

Presented by

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Alternative Fuels

Targeting carbon-neutral aircraft operations
Farnborough Airshow

Eco-Efficient Aviation



- Aviation needs to flourish with reduced environmental impact
- Aviation is necessary for development

Facts:

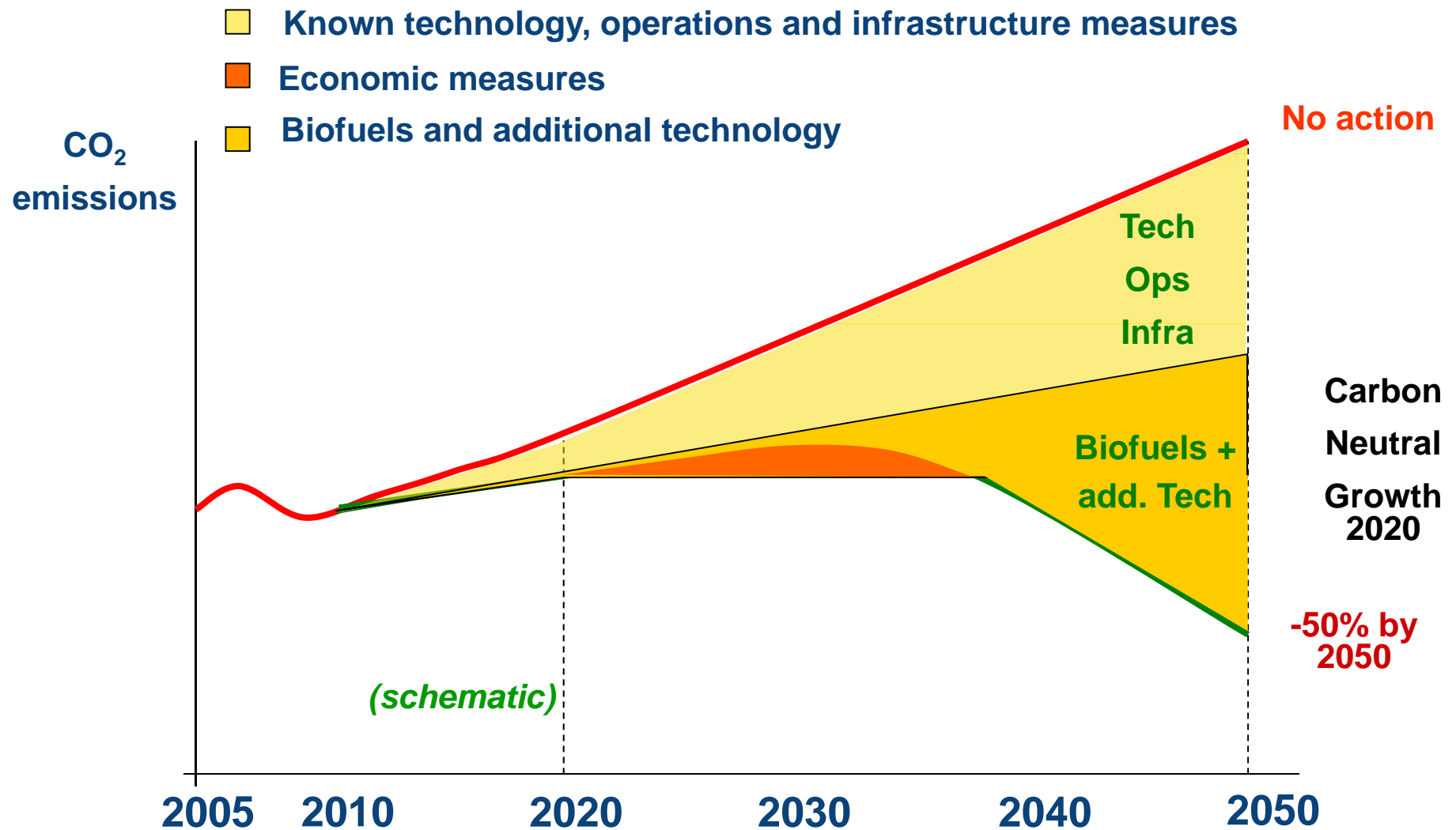
- 8% Global GDP
- 2% man made CO₂ emissions
- Over 40 years the focus on innovation has lead to
 - ▶ 70% reduced aviation fuel consumption and related CO₂ emissions

Targets:

