Environment & Energy Research & Development Portfolio Overview

Prepared for: Full REDAC Meeting

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Office of Environment and Energy
Federal Aviation Administration

Date: October 20, 2021

Presentation Outline

- **Office of Environment and Energy – Background & E&E Overview**
- **Highlights of R&D Program**
- **Direction of the E&E Portfolio**
  - Noise and Emissions
  - Overview of Climate Change Efforts
  - Sustainable Flight National Partnership
  - SAF Grand Challenge
- **Summary**

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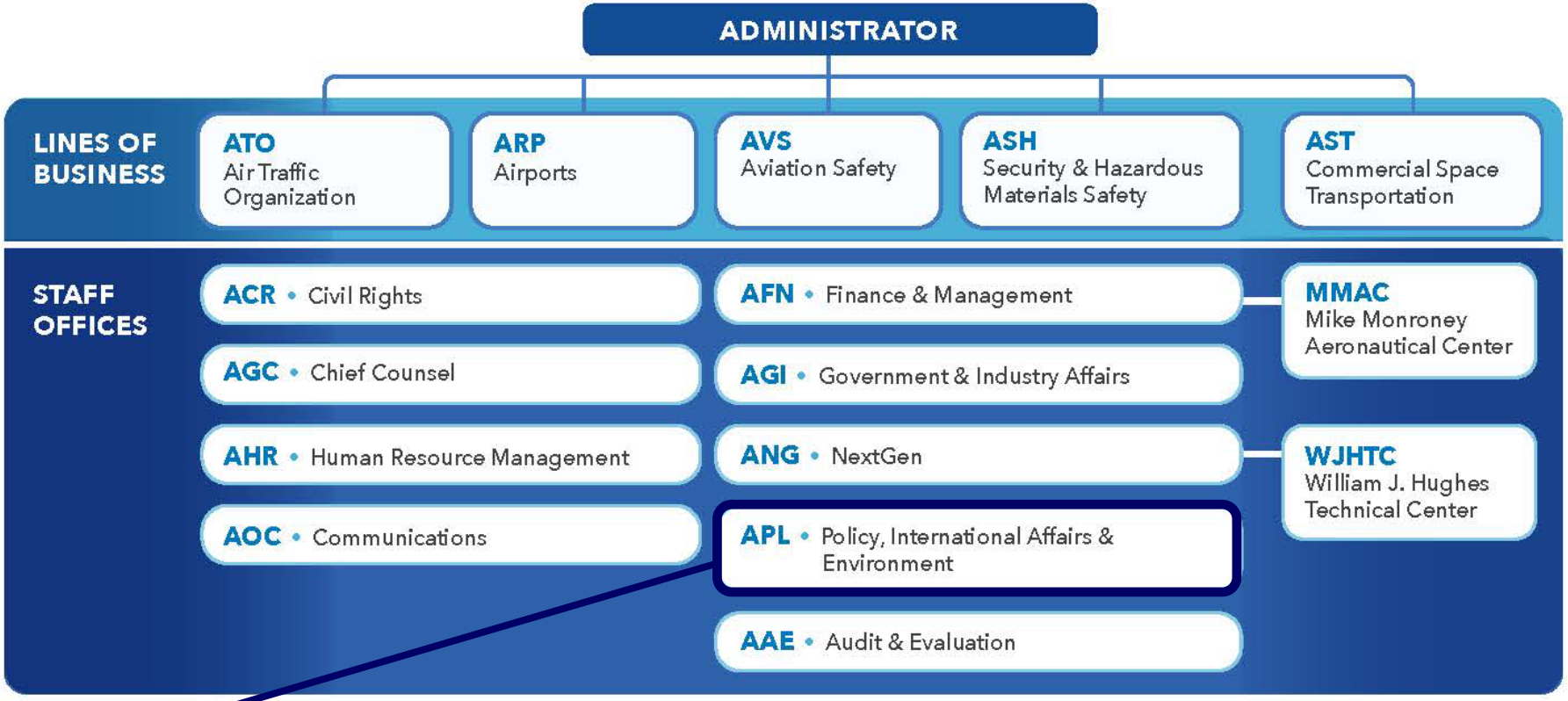
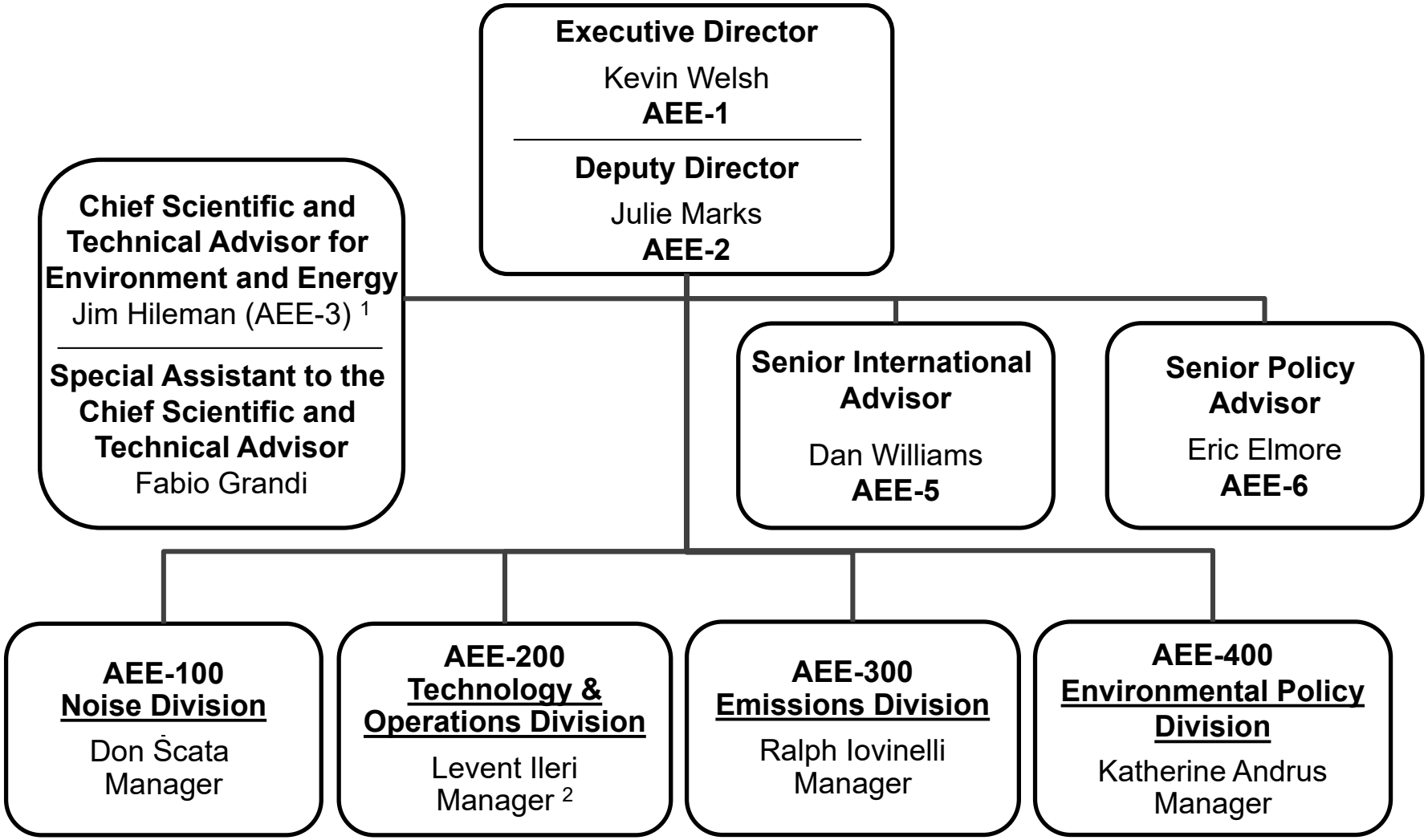
FAA Organizational Structure



