Background
Aviation and fossil fuels

Impact on climate change

PETROLEUM FUEL FOR TRANSPORT (%)

Source: Air Transport Action Group

Price volatility*

* ~40% airlines operating costs in 2008

Progressive depletion

* Progressive depletion of fossil fuels

Price volatility

* ~40% airlines operating costs in 2008

Impact on climate change

Temperature Increase (°C)

Source: Air Transport Action Group
Background

What aviation is proposing

- Technologies, Operations, Air Traffic Management
- Additional technology and biofuels
- Economic measures

CO₂

-50% by 2050

CNG 2020

2005 2010 2020 2030 2040 2050
Background

Targets for 2020 ACARE*

The ACARE targets represent a doubling of the historical rate of improvement...

-80% NOX Emission
-50% CO2 Emission
-50% Perceived Noise

“We want to make our aircraft even more efficient, cleaner and quieter.” Thomas Enders President and CEO Airbus

* Advisory Council for Aeronautics Research in Europe
No parking lots in the air

Distribution network

Any alternative should be fungible ("drop-in")
## Where we are

### What are the options?

<table>
<thead>
<tr>
<th>TYPE</th>
<th>Conventional (&quot;Kerosene&quot;)</th>
<th>Alcohols</th>
<th>Bio Esters</th>
<th>Synthetic Fuels xTL</th>
<th>Hydrogenated Biomass HBO</th>
<th>Cryogenic Fuels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Renewable (Fossil)</td>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jet Fuel</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Renewable</td>
<td></td>
<td></td>
<td>Ethanol</td>
<td>Fame (35% lower energy content, -5°C Freeze point)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BIO-JET FUELS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CTL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exist</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GTL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Future</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BTL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Approved</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low energy content</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liquid Hydrogen</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liquefied Natural Gas</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* FAME = Fatty Acid Methyl Esters  
* CTL, GTL & BTL = Coal, Gas or Biomass to Liquid
Where we are
Fuel type impact

NRT
SYD

JET A1 / xTL / HBO

Ethanol

FAME : starts freezing (no FL limitation)
FAME : FL limitation (avoids freezing)
Where we are
Feedstocks

Jatropha?
Camelina?
Rotation Crops

Algae?
Halophytes?
(Salicornia)

Not all Bio-fuels
are Green!

FOOD CROPS
Where we are
Fuel Readiness Levels (Best Practice ICAO 2009)

<table>
<thead>
<tr>
<th>FRL</th>
<th>Description</th>
<th>Exit Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Basic Principles</td>
<td>Feedstock / Process Observed / Reported</td>
</tr>
<tr>
<td>2</td>
<td>Concept Formulated</td>
<td>Feedstock / Complete Process identified.</td>
</tr>
<tr>
<td>3</td>
<td>Proof of Concept</td>
<td>Basic Fuel Properties Validated at Lab Scale</td>
</tr>
<tr>
<td>4.1</td>
<td>Preliminary Technical Evaluation</td>
<td>System Perf. &amp; Integration Studies</td>
</tr>
<tr>
<td>4.2</td>
<td></td>
<td>Entry Criteria/Specification Properties</td>
</tr>
<tr>
<td>5</td>
<td>Process Validation</td>
<td>Scaling from Laboratory to Pilot plant</td>
</tr>
<tr>
<td>6</td>
<td>Full-Scale Technical Evaluation</td>
<td>Fuel Properties, Rig and Engine Testing</td>
</tr>
<tr>
<td>7</td>
<td>Fuel Approval</td>
<td>Fuel Class/Type Listed in Int’l Fuel Standards</td>
</tr>
<tr>
<td>8</td>
<td>Commercialization</td>
<td>Commercial Purchase Agreements</td>
</tr>
<tr>
<td>9</td>
<td>Production Capability Established</td>
<td>Full Scale Plant Operational</td>
</tr>
</tbody>
</table>

Legend:
- R & D
- Certification Qualification
- Business & Economics

Facility Specific Green House Gas Assessment*
Where we are
Messages, Issues ... and Expectations

Alternative Fuels work!
Commercialisation 7 – 10 years away too slow
Aviation has limited solutions
Other industries have alternatives
30% Aviation Biofuels by 2030?

Missing common sustainability analysis. Why invest?
And what’s next?

Time for action not talk

• (Some) R&T already delivered, let’s deploy and implement
  ‣ Clarified sustainability criteria – not only European RED
  ‣ Lifecycle analysis

• More 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
And what’s next?

Investors to invest...

• Cross industry approach
  ‣ Aircraft / Engine Manufacturers to provide technical support for qualification
  ‣ Airlines (ready ?) to commit to quantities

• Investors needed!
  ‣ Growing local economies in various world locations
  ‣ JVs with airlines groupings?
  ‣ Focus on Aviation!

• Price, price, price…
Conclusion

Partnership to support (Aviation) bio-fuels

Airbus will continue to develop both R&T and industrialization focused projects.
Airbus will continue to look for collaboration projects with (Aviation) counterparts
  - EBTP as a very helpful pillar

Projects with:

- New sustainable feedstocks / processes
- Complete Bio-fuels development process from feedstock selection to test-flying
- Fuel approval projects
- Regular revenue flights using Bio-fuels
- Higher proportion blends
Air transport is essential

Flying is a wonderful thing

Tremendous progress in efficiency over the years

Being eco-efficient makes good business sense

We are committed to eco-efficient growth...

... more value with less environmental impact

This is only the (bio-fuel) beginning!
© AIRBUS S.A.S. All rights reserved. Confidential and proprietary document.

This document and all information contained herein is the sole property of AIRBUS S.A.S.. No intellectual property rights are granted by the delivery of this document or the disclosure of its content. This document shall not be reproduced or disclosed to a third party without the express written consent of AIRBUS S.A.S. This document and its content shall not be used for any purpose other than that for which it is supplied.

The statements made herein do not constitute an offer. They are based on the mentioned assumptions and are expressed in good faith. Where the supporting grounds for these statements are not shown, AIRBUS S.A.S. will be pleased to explain the basis thereof.