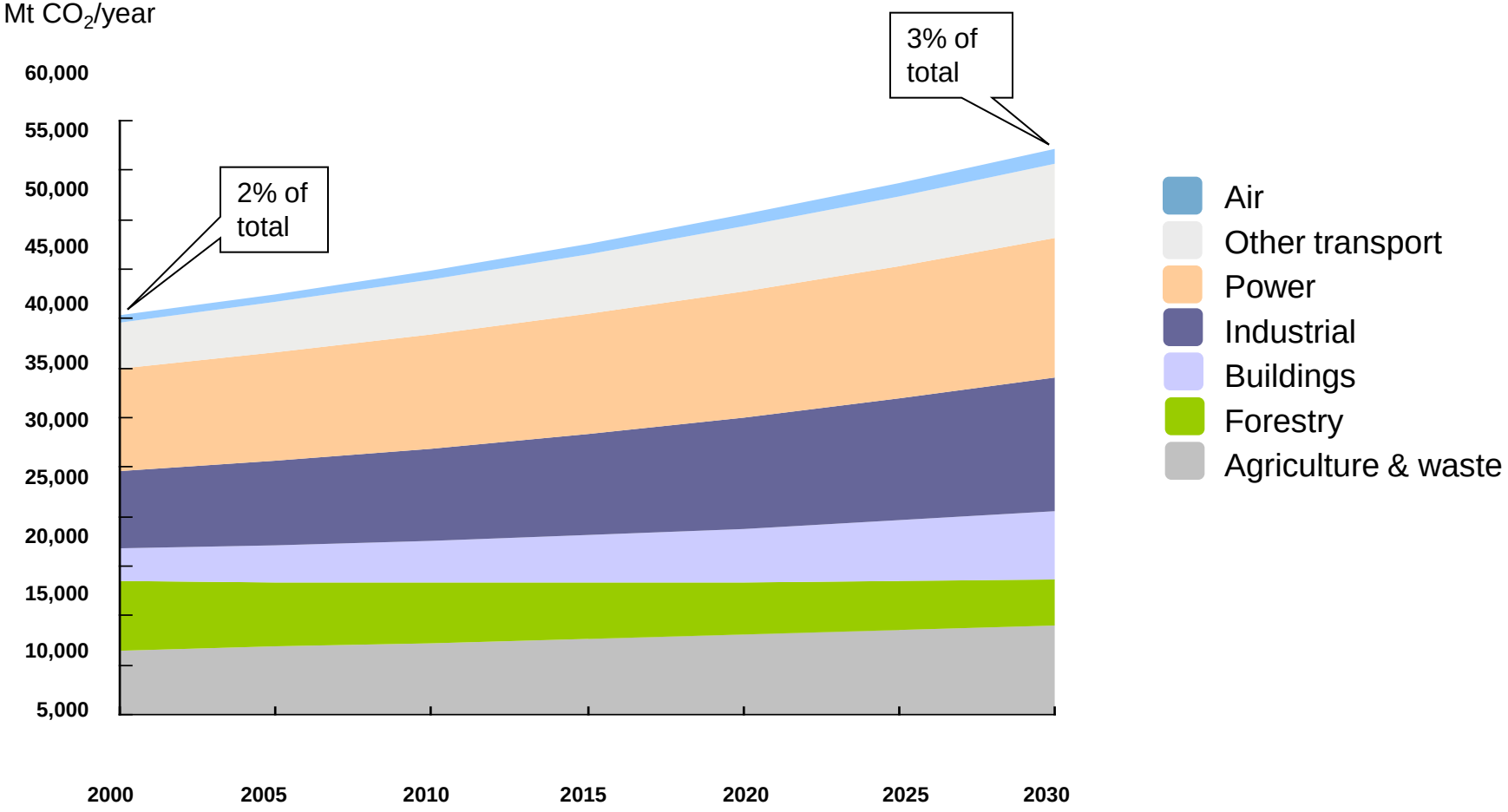
Aviation and the Environment

Opportunities and Challenges
Special Focus on Sustainable Biofuels

Aviation: currently small, but without further action – CO_2 emissions will increase