Office of Environment and Energy (AEE)

- Office within APL, responsible for broad range of environmental policies
- Roughly 45 staff members
- Responsible for roughly one-fourth of FAA RE&D Budget

AEE Organizational Structure



[1] ASCENT Program Manager, as a subset of his Chief Scientist duties

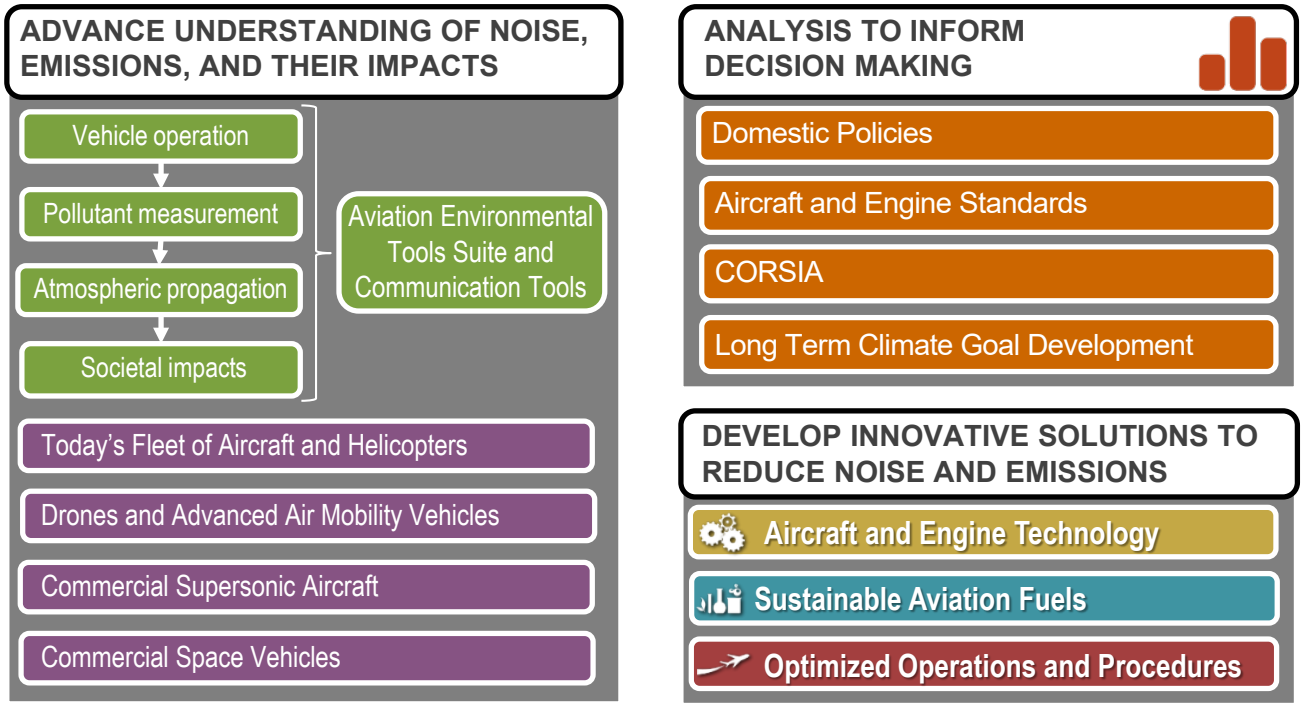
[2] CLEEN Program Manager, as a subset of his Division Manager duties

Environmental & Energy (E&E) Strategy

E&E Mission: *To understand, manage, and reduce the environmental impacts of global aviation through research, technological innovation, policy, and outreach to benefit the public*

E&E Vision: *Remove environmental constraints on aviation growth by achieving quiet, clean, and efficient air transportation*

