Aviation and Climate Change- Managing the Challenge of Growth

Meeting: ICAS Aviation and Environment Workshop

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Policy, Planning and Environment

Date: September 28, 2009
Outline

• U.S. Aviation Performance
• The Evolving Challenges
• A Way Forward: The NextGen Plan
• The Year Ahead
• Some Closing Observations
Energy Intensity of Aircraft and Automobiles

Source: U.S. Department of Transportation, Bureau of Transportation Statistics, National Transportation Statistics 2007, Table 4-20: Energy Intensity of Passenger Modes (Btu per passenger-mile)
U.S. Experience: Transportation Mode Performance

U.S. Experience: Declining Contribution to Global Fuel Use

Regional fuel consumption as % of the global

Source: ICAO based on OAG timetable

*By region of registration

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U.S. Experience: Much Slower Growth than Europe

Growth in Aviation Fuel Consumption 1990-2006

Percentage Growth

Source: BTS, EEA
U.S. Experience: Absolute Decline in Fuel Consumption

U.S. Commercial Aviation Fuel Consumption

Source: BTS

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The Challenge: Multiple Environmental Drivers

- Aviation impacts community noise footprints, air quality, water quality, energy usage and availability, and the global climate.

- Trends show environmental impacts from aircraft noise and aviation emissions will be a critical constraint on capacity growth.

- Fundamental changes ongoing from economic downturn, fuel costs, and financial turmoil.

- The challenge is to ensure energy availability and affordability and reducing aviation’s environmental footprint, even with projected aviation growth.
Challenge: Changing Oil & Energy Dynamics

### Transport Reliance

- **Electric Power**
- **Industrial**
- **Residential and Commercial**

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<td>1960</td>
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<td>1980</td>
<td>10</td>
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<td>2000</td>
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### Price Volatility

![Graph showing daily New York Harbor Jet Fuel Spot Price FOB](image)

### Energy Security

- **U.S. Consumption**
- **U.S. Production**
- **Total Imports**
- **Total Consumption**

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<th>Year</th>
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**Federal Aviation Administration**
The Challenge: Some U.S. Fuel Scenarios

US Fuel Use Growth

- Scenario 1: FESG Baseline
- Scenario 2: FESG Baseline w/Low-Trend Technology
- Scenario 3: ST Adjusted Baseline w/Low-Trend Tech.
- Scenario 4: ST Adjusted Baseline w/Higher-Trend Tech & High US Op’l Efficiency

Source: FAA Preliminary Analysis

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## The Challenge: Growing Role of Developing Countries

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<th>Cum %</th>
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The Challenge: Global Growth Much Higher than U.S.

Global Fuel Use (billion kg per annum)

- FESG Baseline: Baseline Fuel Price
- FESG Baseline: Baseline Fuel Price, Low Trend Technology
- APO Reduced Trend Baseline: Baseline Fuel Price, Low 1% Trend Technology
- Strong Plus: Baseline Fuel Price, 1.5% Trend Technology
- Strong Plus: High Plus Fuel Price, 1.5% Trend Technology

Source: FAA Preliminary Analysis

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The Challenge: Aviation Associated Uncertainties in Climate

Aircraft emissions account for ~3% of total human induced global integrated climate change.
Measures to Tackle the Challenge

NextGen Vision

Provide environmental protection that allows sustained aviation growth

Key Initiatives:

• Continued Local Mitigation
• Better Scientific Understanding
• Enhanced Policy Tools
• Leveraging Research Resources
• Accelerate Operational Changes
• Mature New Aircraft Technology
• Develop Sustainable Alternative Fuels
• Policy Options
A Way Forward: Continuing Mitigation Efforts

- Airport Configuration and Operation for Better Efficiency
  - New runways, extensions, taxiways, preferential runway use
- Airport Ground Measures
  - Run-up areas, aircraft taxiing, noise shielding
- Aircraft Flight Procedures
  - Optimized profile descent, departure profiles
- Program Support Measures
  - Noise monitoring, complaint response, pilot education, noise advisory committees, noise abatement officer, property advisory services, periodic program review
- Voluntary Airport Low Emissions (VALE) Program
  - Financing low emission vehicles, refueling and recharging stations, gate electrification, and other airport air quality improvements for airports in clean air non-attainment and maintenance regions
Improved metrics, measurement techniques, and modeling capability to quantify and predict impacts and to understand inter-relationships of aviation environmental factors.

Aviation Emissions Characterization (AEC) Roadmap

Aviation Climate Change Research Initiative (ACCRI)

Evolving Noise Metrics and Health Impacts Plan
A Way Forward: New Integrated Tools & Approach

**APMT PARTIAL EQUILIBRIUM BLOCK**

- Operations
- Schedule & Fleet
- DEMAND (Consumers)
- SUPPLY (Carriers)
- Fares

**EDS**

What are the environmental implications & costs associated with a vehicle design?

**APMT BENEFITS VALUATION BLOCK**

- Emissions
- CLIMATE IMPACTS
- LOCAL AIR QUALITY IMPACTS
- NOISE IMPACTS
- Noise

**APMT COSTS & BENEFITS**

- Collected Costs
- Emissions & Noise
- Monetized Benefits

**AEDT**

What are the noise and emission characteristics?

Federal Aviation Administration

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A Way Forward: Integrated Assessment

Traditional Increased Stringency Approach to reduce NOx....

Versus consideration of an ultra low sulfur fuel (alternative or conventional)...

Note: All numbers in both charts are not for citation. They are very provisional data used in sample problems for models.
A world-class research organization...