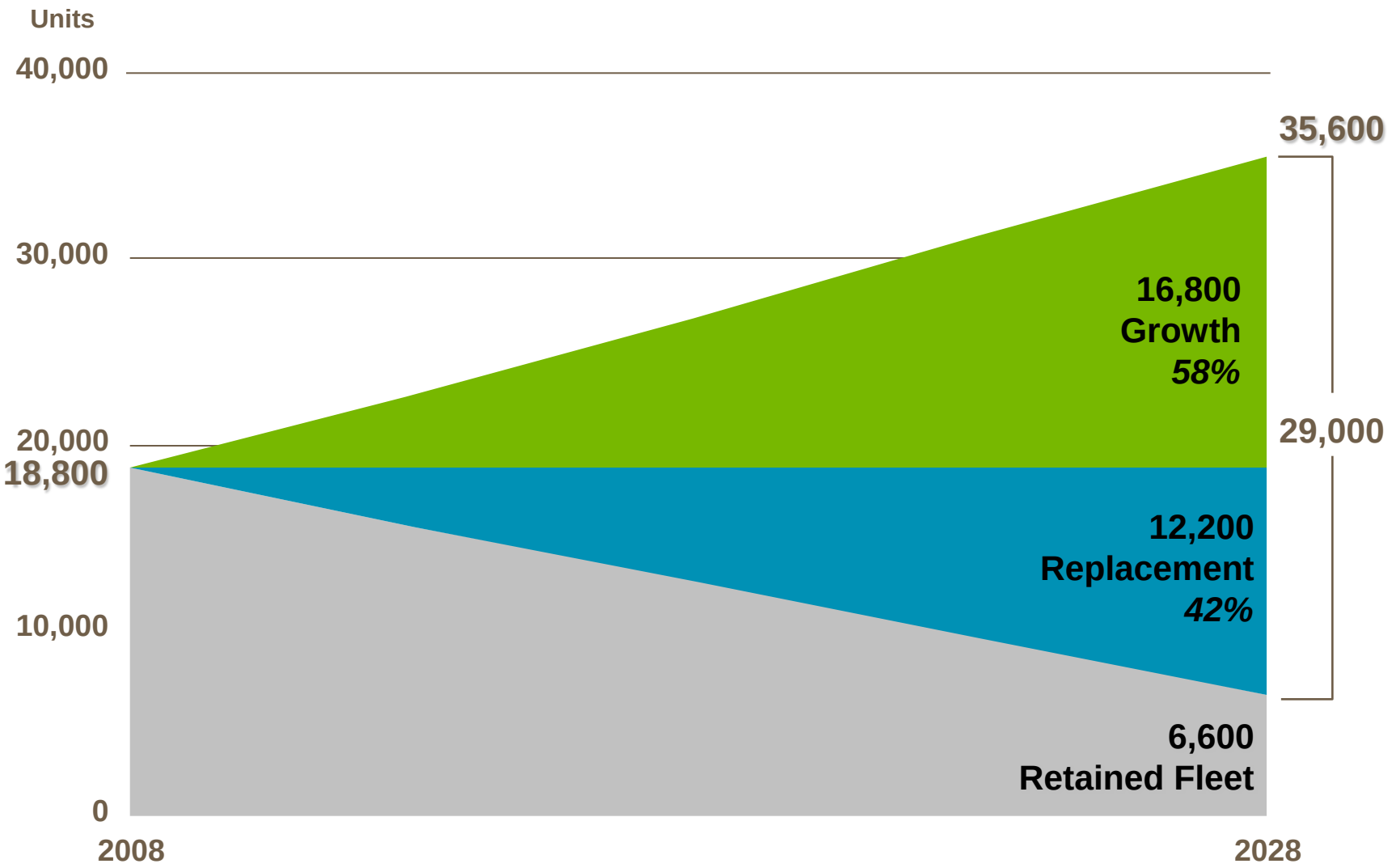
Emissions by sector, 2000-2030

Mt CO_2/year



Source: McKinsey & Co. /WBCSD Mobility 2030 model; IPCC

Older, less efficient airplanes will be replaced with more efficient, newer generation airplanes



The industry is committed to action on climate change

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.