E&E R&D Portfolio Activities & Programs



ASCENT Aviation Sustainability Center
www.ascent.aero/

CLEEN Continuous Lower Energy, Emissions & Noise Federal Aviation Administration
www.faa.gov/go/cleen/

CAAFI®
www.caafi.org/

the VOLPE center

Environmental & Energy R&D Portfolio

RE&D Environment & Energy BLI*

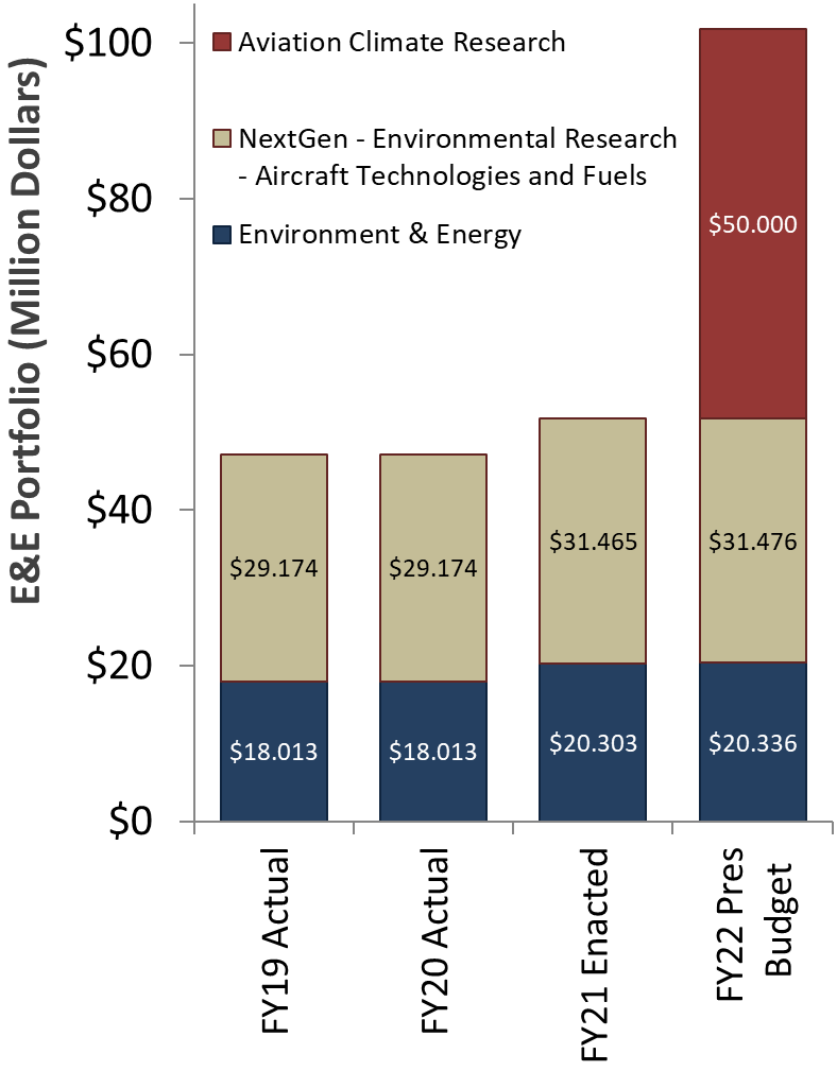
- Advance understanding of noise and emissions
- Analysis to inform decision making

RE&D NextGen – Environmental Research – Aircraft Technology and Fuels BLI**

- Accelerate development of aircraft and engine technologies
- Testing, analysis and coordination on Sustainable Aviation Fuels (SAF)

RE&D Aviation Climate Research BLI***

- New budget line item for FY22
- Enhances efforts on SAF, technology development, and efforts related to unleaded aviation gasoline (led by AVS/ANG)



*Budget Line Items: A13.a (FY18 & FY19), A12.a (FY20), A.T (FY21), A11.u (FY22)

** Budget Line Items: A13.b (FY18 & FY19), A12.b (FY20), A.U (FY21), A11.v (FY22)

*** Budget Line Item: A11.z (FY22)

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Highlights of Ongoing R&D Efforts (E&E Portfolio)

