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The Future of Biofuels: U.S. (and Global) Airlines & Aviation Alternative Fuels

2014 EIA Conference

Nancy N. Young, VP-Environment

July 15, 2014

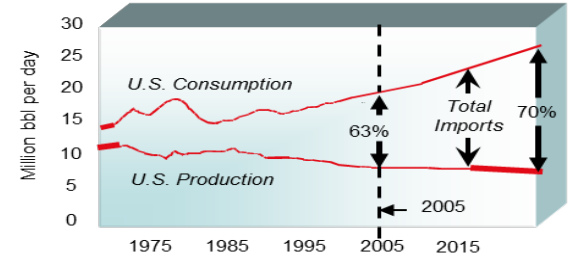
Why Airlines Want Alternative Fuels

» New Supply Chain

- Energy Security/Supply Reliability
- Competitor to Petroleum-Based Fuels

» Environmental Benefit/Imperative

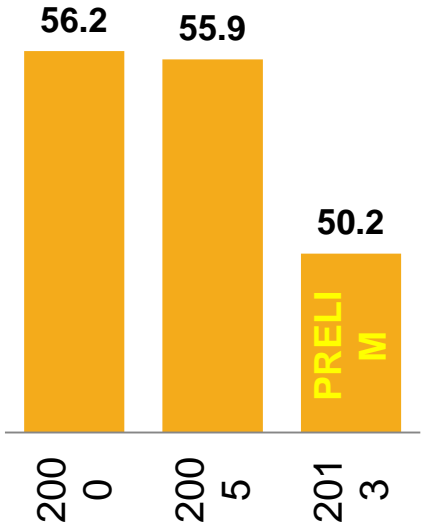
- Greenhouse Gas (Carbon) Emissions Benefits
- Reduce Emissions Affecting Local Air Quality
- Do Not Induce Other Environmental Problems



U.S. Airlines' Fuel Costs Are High, Volatile and Rising

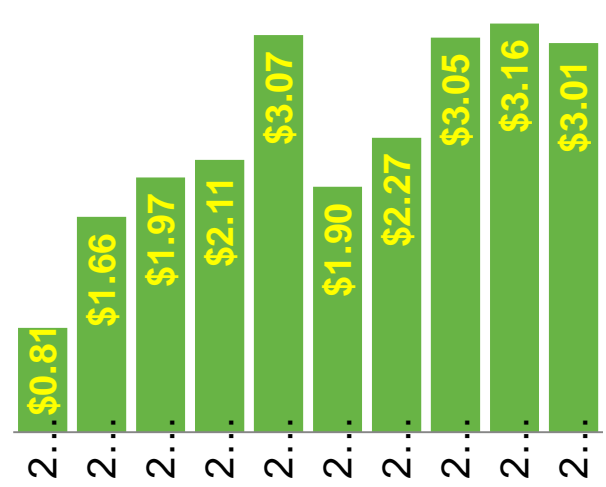
Average Price Paid for Jet Fuel Rose 272% between 2000-2013

Using Less Fuel But ...
Million Gallons per Day



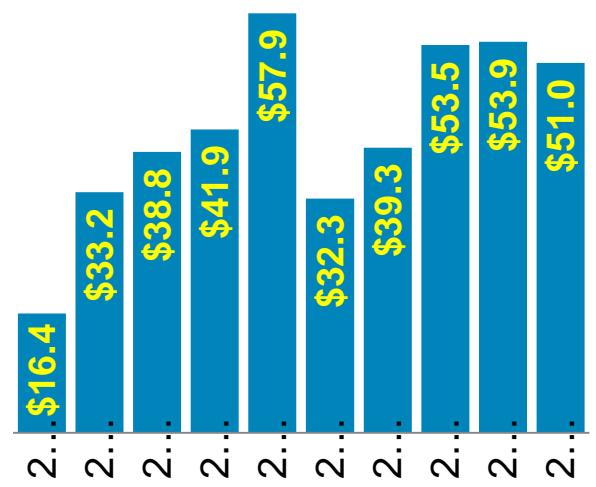
Source: BTS (T2: 921) for U.S. airlines

Due to Rising Prices ...
USD per Gallon (Avg. Price Paid)