- Carbon Neutral growth by 2020
- 50% CO₂ reductions by 2050 compared to 2005

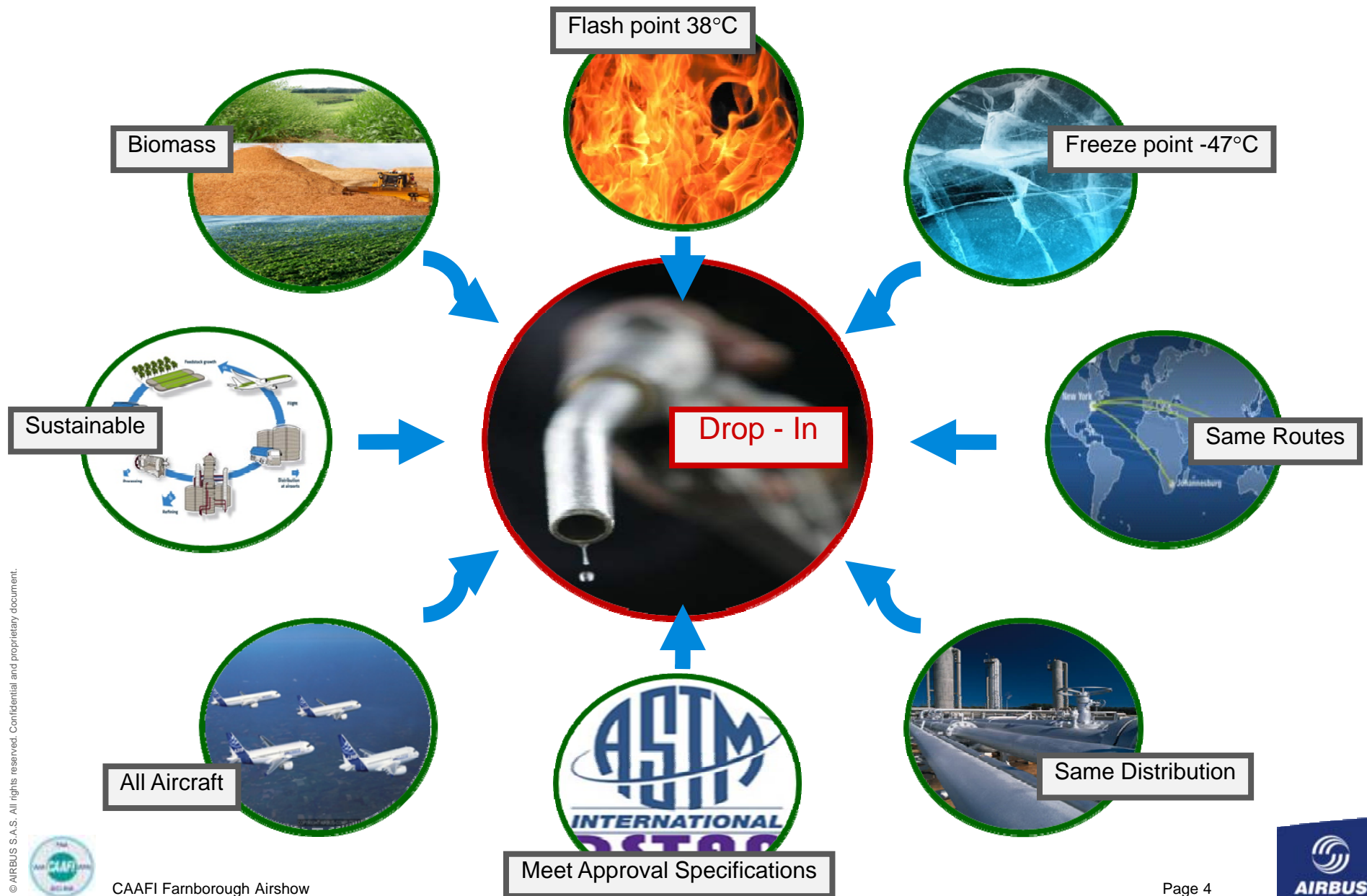
Sustainable Aviation Growth with Environmental targets

Challenge: Emissions reduction roadmap



Strategic approaches to reducing CO2 emissions

What are alternative fuels for Airbus Short / Mid Term



Background: *Short/Medium Term Requirement*



- Use existing airport fuel storage
- Common aviation fuel distribution network
- With common piping and transport infrastructure / mechanisms



- Any alternative should be “drop-in”
.....and mixable with fossil fuel

A “Drop-in” solution is required

What are the alternative fuels?