- Research efforts continue to inform decision making
- Broad ASCENT research portfolio from impacts to innovation
- Technology maturation in CLEEN continues and we have made most of the awards for 3rd Phase of CLEEN
- Sustainable aviation fuels: CORSIA, CAAFI, and ASTM
- Exploring how to use operational procedures to help address noise concerns and climate impacts of aviation
- Released AEDT3d - executing long term vision for AEDT
- Rotorcraft noise research efforts continue: helicopters, drones and advanced air mobility
- Continuing wide-ranging portfolio on supersonic aircraft
- Supporting other parts of FAA and EPA in addressing lead emissions
- ***Considerable inter-agency collaboration to address CO_2 emissions***

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Environmental Impacts of Aviation

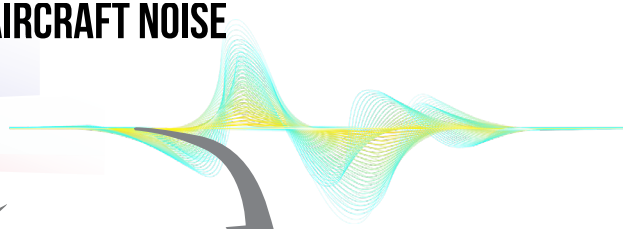
COMBUSTION EMISSIONS

CO_2: 71%

Water: 28%

CO, HC, NO_x, SO_x, Primary $PM_{2.5}$: <1%

AIRCRAFT NOISE



ATMOSPHERIC CHEMISTRY & PHYSICS

Primary $PM_{2.5}$

SO

NO

UHC

CO

Secondary $PM_{2.5}$

Ozone

Primary $PM_{2.5}$

SO_x

NO_x

Ozone

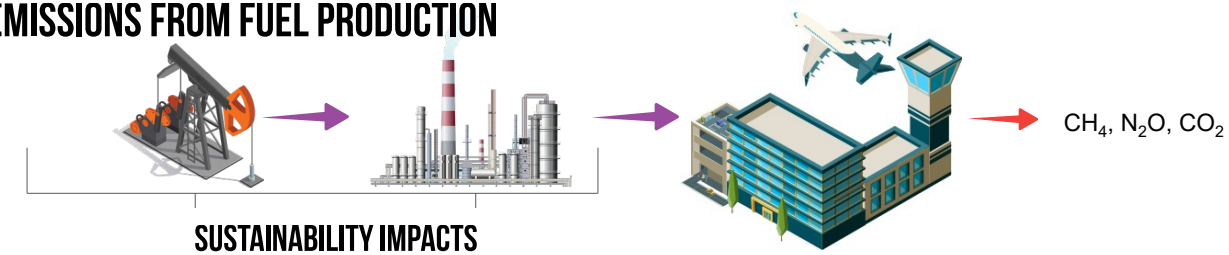
CH_4

CO_2

H_2O

Contrails & Cirrus Clouds

EMISSIONS FROM FUEL PRODUCTION