Source: BTS (Form 41 P-12(a) for U.S. airlines)

... Incurring Higher Costs
Billion USD per Year



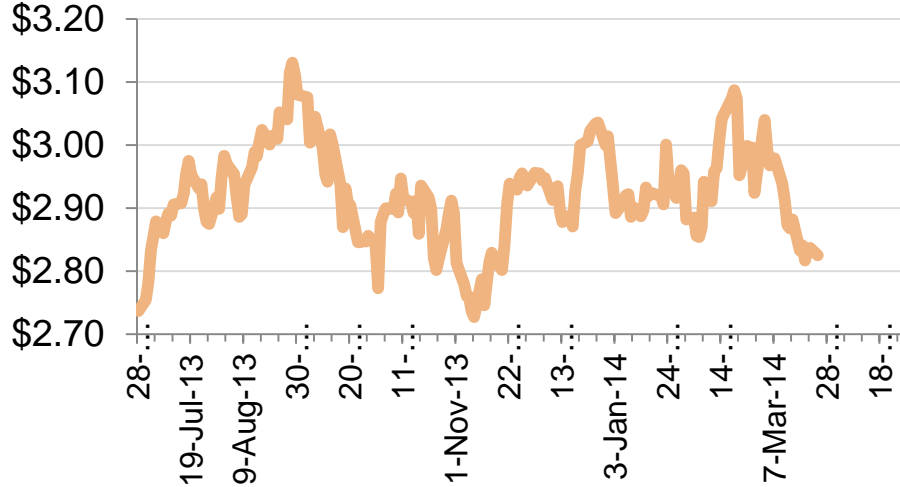
Source: BTS (Form 41 P-12(a) for U.S. airlines)

Jet-Fuel Prices Remain Volatile

And They Continue to Exceed Gasoline Prices

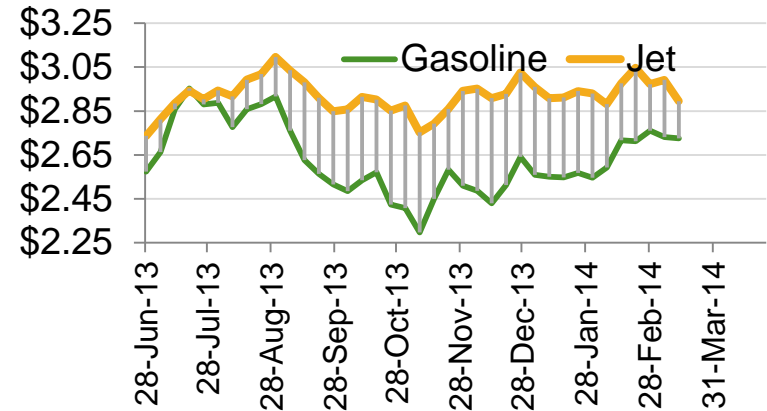
Jet Fuel Price Volatility

Daily Average Spot Price per Gallon



Jet Fuel vs. Motor Gasoline

Weekly Average Spot Price per Gallon



Source: A4A and Energy Information Administration (U.S. Gulf Coast)



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Global Aviation Has Aggressive Carbon Targets

CNG from 2020 Agreed by Countries at United Nations Body (ICAO*)

2010

1.5% annual
fuel efficiency
improvement
(average)