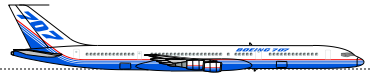
We strongly encourage others to join us in this endeavour.

IATA · AIRBUS · BOEING · BOMBARDIER · EMBRAER · Rolls-Royce · Pratt & Whitney

"…we are committed to a pathway to carbon-neutral growth and aspire to a carbon-free future."

– ATAG 2008 industry declaration for action on climate change

Building on a strong track record



Early Jet Airplanes

MORE FUEL

Relative fuel use

LESS FUEL

EVEN LESS

HIGHER DECIBELS

Noise dB

LOWER DECIBELS

EVEN LOWER

90% Reduction in Noise Footprint

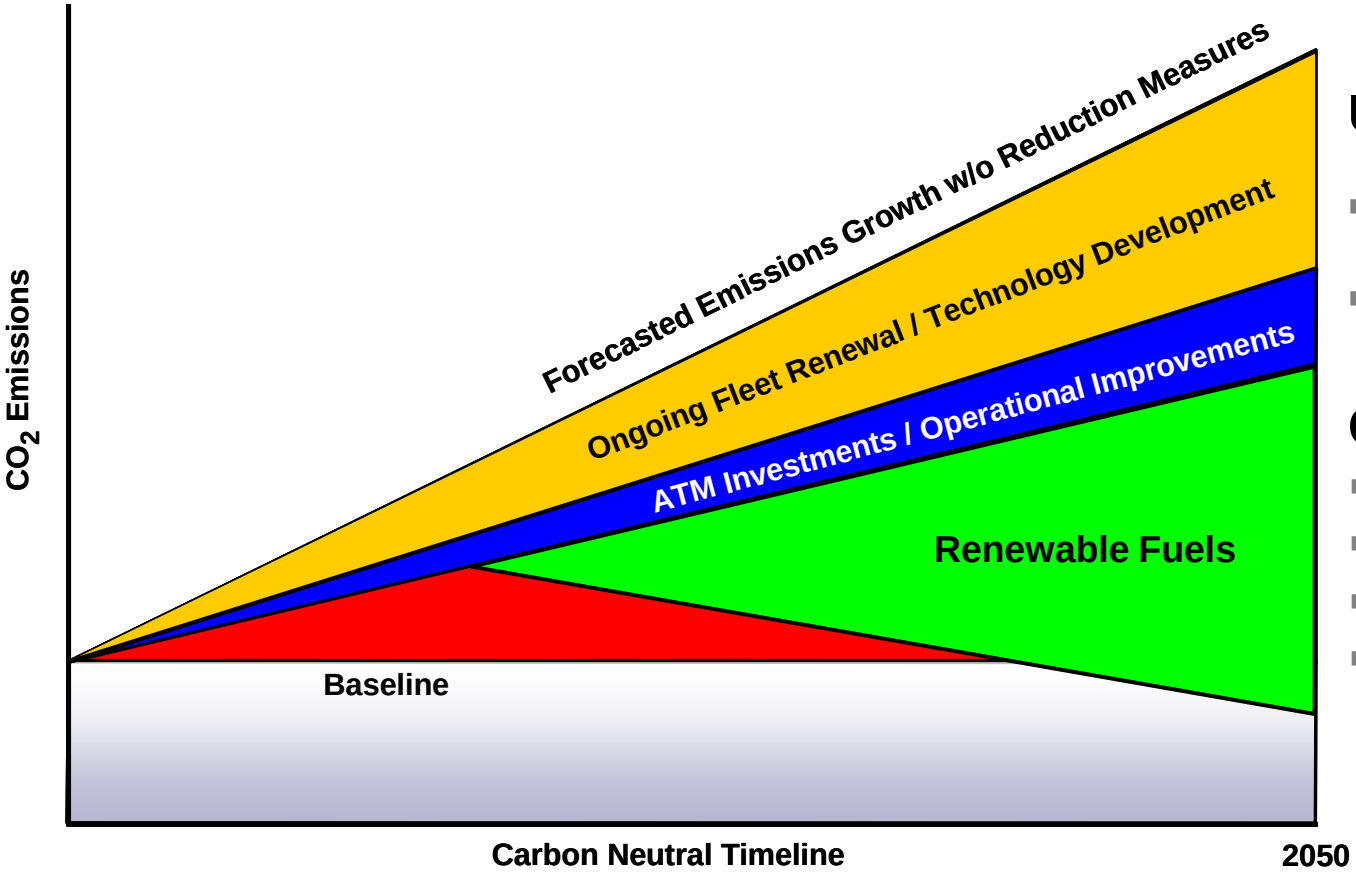
70% Fuel Improvement and Reduced CO_2

New Generation Jet Airplanes

1950s → 1990s

Noise footprint based on 85 dBa.

Key drivers of emissions reductions



Using less fuel

- Efficient airplanes
- Operational efficiency

Changing the fuel

- Lower lifecycle CO_2
- Sustainable
- No infrastructure mods
- "Sustainable Biofuels"

Presented to ICAO GIACC/3 February 2009 by Paul Steele on behalf of ACI, CANSO, IATA and ICCAIA

Sustainable Biofuels are an essential enabler to continued growth

Main Categories of Alternative Fuels

Fossil Fuels	1st Generation Biofuels	2nd Generation Biofuels
		
Opportunities		
