Airlines & Aviation Alternative Fuels: Our Drive to Be Early Market Adopters

Bioenergy 2015

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June 23, 2015
Why Airlines Want Alternative Fuels

» New Supply Chain
  • Energy Security/Supply Reliability
  • Competitor to Petroleum-Based Fuels

» Environmental Benefit/Imperative
  • Greenhouse Gas (Carbon) Emissions Benefits
  • Reduce Emissions Affecting Local Air Quality
  • Do Not Induce Other Environmental Problems
U.S. Airlines’ Jet Fuel Costs Are High and Volatile
Average Price Paid Rose 255% in 2000-2014, Including 26% in 2010-2014

Using Less Fuel But ...  
Million Gallons per Day

<table>
<thead>
<tr>
<th>Year</th>
<th>2000</th>
<th>2005</th>
<th>2010</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
<td>56.2</td>
<td>55.9</td>
<td>50.7</td>
<td>51.6</td>
</tr>
</tbody>
</table>

Due to Rising Prices ...  
Avg. Price Paid per Gallon Systemwide

<table>
<thead>
<tr>
<th>Year</th>
<th>2000</th>
<th>2005</th>
<th>2010</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price</td>
<td>$0.81</td>
<td>$1.66</td>
<td>$2.27</td>
<td>$2.86</td>
</tr>
</tbody>
</table>

... Incurring Higher Costs  
Billion USD per Year

<table>
<thead>
<tr>
<th>Year</th>
<th>2000</th>
<th>2005</th>
<th>2010</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Costs</td>
<td>$16.4</td>
<td>$33.2</td>
<td>$39.3</td>
<td>$48.1</td>
</tr>
</tbody>
</table>

Source: BTS (T2: 921) for U.S. airlines
Source: BTS (Form 41 P-12(a) for U.S. airlines)
Source: BTS (Form 41 P-12(a) for U.S. airlines)
Global Aviation Has Aggressive Carbon Targets
CNG from 2020 Agreed at United Nations Body (ICAO*)

2010
1.5% annual fuel efficiency improvement (average)
Working towards CNG

2020
Carbon Neutral Growth (CNG) from 2020

2050
50% reduction in net CO2 emissions over 2005 levels

ICAO = International Civil Aviation Organization
How Do We Meet Our Targets?
Technology & Alternative Fuels, Operations & Infrastructure

CO₂ EMISSIONS

- Forecasted Emissions Growth Absent Reduction Measures
- Ongoing Fleet Renewal/Technology Development
- ATC/NextGen/Operational Improvements
- Low Carbon Fuels (Life Cycle Basis)

Potential Role for Carbon Credits to Bridge
(Notional Example)

BASELINE

Potential Role for Carbon Credits

CARBON NEUTRAL GROWTH AND REDUCTION TIMELINE

2050

Airlines for America
We Connect the World
What an Airline Needs to Deploy Sustainable Alternative Jet Fuels

1) Safety
   – This is addressed through
     (a) The jet fuel specification; and
     (b) Application of procedures to assure fuel quality is maintained

2) Environmental Benefit
   – This is being addressed through
     (a) Lifecycle greenhouse gas emissions; and
     (b) Sustainability review

3) Commercial Viability
   – Need cost competitiveness &
   – Supply reliability

We know how to do this
Covered in U.S. & EU; working on global acceptance
Making significant progress
A4A & Sustainable Alternative Aviation Fuels
Working Within Coalitions to Achieve Success

» Co-Founded and Co-Lead the Commercial Aviation Alternative Fuels Initiative® (CAAFI)

- Co-Leads: A4A, FAA, ACI-NA (airports) and AIA (airframe & engine manufacturers)
- Four Teams Aimed at Addressing Key Questions – Over 300 Participants
  - Certification/Qualification (e.g., jet fuel specs)
  - Research and Development (e.g., suitable fuels)
  - Environment (e.g., methodologies and case studies)
  - Business/Economics (e.g., finance/commercial terms)
Drive to “Drop-In” through Jet Fuel Specs
Safety/Quality – But Also Important to Supply & Cost

» ASTM International: New Jet Fuel Spec (D7566) for Alternative Jet Fuels
  • Fischer-Tropsch-Derived (FT) Jet Fuel – 2009
  • Hydrotreated Esters & Fatty Acids (HEFA) – 2011
  • Synthesized Iso-Paraffinic (SIP) – 2014
  • Working on Alcohol-to-Jet (expected 2015); others

» Drop-In Allows Use of Same Infrastructure
  • Working up fuel quality protocols specific to alternative fuel (already have for traditional jet fuel)
Jet Fuel Spec Enables Commercial Flights
Over 1600 Commercial Flights!
Getting to Full Commercial Viability

What Is Needed

» Market Signals from Fuel Purchasers (Beyond Demo Flights to Full Off-Take Agreements)

» Consistent Energy/Biofuels Policy from Governments

» Scale-up Capability and “Positive” Economics (Relative to Petroleum-Based)
  • Feedstock costs and availability are particularly critical
Airline Off-Take Agreements (Full Scale)
Starting with Millions of Gallons; Key Step to Scale-Up

5 M gpy from 2014
Supplied 2018
3 M gpy
370M usg
180M usg over 11 years
Other Airlines’ Purchase Agreements

» KLM (The Netherlands) – SkyNRG
» Lufthansa (Germany) – Neste & GEVO Project
» GOL (Brazil) – Amyris
» Alaska Airlines – GEVO (for commercial demo flight +)
Commercial Viability: What A4A Is Doing

» Public-Private Coalitions to Marshal Resources
  • CAAFI®; Strategic Alliance with the U.S. Military (Defense Logistics Agency); Farm to Fly with USDA, DOE, FAA, CAAFI, Boeing and other partners; Regional initiatives: e.g., Pacific Northwest & Midwest; Defense Production Act

» Achieved Eligibility for RFS/RIN Credit

» Developed Key Guidance for Doing Deals
  • “Guidance for Selling Alternative Fuels to Airlines”

» Advocating Appropriate Government Policy
A Moment on *Farm to Fly* & the Defense Production Act Initiatives

» **Farm to Fly – Critical to Enabling Biojet Eligibility for Existing Biofuel Programs**

- Programs such as biorefinery and biomass crop assistance, which have focused almost entirely on ground-based fuels
- Crop insurance for proven energy crops
- Demonstrating and implementing a sustainable supply chain

» **Defense Production Act Project**

- Helping to “kick-start” the industry through demonstrated supply chains
- It is critical that Congress allow this project to continue
If You Want to Feel Good About the Future, Look Up!