Working
towards CNG

2020

Carbon Neutral
Growth (CNG) from
2020

2050

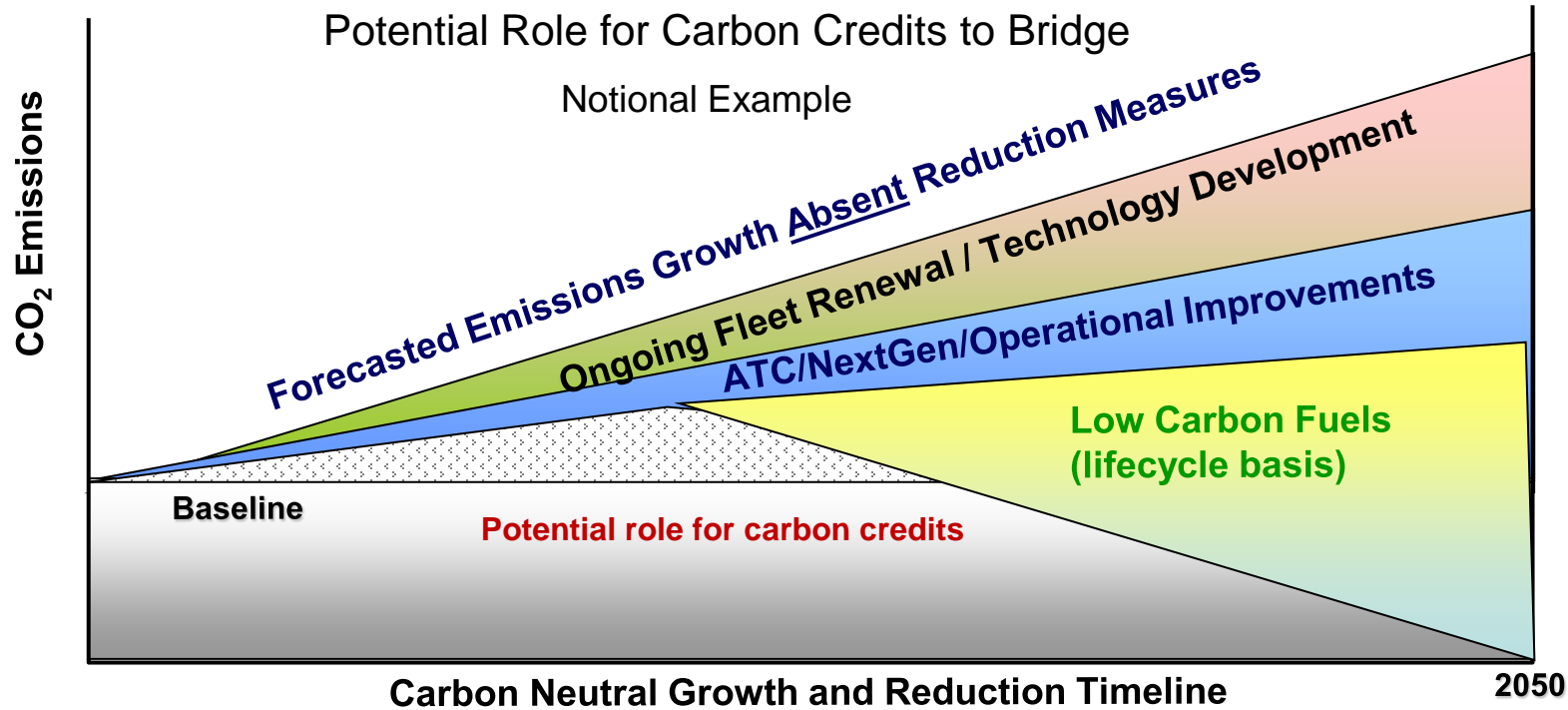
50% reduction in
net CO₂ emissions
over 2005 levels



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How Do We Meet Our Aggressive Emissions Targets?

