Sustainable Aviation Fuels in Brazil

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Boeing Research & Technology Centers

Supporting innovation around the world 24/7

Number of BR&T Research Centers: 11
Number of U.S. BR&T Research Centers: 5
Number of International BR&T Research Centers: 6
Boeing’s role and actions

Development of Sustainable Alternative Fuels

Boeing’s role

- Protect the environment
- Assure industry growth
- Address customers’ needs

Act as industry catalyst to accelerate commercialization

Core activities

- Support and advocacy
- Feedstock and pathway R&D
- Fuels approval

Ultimate goal is to catalyze a vibrant commercial market
Aviation CO2 emissions are growing, but slower than traffic growth.

Within 20 years: global fleet x 2 due to strong demand in air travel sustained by Asia and Middle East.

Source: Boeing 2015 Current Market Outlook; Passenger traffic (RPKs) billions
A history of strong environmental performance

Sustainable aviation fuels are strategic to long term goals

GOAL 1

1.5% AVERAGE ANNUAL FLEET FUEL EFFICIENCY IMPROVEMENT FROM 2009 TO 2020

PROGRESS
Currently tracking well above goal, although figure expected to normalize

HOW IS INDUSTRY ACHIEVING THIS?
• New airplane and engine technologies
• More efficient operations by airlines
• Better use of air traffic management infrastructure

GOAL 2

STABILIZE NET AVIATION CO\textsubscript{2} EMISSIONS AT 2020 LEVELS THROUGH CARBON-NEUTRAL GROWTH

PROGRESS
Industry is actively supporting global actions at an intergovernmental level

HOW IS INDUSTRY ACHIEVING THIS?
• All actions for Goal 1
• Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) at the International Civil Aviation Organization (ICAO)

GOAL 3

REDUCE AVIATION NET CO\textsubscript{2} EMISSIONS TO 50% OF WHAT THEY WERE IN 2005, BY 2050

PROGRESS
Significant research and innovation efforts underway

HOW IS INDUSTRY ACHIEVING THIS?
• All actions for Goal 1 & 2
• Development of sustainable alternative aviation fuels
• Research into future design concepts by airplane and engine manufacturers
A history of strong environmental performance

Sustainable aviation fuels are strategic to long term goals

![Graph showing CO₂ emissions and timeline towards carbon neutrality.]

- Forecasted emissions growth without reduction measures
- Airplane Technology
- Operational Efficiency
- Sustainable Biofuel & CORSIA
- Industry Emissions
We need truly sustainable alternative fuels

Strong demand by major airlines

- Demonstrated life-cycle GHG reductions
- Measured and verified by objective third party standard
- No negative impact to food security, fresh water supplies or land-use
- Powers sustainable growth and economic development
Aviation needs “drop-in” alternative fuels

Meets strict sustainability criteria, reduces lifecycle CO2 by 50 – 80%

New ways to make the same fuel

Blend directly with conventional jet fuel

Meets or exceeds performance of petroleum

No change to airplanes, engines or fueling infrastructure
Brazil, “the biomass country”

Sustainable Alternative Fuels in Brazil

Brazil second largest biofuels producer

<table>
<thead>
<tr>
<th>Biofuel</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biodiesel (B100)</td>
<td>2.929</td>
<td>3.410</td>
<td>4.005</td>
<td>3.799</td>
<td>4.302</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>24.370</strong></td>
<td><strong>27.495</strong></td>
<td><strong>32.802</strong></td>
<td><strong>30.000</strong></td>
<td><strong>29.884</strong></td>
</tr>
</tbody>
</table>

Source: ANP (2018)

Large Jet fuel consumption

2nd largest employer in renewable energy

- China: 3.52
- Brazil: 0.92
- USA: 0.77
- India: 0.42
- Japan: 0.39
- Germany: 0.36
- Rest of the world: 1.71

Note: a) Excluding large hydropower.
Source: IRENA, 2016c

Source: ANP (2016)
Sustainable Alternative Fuels in Brazil

Collaborations

Joint Research Center

Regional Platforms

GOL Airlines
Collaboration FIFA World Cup 2014
Sustainable Alternative Fuels in Brazil

RenovaCalc – Calculation of Biofuel Carbon Intensity in g CO2eq/MJ

- Ethanol – Sugarcane
- Ethanol – corn in Dedicated mill
- Ethanol in “flex” mills
- Ethanol – imported corn
- Ethanol – 2G

- Ethanol – 1G2G integrated
- Biodiesel - soy
- Biodiesel – animal fat
- Bio-methane – residues
- HEFA Biokerosene

Currently under construction
Final Remarks

▪ Brazil is rising to the challenge to further develop its biofuels industry – including SAF

▪ Realistic targets and focus on credibility of its governance model – some of the main goals of RenovaBio

▪ Sustainability a key component in the new policy

▪ Brazil with good conditions to scale up production and use of sustainable aviation fuels