CH_4, N_2O, CO_2

SUSTAINABILITY IMPACTS

POPULATION EXPOSURE AND HEALTH IMPACTS

GLOBAL CLIMATE CHANGE

Cooling Effects

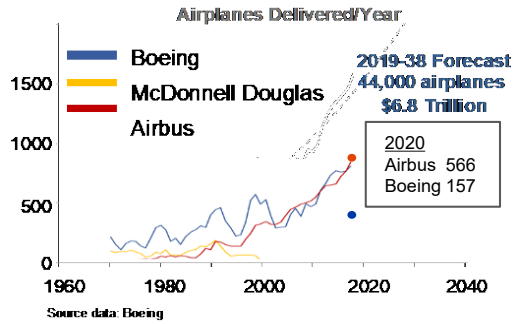
Warming Effects

OZONE LAYER

Slide created in collaboration with NASA ARMD

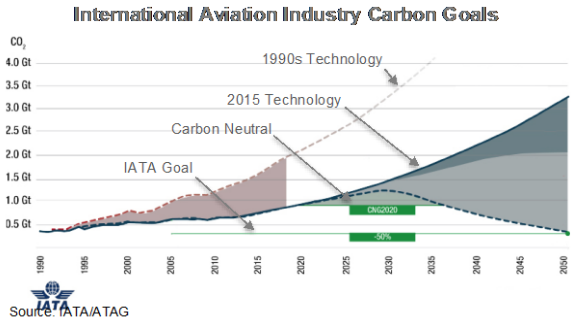
Global Competition and Environmental Pressures

Economic Perspective



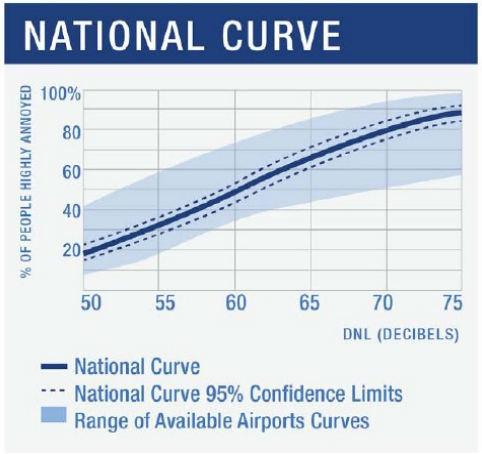
- Airline industry hard hit by COVID-19
- Global competition growing
- Limited industry funding for R&D investments

Environmental Context – CO_2



- Societal pressure growing on climate globally

Environmental Context – Noise



Technological innovation essential to enable sustainable growth & maintain U.S. global leadership

Noise R&D Update

Federal Register Notice

Provides comprehensive overview of FAA R&D efforts on noise

- Effects of Aircraft Noise on Individuals and Communities
- Noise Modeling, Noise Metrics and Environmental Data Visualization
- Reduction, Abatement and Mitigation of Aviation Noise

Includes neighborhood environmental survey results with a link to the full study

Received 4,162 comments

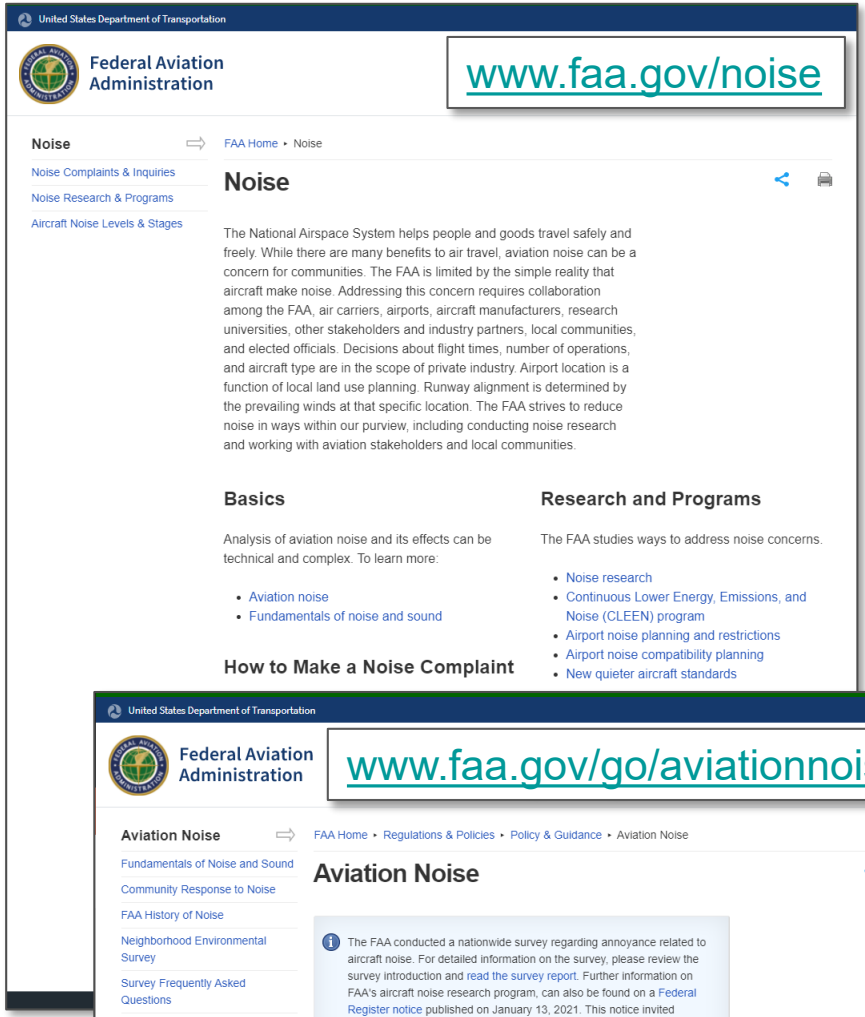
https://www.regulations.gov/docket/FAA-2021-0037