Potential sustainable feedstocks



Algae



Jatropha



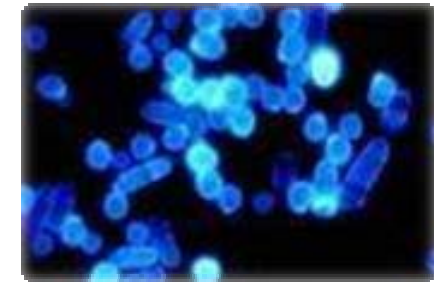
Wood waste



Salicornia









Camelina



Yeast

Multi options in different locations

Alternative Fuels Options Commercial Aviation

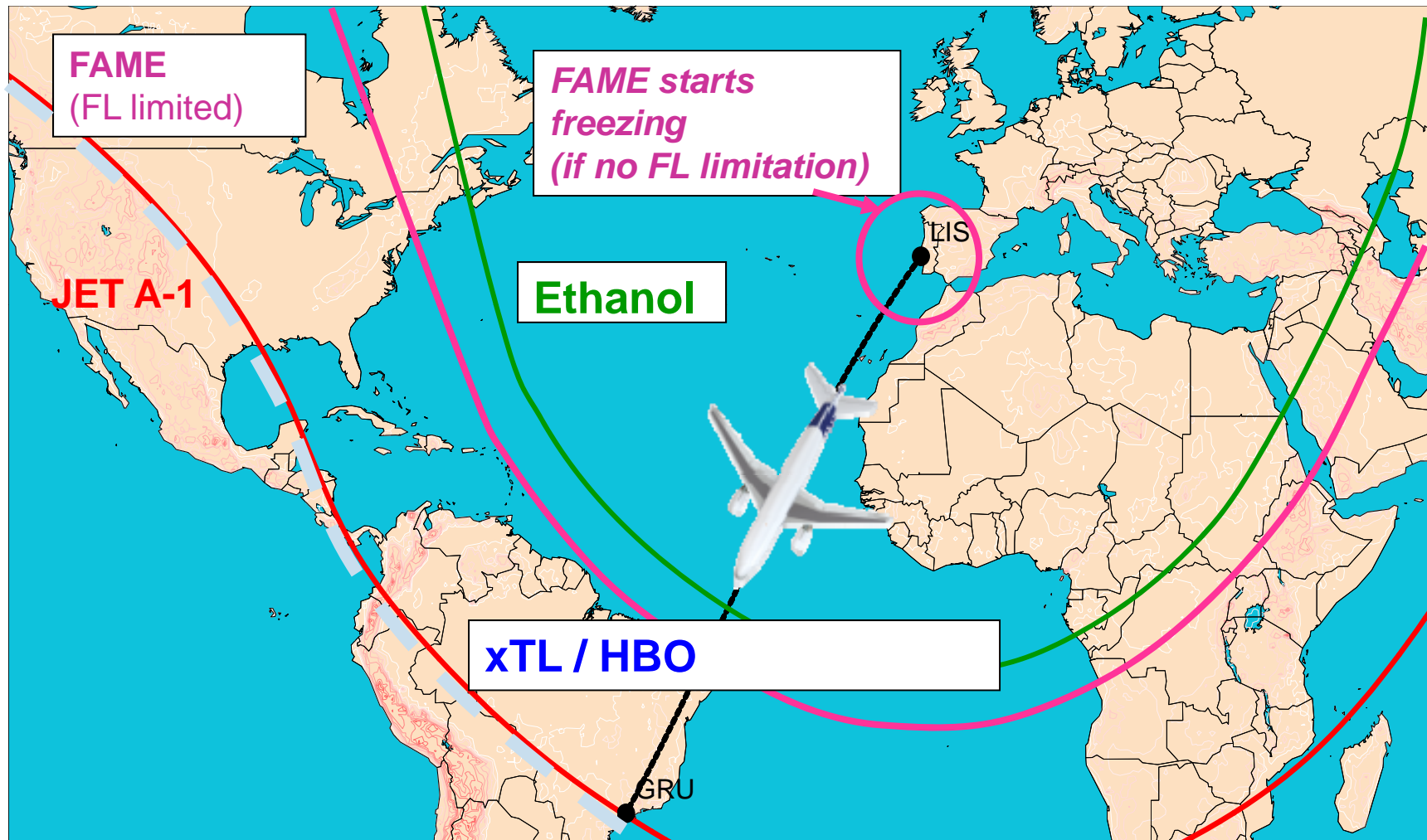
		TYPE					
		Conventional Jet Fuel ("Kerosene")	Alcohols	Bio Esters	Syn. Fuels	Hydrogenated bio-mass	Cryogenic Fuels
CATEGORY	Non-Renewable (Fossil)	Jet Fuel 			CTL & GTL DROP-IN 		Liquefied Natural Gas NOT drop-in 
	Renewable		Ethanol NOT drop-in  35% lower energy content	FAME* NOT drop-in  10% lower energy content Freezes at -5°C	<div><div>BTL DROP-IN </div><div>HBO & HCF DROP-IN FUTURE</div></div>		Liquid Hydrogen Low energy per unit volume, Availability, Infrastructure., Airframe

✗ Not suitable for aviation

✓ Approved suitable for aviation

* **FAME** = Fatty Acid Methyl Esters

Alternative Fuels illustrated:



(GRU) Guarulhos Intl, Sao Paulo, SP, BR

JET A-1, xTL's and HBO's gives the performance as a drop-in

Biomass Jet Fuel

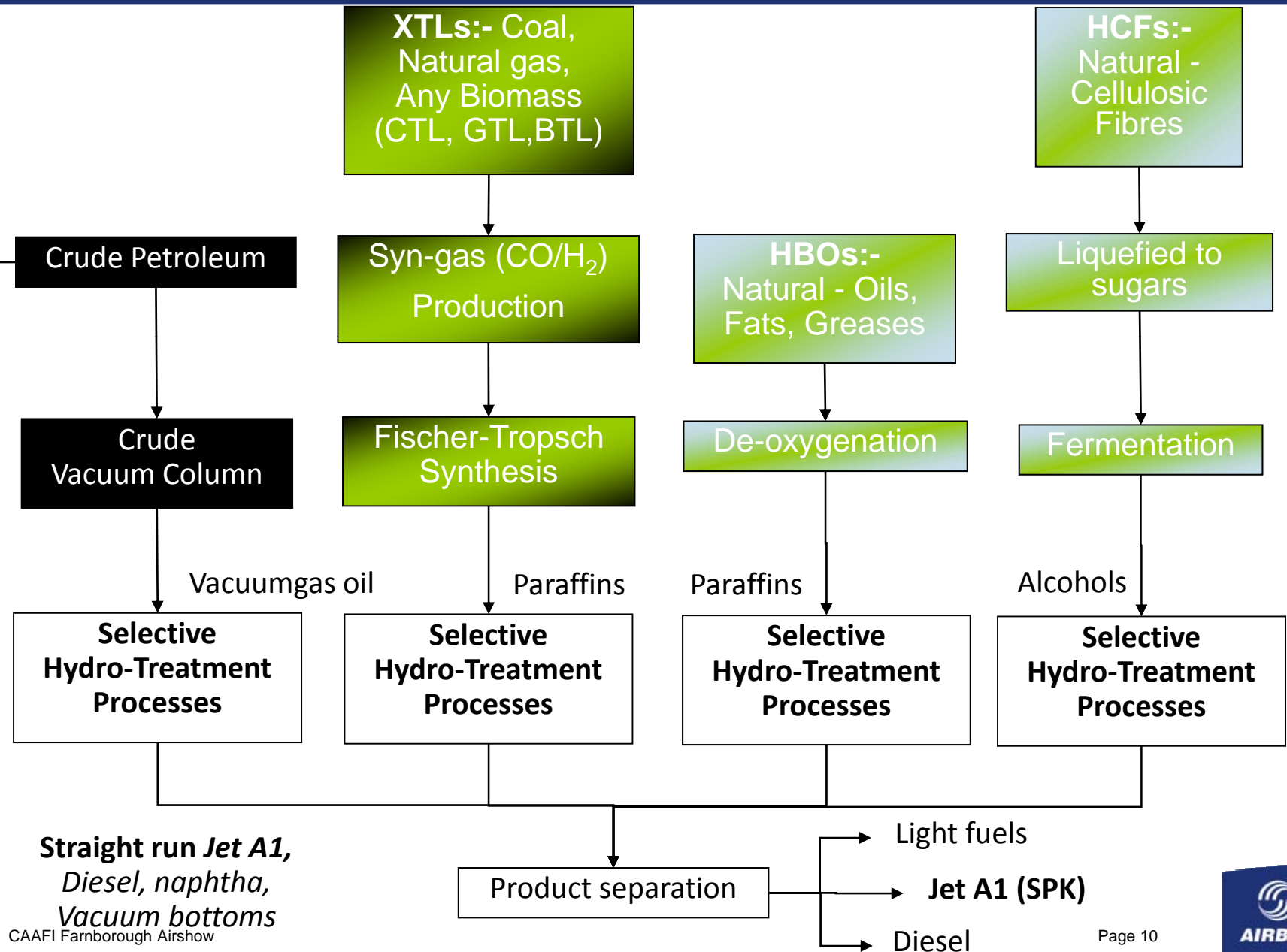
It has been estimated that cultivating an area equivalent to France with Sunflowers could produce enough Bio-Jet to support the French civil aviation industry