• Significant supplies • Proven technology	• Steady supply • Public policy support	• Lower lifecycle CO_2 • Avoids “food for fuel” • Regional solutions
Challenges		
• Capital costs • Energy, water intensive • CCS tech. not mature	• Competes with food • Airplane compatibility	• Supply chain not mature • Costs near-term

We are focusing our efforts on sustainable biofuels

The alternative fuel must work within the existing aviation infrastructure

- Meets fuel performance requirements
- Requires NO change to airplanes or engines
- Requires NO change to infrastructure
- Can be mixed or alternated with Jet-A fuel

Sustainable biofuel supply chain overview

Commercial viability threshold requirements:

- ☑ Sustainability principles established
- ☑ Sustainability practices and auditing
- ☑ Technology/agronomy in place
- ☑ Fuel processing technology in place
- ☑ Viable feedstock and processing developers in place

3 – 5 years

Feedstock project

Biofuel processing project

Biofuel delivery infrastructure

Airline use

Candidate Sustainable Biofuel Feedstocks

Camelina
Ready Now

Challenges

- **Limited total yield**
- **Tied to grain markets**

Jatropha
Ready in 2 to 4 years

Challenges

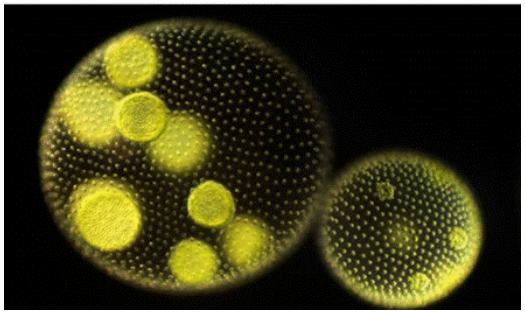
- **Warm climates only**
- **Manual harvest today**