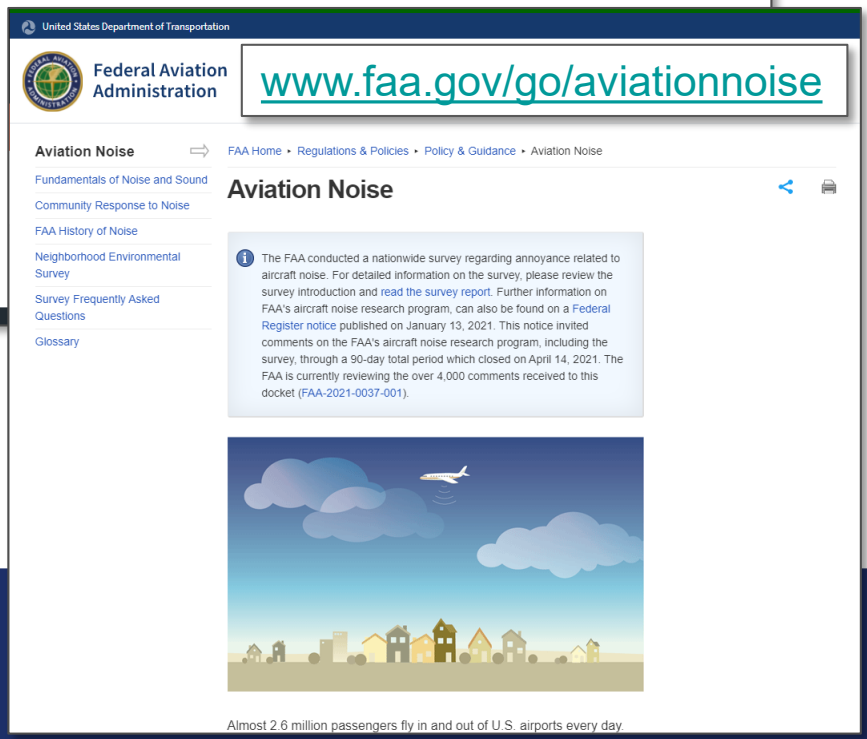
Expanded the aviation noise website to include details on the noise survey

https://www.faa.gov/regulations_policies/policy_guidance/noise/survey/

Have had extensive outreach on FRN including a public webinar on February 22, 2021.