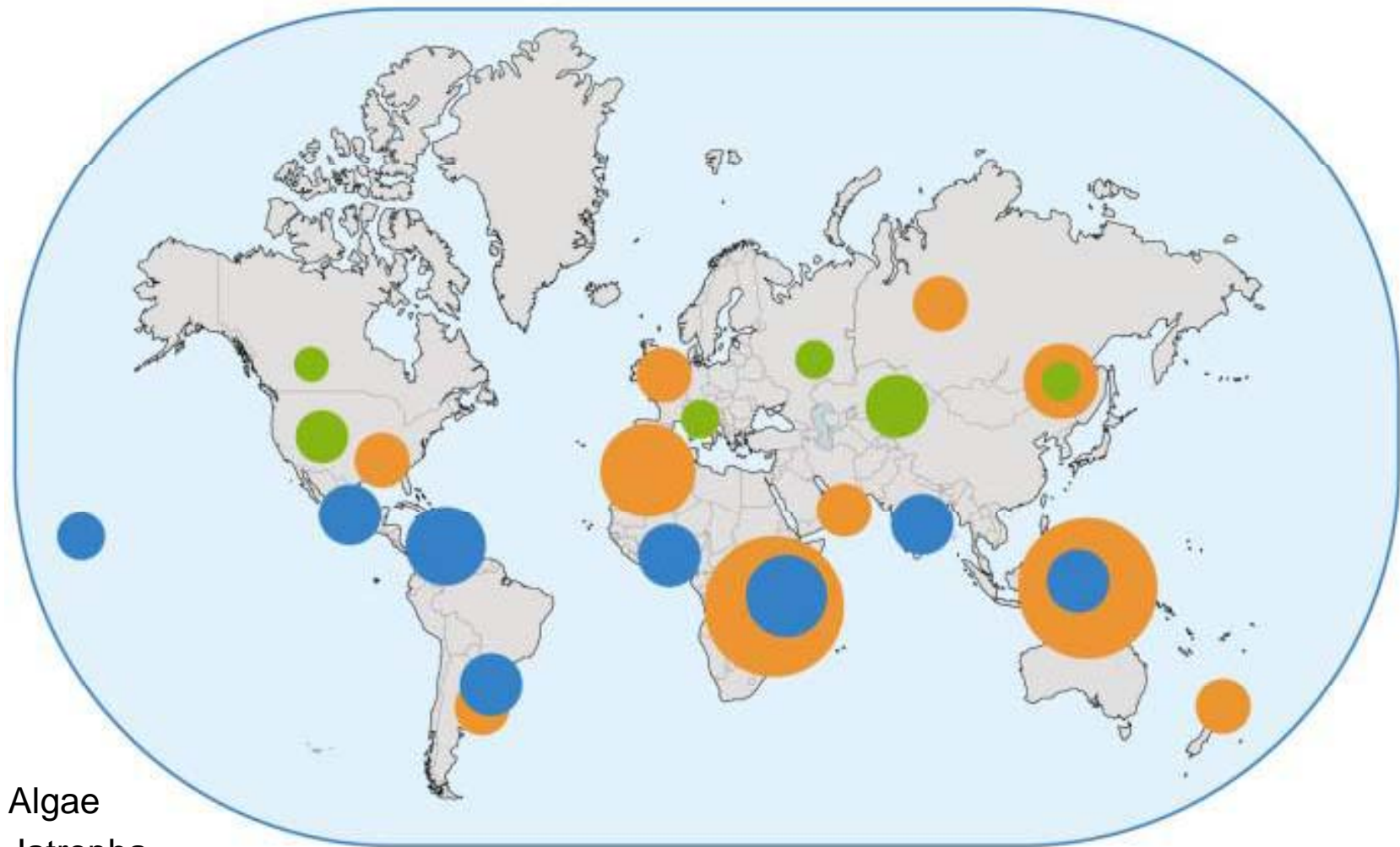
It has been estimated that cultivating an area equivalent to Belgium with Algae could produce enough Bio-Jet to support the World civil aviation industry

