Environmental & Energy Strategy

Addressing Noise, Emissions, and Climate Impacts from Civil Aviation

Presented to: ASCENT Advisory Committee Meeting

By: Dr. Jim Hileman
Office of Environment and Energy
Federal Aviation Administration

Date: October 14, 2015

Economic and Social Benefits of Aviation

5.4% of U.S. GDP

11.8 Million
U.S. jobs

1.5 Trillion
in U.S. economic activity annually

27% of U.S. exports
$430.9 billion

22% of U.S. imports
$509.4 billion

SOURCE: FAA Air Traffic Organization; US Census Bureau

Environmental Protection to enable Increased Mobility

NOISE

Reduce the number of people exposed to significant noise around U.S. airports

AIR QUALITY

Reduce significant air quality impacts attributable to aviation

CLIMATE

Achieve carbon neutral growth by 2020 relative to a 2005 baseline

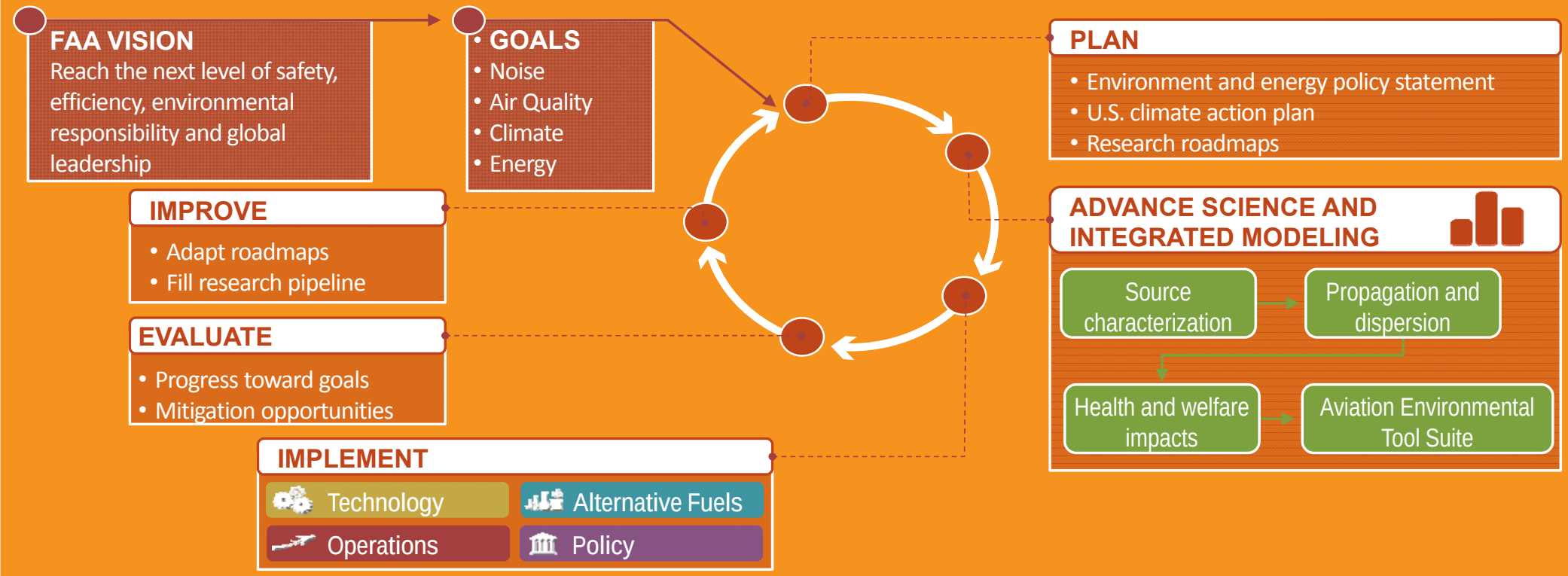
ENERGY

Develop and deploy sustainable alternative aviation fuels

ENVIRONMENT AND ENERGY GOALS

Environmental & Energy Strategy

A holistic approach that builds on aviation's history of technological and operational innovation