Technology & Alternative Fuels, Operations & Infrastructure

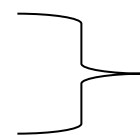


What an Airline Needs to Deploy Sustainable Alternative Jet Fuels

1) Safety

–This is addressed through

- (a) The jet fuel specification; and
- (b) Application of procedures to assure fuel quality is maintained

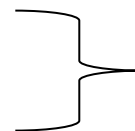


We now know how to do this

2) Environmental Benefit

–This is being addressed through

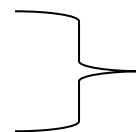
- (a) Lifecycle greenhouse gas emissions; and
- (b) Sustainability review



Need regulatory and contract acceptance

3) Commercial Viability

- Need cost competitiveness &
- Supply reliability



Poses the highest hurdles at this stage



A4A & Sustainable Alternative Aviation Fuels

Working Within Coalitions to Achieve Success

» Co-Founded and Co-Lead the Commercial Aviation Alternative Fuels Initiative[®] (CAAIFI)

- 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; others

All pathways can generate “advanced biofuels”

» Drop-In Allows Use of Same Infrastructure

- Working up fuel quality protocols specific to alternative fuel (already have for traditional jet fuel)
-



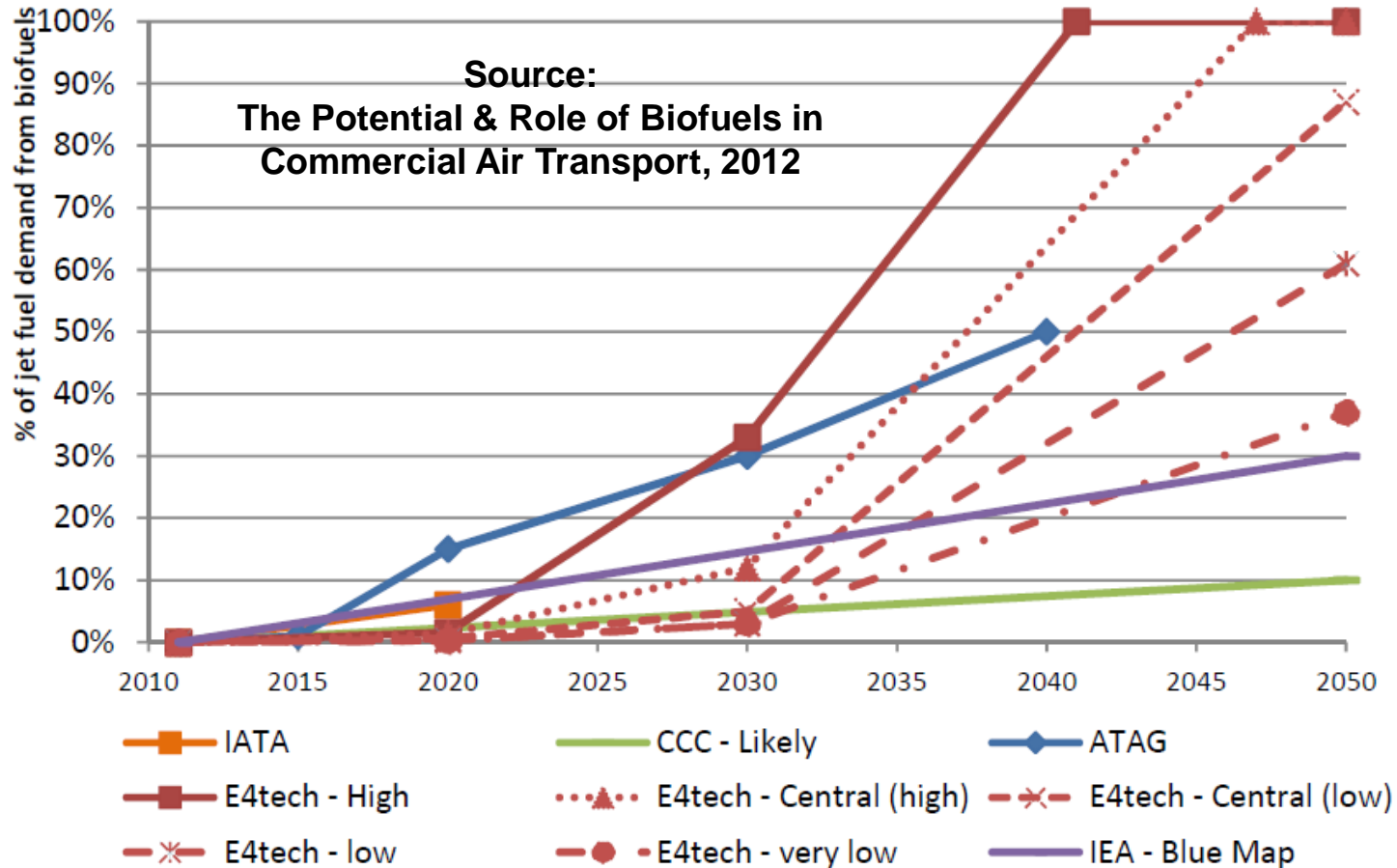
Jet Fuel Spec Enables Commercial Flights