Different feedstock's = different oil yields

Transformation Processes



Biomass Jet Fuel Locations

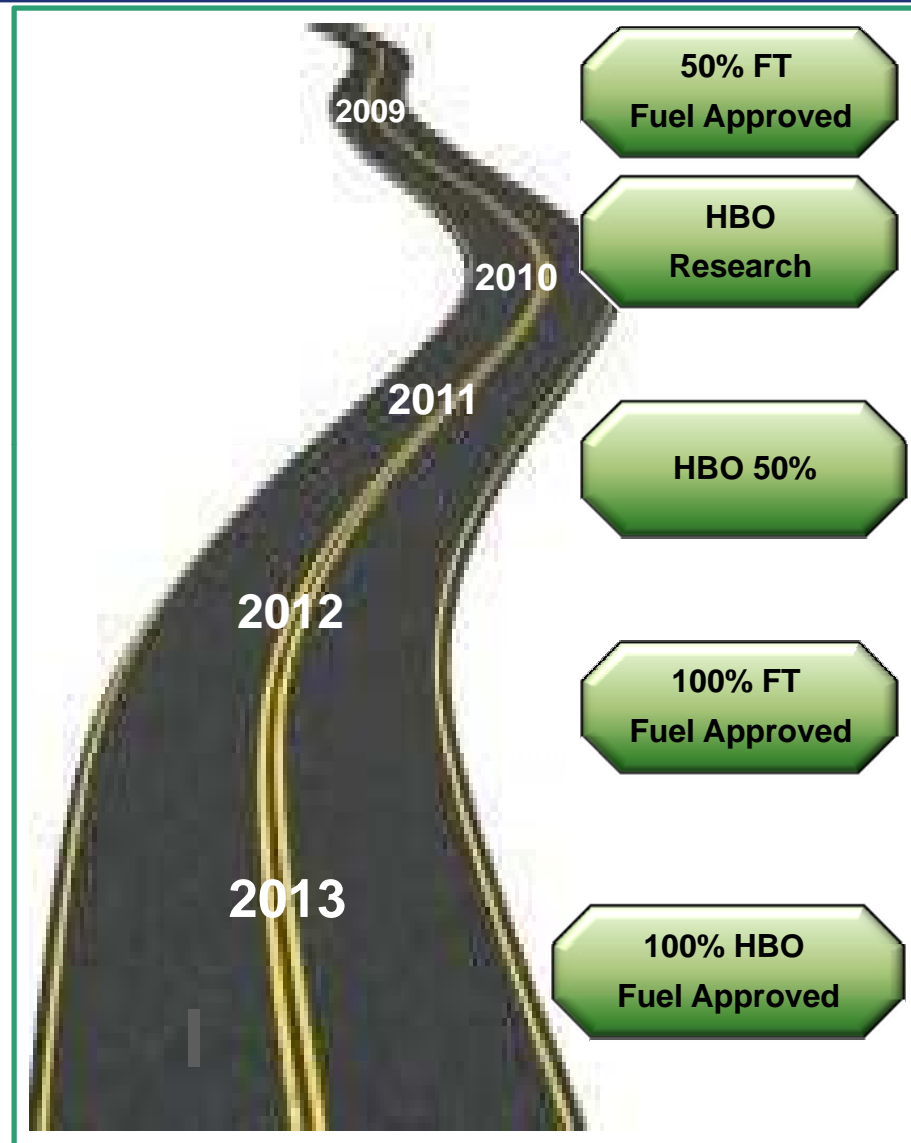
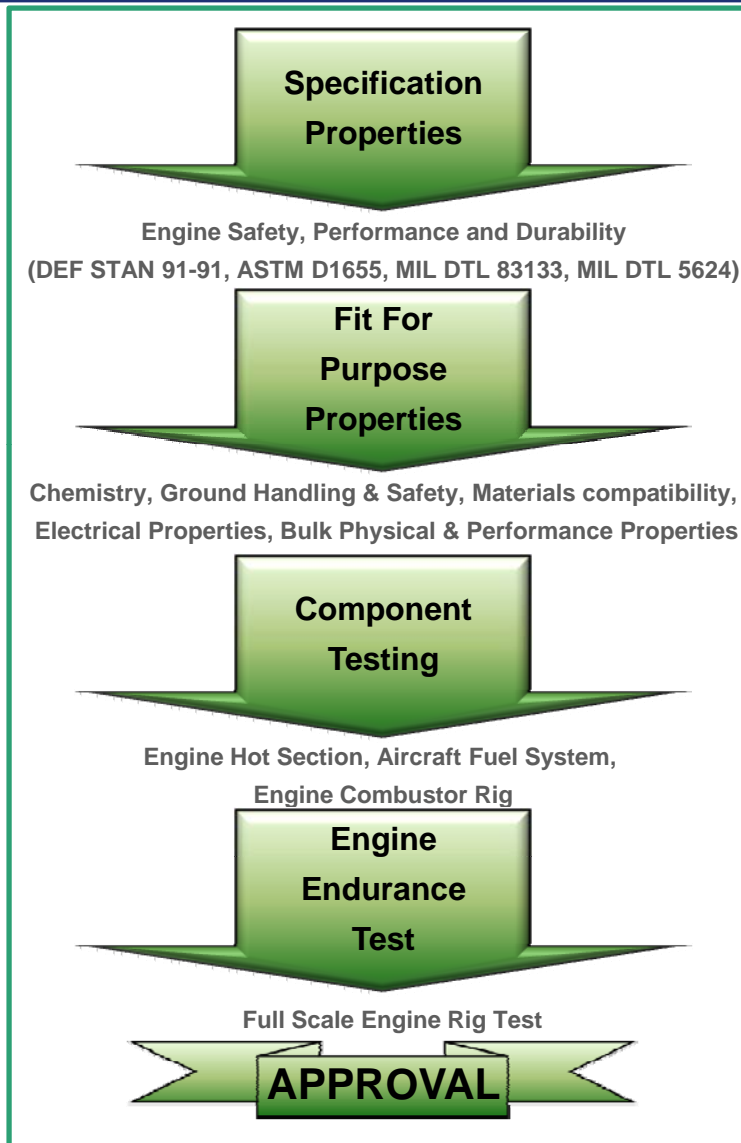