...closely aligned with national and international needs

...leveraging a broad range of stakeholder capabilities

...fostering breakthrough technological, operational, policy and workforce advances

- Georgia Institute of Technology
- Harvard University
- Massachusetts Institute of Technology
- Pennsylvania State University
- Purdue University
- Stanford University
- Missouri University of Science and Technology
- University of North Carolina
- York University
New air traffic management capabilities and procedures will allow us to further reduce aviation’s environmental footprint.
A Way Forward: Benefits of New Procedures Arriving Now

- Instituted in US in Jan 2005
- Enhances capacity in preferred altitudes
- Estimated 300 million gallons saved yearly

- Continuous Descent Approach at LAX
- Saves fuel usage, emissions, and noise

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A Way Forward: U.S. Aeronautics Environmental Goals

N + 1 (2015 EIS)
- 33% Fuel burn
- 60% LTO NOx ref CAEP/6
- 32 dB noise ref Stage 4

N + 2 (2020 IOC)
- 40% Fuel burn
- 70% LTO NOx ref CAEP/6
- 42 dB noise ref Stage 4

N + 3 (2030-35 EIS)
- 70% Fuel burn
Better than - 75% LTO NOx ref CAEP/6
55 LDN (dB) at airport boundary
FAA Continuous Low Energy, Emissions and Noise (CLEEN)
Establishing a consortium to accelerate development of aircraft and engine technologies – to reduce noise, air quality, and greenhouse gas emissions.

Commercial Aviation Alternative Fuel Initiative

http://caafi.org

- Looking at a range of fuels
- Potential to enhances energy security and environmental performance
- Assessing business, safety, and environmental aspects
- Aggressive certification targets
- Operational use in 3-5 years
## The Way Forward: CAAFI Roadmaps

### Alternative Fuel Products
- **2005**
  - SASOL Jet Fuel
  - Qatar GTL
- **2007**
  - Boeing/Virgin Test
  - Qatar GTL Production
- **2010**
  - US Coal CTL
  - US CTL Biomass Co-fired
- **2015**
  - Bio-jet fuel approved
  - China Coal GTL
- **2030**
  - Bio-butanol for ground use
- **2050**
  - Start of Hydrogen Economy

### Economics & Business
- **2005**
  - CTL Economics – Scully Financial
  - ACRP Handbook complete
  - DOE Step Gain in CO2 Sequestration Efficiency
- **2007**
  - 50% USAF Syntroleum Jet Fuel in B-52
  - Spec for 100% SASOL
  - 50/50 Generic FT Blend Listed in ASTM
- **2010**
  - ASTN Lists 100% FT Generic
  - ASTM Bio Fuel Spec
  - Resurgence in Nuclear Power
- **2030**
  - 70% USAF Domestic CTL Sourcing (2025)
  - Future Aircraft for Advanced Fuel
- **2050**

### Certification
- **2005**
  - Spec for 50% SASOL Blend
  - 200M Gals F/T Prod
- **2007**
  - 50/50 Generic FT Blend Listed in ASTM
  - 70% USAF Domestic CTL Sourcing (2025)
- **2010**
  - AF Approval of F/T Fuels
  - AF Approval of F/T Fuels
  - US CTL Production
- **2015**
  - ASTM Bio Fuel Spec
  - Future Aircraft for Advanced Fuel
- **2030**
  - Adv bio fuel emissions
- **2050**

### Environmental
- **2005**
  - B-52 emissions
  - Spec for 100% SASOL
  - Bio-jet tests done
  - Low emissions Bio-fuel certified
- **2007**
  - CTL & Bio-fuel emissions Test
  - LS Bio-FT emissions
  - Bio-jet blend tested
- **2010**
  - Impacts assessment
  - Bio-jet tests done
  - High energy deoxygenated bio-jet fuel from algae
- **2015**
  - Coal to liquids
  - New bio-fuel impacts
- **2030**
  - Coal to liquids
- **2050**

### R&D
- **2005**
  - B-52 syn-fuel flight test
  - Tar Sands Online
  - GE/cruise ships burn biofuel in turbines
- **2007**
  - Biofuel Tested
  - 18t bio-jet Lab tested
  - HBR FT emissions
  - LS Bio-FT emissions
- **2010**
  - F/T swell lubricity issues solved
  - Generic mat.
  - Adv bio fuel emissions
  - Adv bio fuel emissions
- **2015**
  - Boeing/ Virgin 747 Test
  - F-T Fuel Carbon Sequester
  - Bio-jet blend tested
  - F-T and bio-jet blend tests done
- **2030**
  - Synthetic biolog fuels developed
  - Advanced aviation fuel dev
  - High energy deoxygenated bio-jet fuel from algae
- **2050**

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A Way Forward: Some Policy Options

- Developing an “Environmental Management Systems (EMS) Approach” for NextGen
- New decision support tools
- Developing initial metrics and targets for NextGen
- Possible Market-Based Measures
The Year Ahead: Political Developments

December 2009 Copenhagen meeting could shape future decisions on international bunker fuels.


EU steps to include international aviation continue. The current design of their system is likely to produce legal conflict with multiple countries around the world.

U.S. Congress considering a number of climate and energy bills. Unclear what and when legislation will pass.
Some Closing Observations

• U.S. aviation has exceptional environmental record.

• Despite past progress, more complex environmental challenges to aviation growth ahead

• Climate change and energy issues could prove the most significant challenge.

• NextGen plan offers an integrated approach of technology, operational and policy innovation to address environmental constraints.

• A number of international and domestic decisions this year will shape the future of aviation.

• International partnership and collaboration is essential for success in meeting the challenges.