Over 1500 Commercial Flights!



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PROJECTED DEMAND FOR BIO-JET FUEL



Getting to Commercial Viability

What Is Needed for Supply & Cost-Competitiveness to Meet Demand

- » **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

A4A Carrier Off-Take Agreements

Starting with Millions of Gallons; Key Step to Scale-Up



» Demonstrating What Is Possible

- Innovation in financing
- Leveraging the product slate

» More U.S. Airline Commercial Agreements in the Works

Examples of Alt. Jet Fuel Projects Around the World

Off-Take Agreements, Production & Developing New Pathways

» **Off-Take:**

- KLM (The Netherlands) – SkyNRG
- GOL (Brazil) – Amyris

» **Off-Take Plus Direct Engagement in Production:**

- BA (United Kingdom) – Solena (new facility in London)

» **Production:**

- UOP/Honeywell & Petrioxo Oil & Gas (UAE)

» **Development/Commercialization:**

- Lufthansa (Germany) – GEVO; Virgin Atlantic (United Kingdom) & Lanzatech; Etihad (UAE) & Masdar; Virgin Atlantic & Delta
-



Pushing for Commercial Viability: What A4A Is Doing

» Public-Private Coalitions to Marshal Resources

- CAAFI[®] - alliances with Brazil, EU, Australia, etc.
- Strategic Alliance with the U.S. Military (Defense Logistics Agency)
 - Combining experience and potential demand (market signals)
- *Farm to Fly* with the U.S. Department of Agriculture, CAAFI, Boeing (and other partners)
 - Primary focus on linking feedstock supply chain with fuel production and end users; leverage agricultural programs
 - Goal is 1 billion gallons of alternative jet fuel in 2018
- Regional U.S. initiatives: e.g., Pacific Northwest & Midwest



Commercial Viability: What A4A/Airlines Are Doing

» Achieved Eligibility for RFS/RIN Credit

» Developed Key Guidance for Doing Deals

- “Guidance for Selling Alternative Fuels to Airlines”

http://www.caafi.org/files/CAAFI_Business_Team_Guidance_Paper_060413.pdf

» Advocating Appropriate Government Policy

- In support of scale-up and cost-competitiveness
- But, clearly a challenge in today’s political climate

» Engaging in Global Aviation Coalitions



In-Progress Public-Private Deployment Initiative

» U.S. Defense Production Act Project

- USDA, Department of Energy and Navy (Aviation & Marine Alternative Fuels)
- Scale-up full supply chain
- Up to \$510 million government investment over 3 years (2013-2015)
- Public-private partnership (so industry financial contribution too)

» Helping to “Kick-Start” the Industry

- A “bridge” to self-sustaining commercial viability

Advantages of Coalition Approach

Recipe for Success

- » **It Would Be Difficult for Individual Airlines to Replicate the CAAFI Process and Other Cooperative Efforts**
- » **Spread Financial Risks for Airlines & Potential Suppliers**
- » **Commercial & Military Aviation Connection Leverages Demand, Experience and Market Opportunities**
- » **Accelerate Deployment of Projects**
- » **Global Engagement for a Global Industry**



If You Want to Feel Good About the Future, Look Up!



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