Source: ATAG

- Algae
- Jatropha
- Camelina

Global solutions possible

Airbus in the Fuels Approval Process



Airbus supports the Def-Stan and ASTM Approval processes

What has Airbus achieved

*GTL = Gas To Liquid



- February 2008
 - ▶ Flight test
 - ▶ ~50% GTL
 - ▶ A380 on one out of the four engines

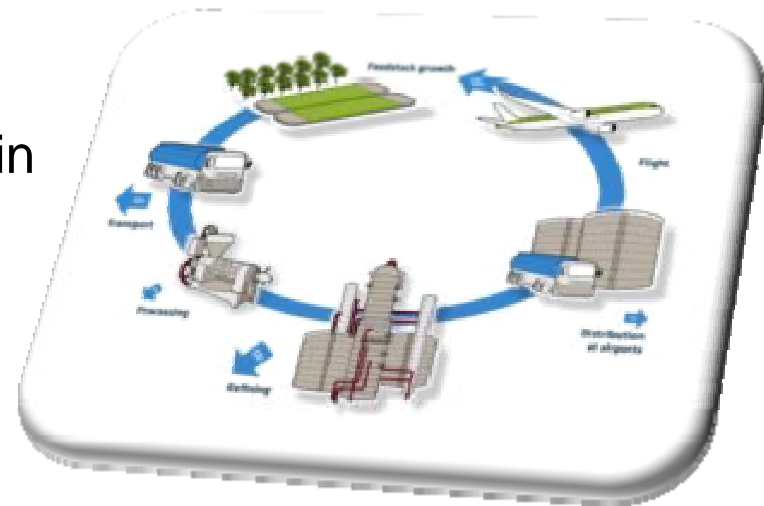
- October 2009
 - ▶ First ever commercial revenue flight
 - ▶ ~50% GTL
 - ▶ A340-600 all engines



Synthetic fuels work and are a precursor for Biofuels

What's planned - Value Chain Projects

- Airbus acting as a Catalyst for Biofuel commercialisation
- Projects that develop the Biofuel value chain in different regions
 - Agriculture, Refiners, Investors, Airlines....
- Closed loop process to reduce CO₂ emissions



Source: ATAG



- Biofuel commercialisation
- Investment strategy



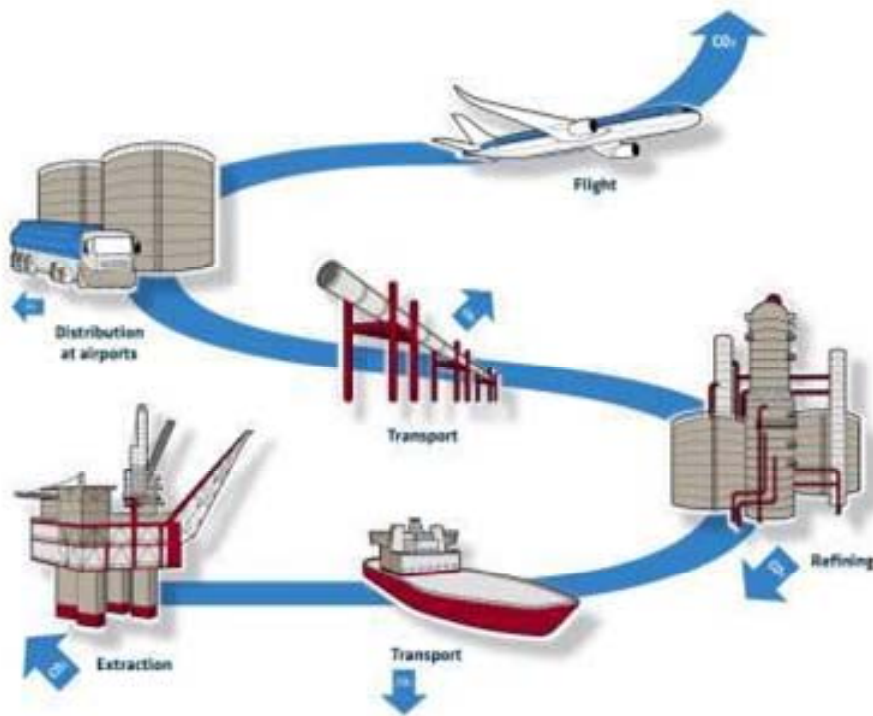
- Biofuel flight 2010
- Biofuel commercialisation
- Sustainability Analysis