The Five Pillar Approach

Science and Tools

PILLAR 1: Improved Scientific Knowledge and Integrated Modeling

- Decision-making based on solid scientific understanding
- Work with research community through the **Aviation Sustainability Center (ASCENT)**
- Understand public health and welfare impacts
- Incorporate this knowledge within the Aviation Environmental Tool Suite

Technology

PILLAR 2: New Aircraft Technologies

- Offer the greatest opportunity to reduce environmental impacts
- Partner with industry, research community, NASA, and Department of Defense
- Mature new engine and airframe technologies through the **Continuous Lower Energy, Emissions and Noise (CLEEN) Program**

Alternative Fuels

PILLAR 3: Sustainable Alternative Aviation Fuels

- Reduce environmental impacts, enhance energy security, and provide economic benefits
- Collaborate with stakeholders through the **Commercial Aviation Alternative Fuels Initiative (CAAFI)**
- Test alternative jet fuels to ensure they are safe for use through **ASCENT** and **CLEEN**
- Analyze their potential for reducing the environmental impacts of aviation

Operations

PILLAR 4: Air Traffic Management Modernization and Operational Improvements

- Increase efficiency of aircraft operations through the **Next Generation Air Transportation System (NextGen)**
- Engage with industry, research community, NASA, and Department of Defense
- Develop advanced operational procedures to optimize gate-to-gate operations
- Integrate infrastructure enhancements to the National Airspace System (NAS), improving environmental performance

Policy

PILLAR 5: Policies, Environmental Standards, and Market Based Measures

- Implement domestic policies, programs, and mechanisms to support technology and operational innovation
- Develop and implement aircraft emissions and noise standards
- Work within the International Civil Aviation Organization (ICAO) to pursue a basket of measures to address emissions that affect climate, including a global market based measure as a gap filler
- Seek international partners to further our environmental and energy strategy

NextGEN

CAAFI

CLEEN

NextGEN

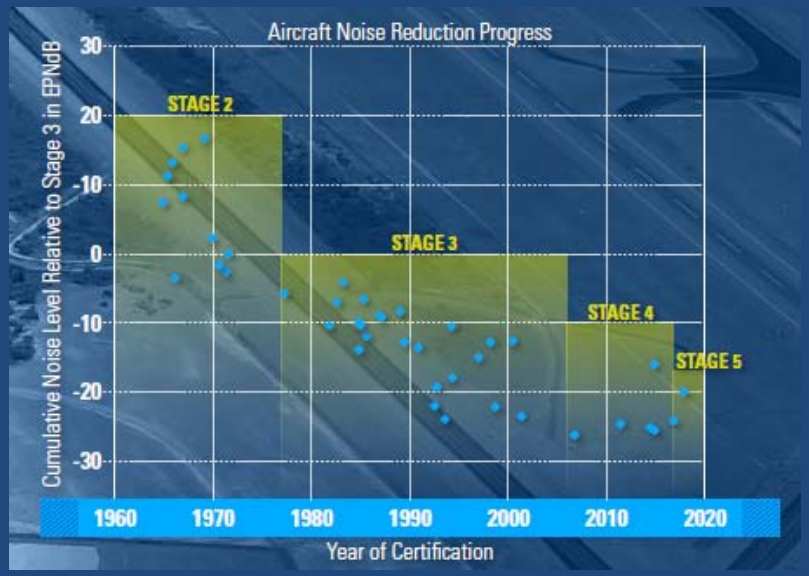
ASCENT

go/cleen

Noise

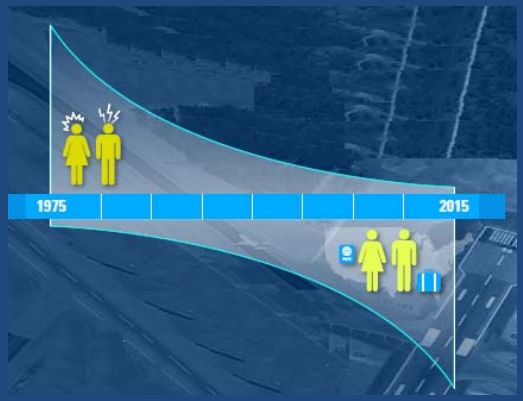
GOAL: Reduce population exposure to significant noise around U.S. airports