Halophytes
Ready in 2 to 4 years

Challenges

- **Prove at scale**
- **Optimize agronomy**

Algae
Ready in 8 to 10 years



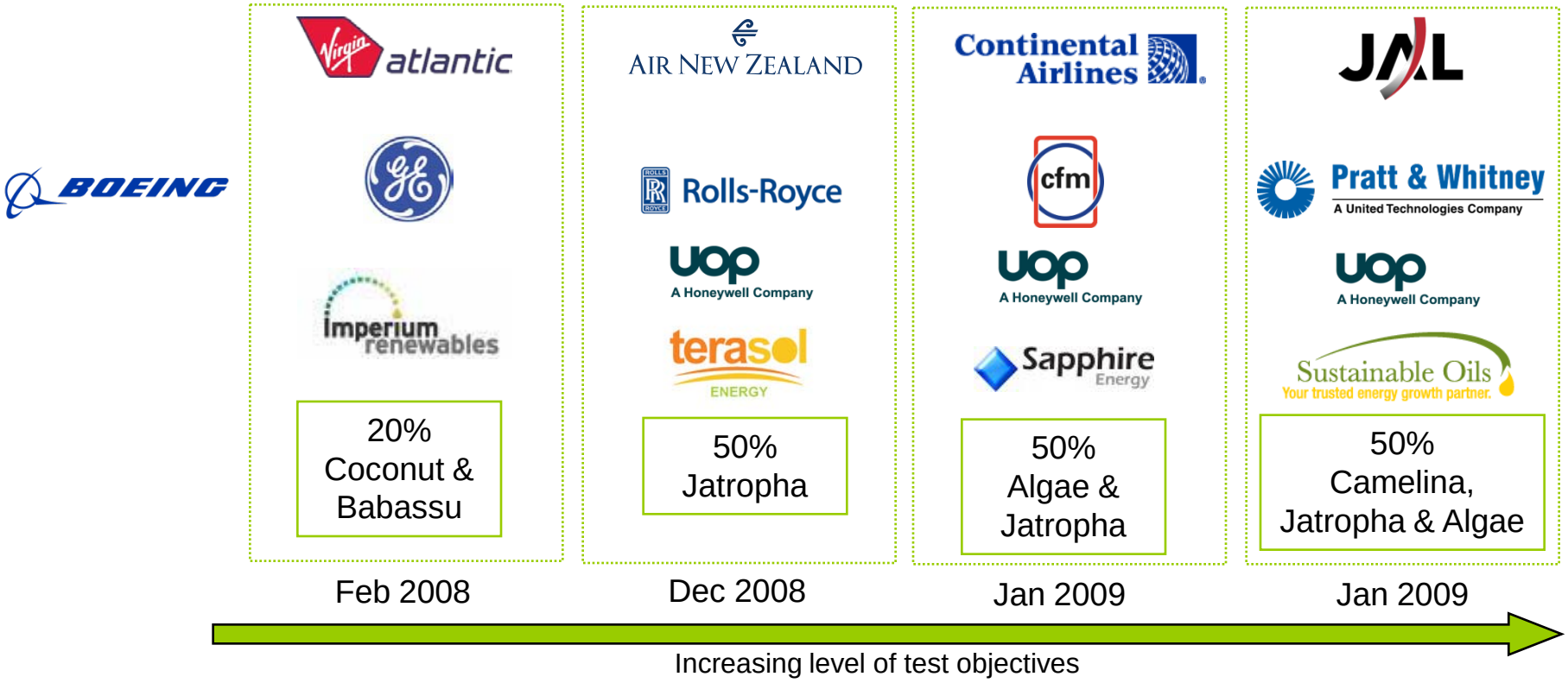
Challenges

- **Bio-optimization**
- **Competing approaches**
- **Processing costs**

Viability based on timing, technology and local resources

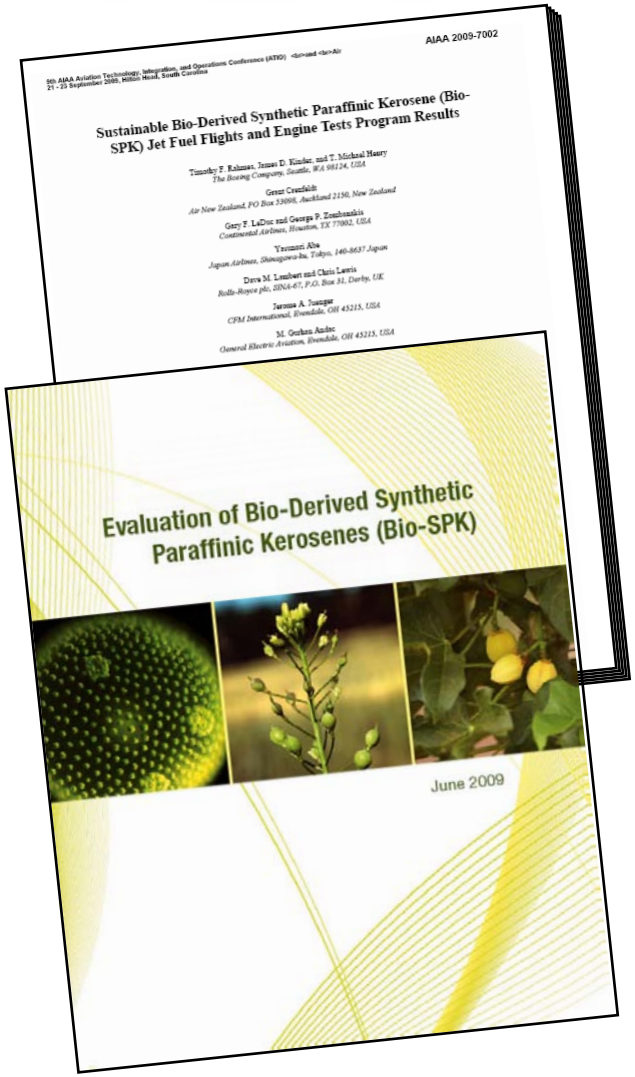
Four Flight Tests Have Been Completed

- Demonstrated technical feasibility
- Identified sustainable biofuel sources
- Promoted development of viable commercial markets
- Demonstrated diverse engine / airframe combinations



Test program demonstrated biofuel viability

We Have Published Biofuel Test Results



- **Paris Air Show executive summary – Jun ‘09**
- **AIAA technical conference – Sep ‘09**
- **Full Research Report – Mar ‘10**

- **Excellent fuel properties**
  - **Lower freeze point**
  - **Higher thermal stability**
  - **Higher energy content**

- **Targeting fuels approval in late 2010**

All tests either met or exceeded expectations – fuel is superior

Commercial efforts underway via Sustainable Aviation Fuel User Group

GOAL: To help speed the creation of a viable market mechanism for sustainable biofuels.

Members are using power of their fuel spending dollars to ensure sustainability of future aviation fuels

- ☑Sustainability principle and monitoring in place
- ☑Technology/agronomy in place
- ☑Fuel processing technology in place
- ☑Viable feedstock and processing developers in place

www.safug.org

Sustainable biofuels strategy

Enable the industry to achieve market viability– by 2015

Success Criteria

- 600+ million gallons/yr of bio content
- 5-10 feedstock/fuel production projects

Five Focus Areas

Fuels Approval

Feedstock Viability

Airport Infrastructure

Commercial Production

Support and Advocacy

Act as catalyst to accelerate broad commercialization

A Global Program of Sustainable Aviation Biofuel Projects

- Finding effective regional solutions
- Airline led initiatives supported by Boeing and stakeholders
- Connecting global teams to share best practice from regions

Summary

- Growing industry, small relative CO_2 footprint
- Ability to grow threatened
- Company and industry commitment to action
- Fuel is the priority focus for CO_2 emissions reduction
  - Fuel efficiency will continue to drive technology
  - New opportunity – sustainable biofuels

Sustainable Biofuels – great start, rapid progress, long journey

We are committed to a better future

THANK YOU