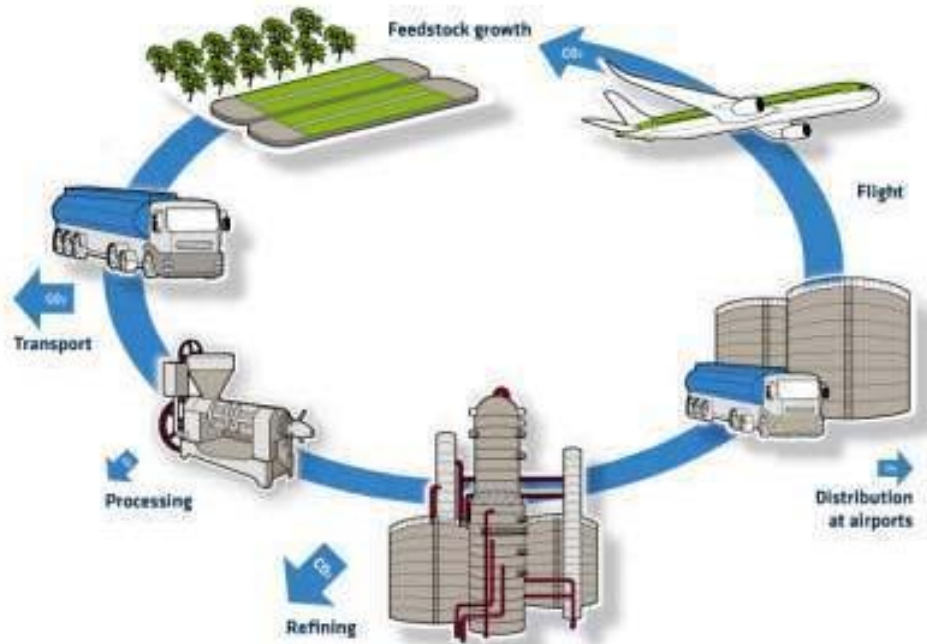
- Others projects under development with airlines

Develop projects that speed up sustainable commercialisation

Bio fuel an Aeronautical efficient solution



At each stage in the distribution chain, carbon dioxide is emitted through energy use by extraction, transport, etc



Carbon dioxide will be reabsorbed as the next generation of bio fuel feedstock is grown.

Bio fuel use for Aeronautical sector is reliable and sustainable

Common Sustainability Analysis is a must

RSB Principles & Criteria

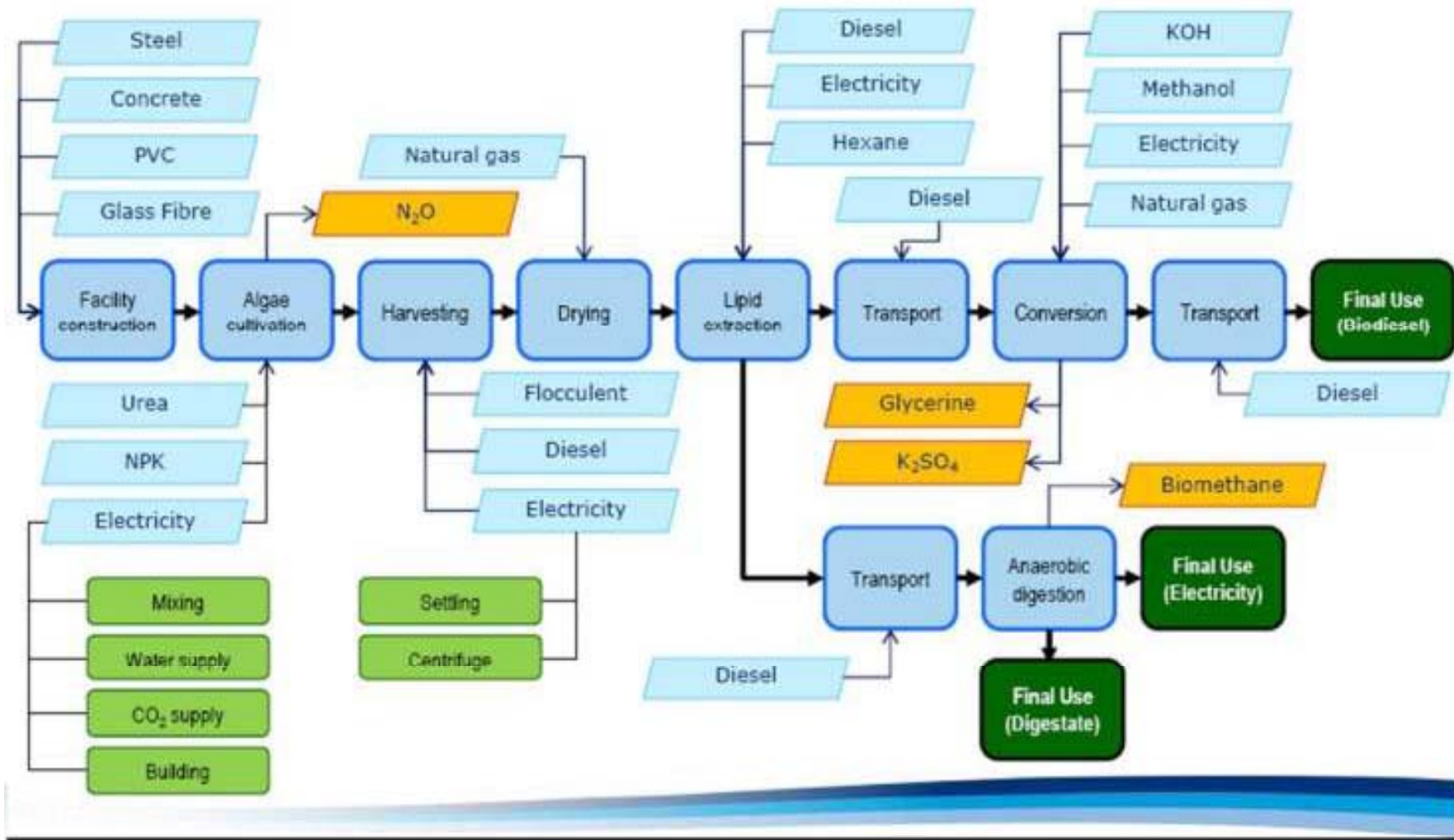
1. Legality
2. Planning, Monitoring & Continuous Improvement
3. Greenhouse Gases Emissions
4. Human & Labor Rights
5. Rural & Social Development
6. Food Security
7. Conservation
8. Soil
9. Water
10. Air
11. Use of Technologies, Inputs & Management of Wastes
12. Land Rights