What we have ACHIEVED



SOURCE: FAA Office of Environment and Energy

95% reduction
in the number of people exposed to significant noise in proximity to U.S. airports



260% increase in passengers travelling in the U.S. from **200 million** to **720 million**

9 Billion provided by FAA
since 1982 for sound insulation of homes and schools around U.S. airports

Developed a Balanced Approach
using Source Reduction, Land Use Planning, and Operational Procedures and Restrictions

Noise: What we are DOING NOW

SCIENCE & INTEGRATED MODELING

ANNOYANCE
Nationwide survey to understand community reaction to aircraft noise

CHILDREN'S LEARNING
Case Studies through the National Academy of Science

HUMAN HEALTH
Explore the incremental effects of aviation noise on human health

SLEEP DISTURBANCE
Field studies to determine physiological impacts of aviation noise

MODELING
Improve modeling of noise effects and impacts

MITIGATION

NEW TECHNOLOGY
Mature new aircraft and engine technologies to reduce aircraft source noise through FAA's CLEEN Program

OPERATIONS
Develop and implement procedures to reduce noise exposure

SOUND INSULATION
Continue the long-established Sound Insulation Program and improve eligibility criteria

LAND USE PLANNING
Examine land use compatibility older jet aircraft so Stage guidelines

POLICY
Promulgate Stage 5 noise standard and phase out 3 and quieter are flying after end of 2015

Noise: What we are DOING NOW

The FAA's CLEEN Program is working with Pratt & Whitney to develop technologies for the **ultra-high bypass geared turbofan engine** that enable a **25 EPNdB noise reduction** relative to the Stage 4 noise standard while **reducing fuel consumption by 20%**

The "**double bubble" D8 Series aircraft design concept** developed by NASA, MIT, Aurora Flight Sciences, and Pratt & Whitney is demonstrating how aircraft configuration changes can provide a **step change in noise and fuel use**

Air Quality

GOAL: Reduce significant air quality impacts attributable to aviation

What we have ACHIEVED

Eliminated smoke emissions

DC-8, 1958

Boeing 787, 2012

50% reduction in CAEP Nitrogen Oxides (NO_x) emissions standard since 1995

18% reduction in fuel burned over the last 7 years, yielding lower pollutant emissions despite growth in civil aviation

Characterized gaseous and Particulate Matter (PM) emissions from aircraft engines burning jet fuel

Measured 50% reduction in PM emissions from the use of alternative jet fuels in full scale jet engines

SOURCE: EPA Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2012, EPA 430-R-14-003, April 15, 2014

Air Quality: What we are DOING NOW

SCIENCE & INTEGRATED MODELING

HUMAN HEALTH

Explore the incremental effects of aviation emissions on human health

ENGINE CERTIFICATION

Use the latest measurement technology to certify engine emissions

EMISSION MEASUREMENTS

Develop gaseous and PM emissions measurement systems for jet engine exhaust

MODELING

Improve modeling of aviation emissions consequences and impacts

MITIGATION

NEW TECHNOLOGY

Mature new aircraft and engine technologies to reduce emissions through FAA's CLEEN Program

OPERATIONS

Develop and implement procedures to reduce emissions

ALTERNATIVE FUELS

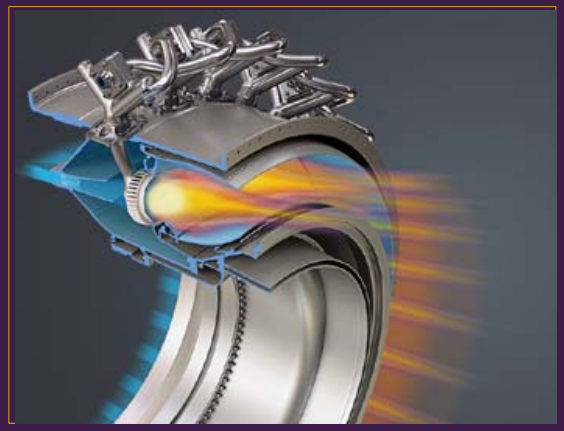
Deploy alternative fuels to reduce PM emissions

POLICY

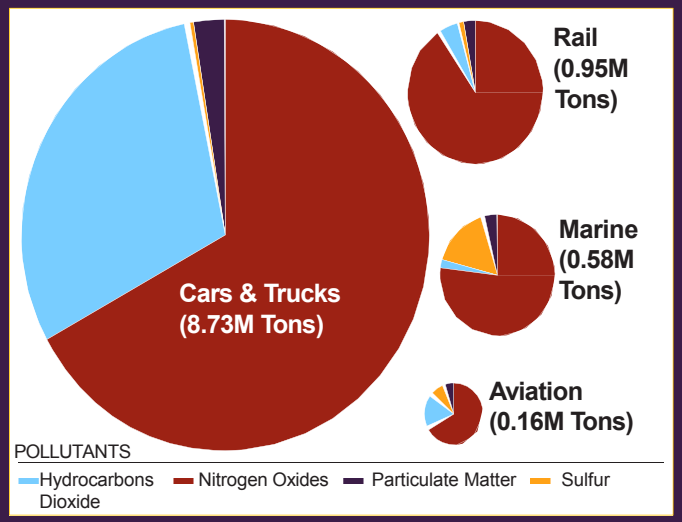
Promulgate engine PM emissions standard

Air Quality: What we are DOING NOW

The FAA's CLEEN Program is developing aircraft technologies that reduce emissions, including GE's TAPS II Combustor, which reduces landing and takeoff NO_x emissions **55% below** the most recent CAEP standard and PM **90% below** ICAO's visibility smoke limit



Aviation's **contribution to emissions inventories** compared to other sources **has remained modest**



SOURCE: EPA, 2011 National Emissions Inventory

Climate

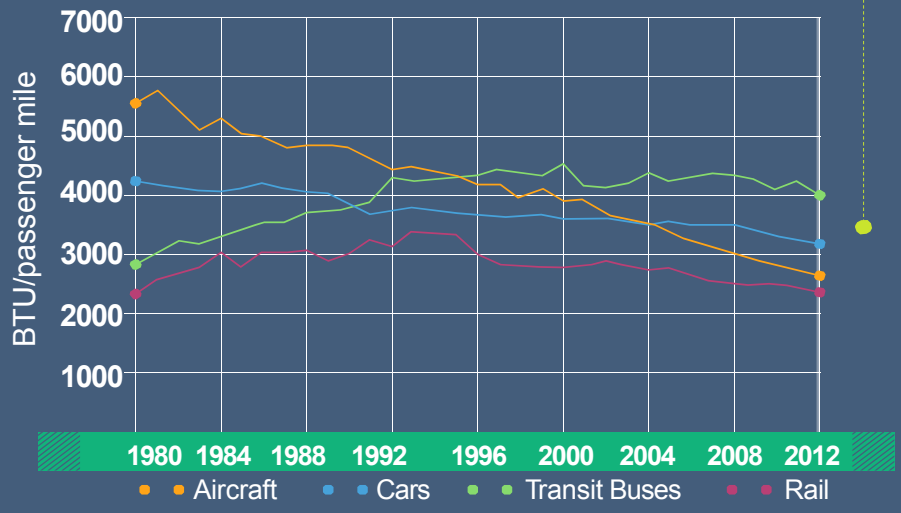
GOAL: Achieve carbon neutral growth by 2020 relative to a 2005 baseline

What we have ACHIEVED

Climate Action Plan
for U.S. Aviation

Three decades of aviation energy efficiency improvement

SOURCE: FAA Office of Environment and Energy, Transportation Energy Data Book, 2014



Estimated that **global aviation Carbon Dioxide (CO_2) emissions** could grow to **5%** by 2050 from current 2% level

80% reduction in lifecycle greenhouse gas emissions compared to conventional fuels achievable via certified alternative jet fuels

Quantified aviation greenhouse gas emissions and **reduced uncertainties on contrail effects**

Climate: What we are DOING NOW

SCIENCE & INTEGRATED MODELING

CLIMATE METRICS
Explore the incremental effects of aviation emissions on climate change

CONTRAILS
Understand condensation trails formation and their effects

CRUISE EMISSIONS
Study impacts from aircraft emissions at altitude

MODELING
Improve fuel use calculations and climate impacts modeling

MITIGATION

NEW TECHNOLOGY
Mature new aircraft and engine technologies to reduce CO_2 emissions through FAA's CLEEN Program