- **Roundtable on Sustainable Biofuels (RSB)**
- Sustainability Standards for entire Biofuel value chain
- From Farm to Tank
- Standard used for certification system (3rd party)
- Implementation a priority for 2010
- Basis for future Airbus Biofuel sustainability analysis

Ref: RSB-STD-20-001

Core Principles for the use and experimentation with Biofuel

Common Life Cycle Analysis (LCA) is key



We need common Life Cycle Analysis (to encourage investment)

Industrialization



- (Some) R&T already delivered, let's deploy and implement
 - Common sustainability criteria
 - Lifecycle analysis

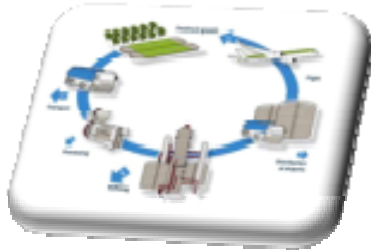


- More industry wide and Airbus R&T needed on e.g. algae
 - Also building on early industrial experience



- Government support through policy and incentives
 - Prioritisation of Energy types for different transport modes
 - Tax incentives / carbon credits

Industrialization



- Cross industry approach
 - Aircraft / Engine Manufacturers to provide technical support for qualification
 - Airlines to commit to using and buying bio-fuels



- Investors needed!
 - Growing local economies in various world locations
 - Sustainability criteria
 - Joint ventures with airlines and stakeholders

Alternative fuels must be commercially viable...

Sustainable Alternative Fuels User Group

The Pledge

- Will not displace, or compete with, food crops or cause deforestation
- Minimises impact to biodiversity
- Produces substantially lower life cycle greenhouse gas emissions than conventional fossil fuels
- Certified sustainable with respect to land, water, and energy use
- Delivers a positive socioeconomic impact

Members:



Affiliates Members:



Committed Cross Industry

Initiatives (Including R&D) “Simple” description

- **CALIN** - Research work which aims to identify and evaluate a number of alternatives to kerosene for the short, medium, and long term.
- **ALFA-BIRD** - Overview of potential alternative fuels, assessment for suitability for aircraft, technical analysis and future alternative fuel strategy
- **CAER** - In preparation: establish a French aeronautic alternative fuel program
- **SWAFEA** - Forum for the community (industry, policy, science and research) to meet and discuss state of the art in alternative fuels and energy for aviation
- **DREAM** - Engine (helicopter) endurance test with an alternative fuel
- **CAAFI, ICCAIA, ECAC, European Platform, and more and more...**

R&D a Key Component

Main Issues

**Alternative
Fuels work!**

**Market based measure
should partly finance
R&T**

**Bio Fuel
Commercialisation is 7 –
10 years away – too
slow**

**Reduction of Aviation
emissions requires
investments in
innovation**

**Government policy and
incentives required.
Cannot be left to market
dynamics**

**Biofuel availability in
Europe is limited
even for testing**

**30% Biofuel by
2030**

**Continued Biofuel
certification /
approval**

**Cross-Industry
collaboration is
essential**

**Aviation has limited
solutions
(Biofuels)**

**Missing common
sustainability analysis
Why invest?**

**Other industries
have alternatives**

**Airlines are ready
to use Bio Fuels**

Airbus continues to act as a Catalyst

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Glossary

- **GDP** Gross Domestic Product
- **ATM** Air Traffic Management
- **ASTM** American Society for Testing and Materials
- **Def-Stan** UK Defense Standard
- **HBO** Hydrogenated Biomass Oils
- **HCF** Hydrotreated Cellulosic Fibre
- **FT** Fisher Tropsch
- **GTL** Gas To Liquid
- **CTL** Coal To Liquid
- **BTL** Biomass to Liquid
- **RSB** Roundtable on Sustainable Biofuels
- **FAME** Fatty Acid Methyl Esters
- **ATAG** Air Transport Action Group
- **CO₂** Carbon Dioxide
- **CFMI** CFM International (Engine joint venture between GE Aviation of the United States and Snecma of France)
- **LCA** Life Cycle Analysis
- **SPK** Synthetic Paraffinic Kerosenes