OPERATIONS
Develop and implement procedures to reduce fuel use

ALTERNATIVE FUELS
Advance certification of drop-in alternative jet fuels, and calculate well-to-wake climate benefits

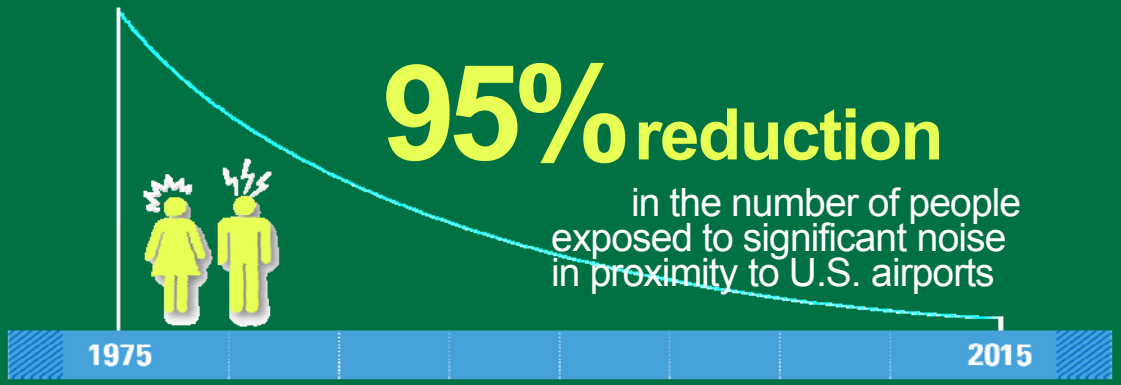
POLICY
Develop global market based measure for international aviation and promulgate aircraft CO_2 standard

Climate: What we are DOING NOW

The FAA's CLEEN Program is developing aircraft technologies that **reduce fuel use and CO_2 emissions**, including Boeing's adaptive trailing edge and ceramic matrix composite exhaust nozzle technologies which were flight tested on the Boeing ecoDemonstrator aircraft

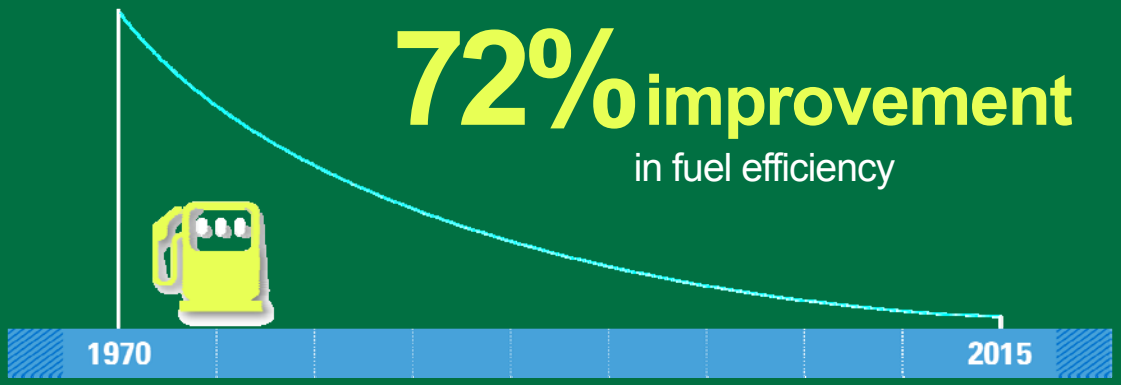
NASA and FAA are working with international partners from Canada and Germany to **characterize alternative fuel emissions in flight and to understand contrail formation**

What we have ACHIEVED



95% reduction

in the number of people exposed to significant noise in proximity to U.S. airports



72% improvement

in fuel efficiency

SOURCE: Office of Environment and Energy; Lee, J., et al. 2001, and Bureau of Transportation Statistics (BTS)

260% increase in passengers travelling in the U.S. from **200 million** to **720 million**

Ultra low nitrogen oxides (No_x) emissions combustor technology developed and in use

Alternative jet fuels approved and in use by industry