Webinar link https://www.youtube.com/watch?v=Mku13gL0xGc





Helicopters, New Entrants and Commercial Space

Helicopters

- Continuing efforts to use noise measurements and modeling to improve our analytical capabilities and develop measures to reduce noise from operations

Unmanned Aerial Systems

- Conducting noise measurements and developing analytical capabilities to enable improved noise predictions for potential use in AEDT

Advanced Air Mobility Vehicles

- Conducting noise measurements and developing analytical tools to aid in designing quieter vehicles
- Looking to stand up research to enable improved noise predictions for AEDT

Supersonic Civil Aircraft

- Continuing research efforts on multiple fronts through ASCENT, CLEEN and Volpe to support standard setting in ICAO, understand environmental impacts, and to aid in the development of lower noise / emissions vehicles

Hypersonic Civil Aircraft / Commercial Space

- Monitoring environmental efforts in this area – depending on appropriations levels, will stand up research effort to examine climate/ozone impacts

Efforts Relating to Aircraft Emissions

Understanding Emissions

- Conducting Particulate Matter (PM) measurements
- Improving atmospheric modeling capabilities for regulatory tools
- Assessing impacts on air quality, climate change, and ozone layer
- Evaluating current aircraft, commercial supersonic aircraft, unmanned aerial systems, advanced air mobility, and commercial space vehicles

Reducing Emissions at the Source

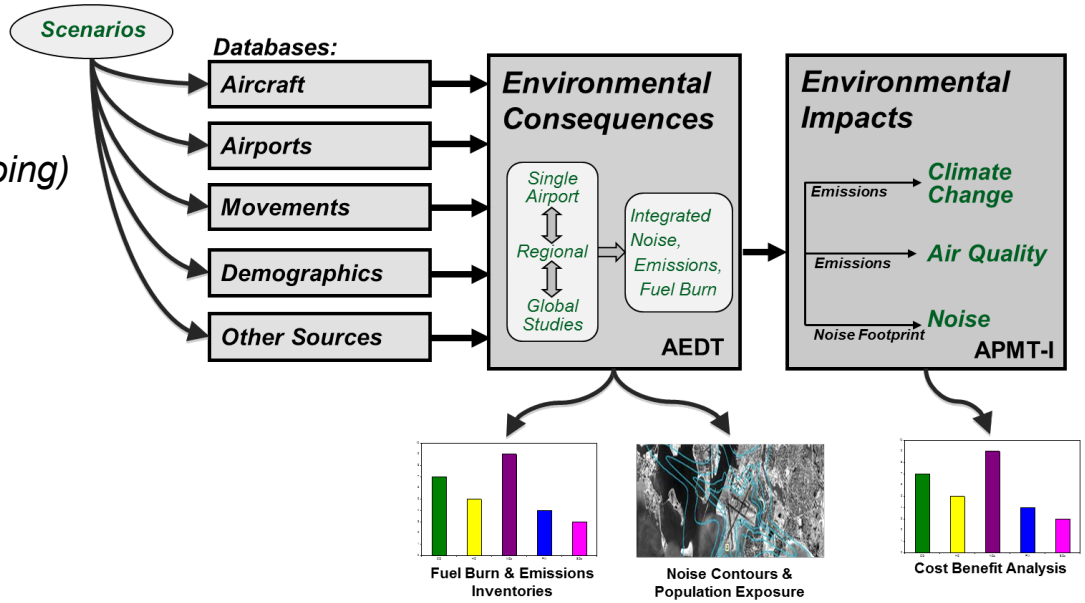
- Aircraft technologies and architecture
- Modifications to fuel composition
- Vehicle operations
- Engine standard (NO_X, CO_2, and PM standards)
- Future trends analysis
- *Working across agency to address lead emissions*

Mitigation

- Alternative fuel sources
- Policy measures (CORSIA)

Efforts to Support Decision-Making

- Using research portfolio to ensure we have a robust assessment of a wide range of economic and environmental impacts that could result from aviation noise, emissions, and energy policy.
- R&D program informing decision making:
  - *Long-term aspirational CO_2 goal (ongoing)*
  - *Supersonic Aircraft Noise (ongoing)*
  - *Fuel Composition (ongoing)*
  - *ICAO CAEP/11 PM Standard (2019)*
  - *CORSIA (2019)*
  - *ICAO CAEP/10 CO_2 Standard (2016)*
  - *ICAO CAEP/9 Noise Standard (2013)*
  - *ICAO CAEP/8 NOx Standard (2010)*

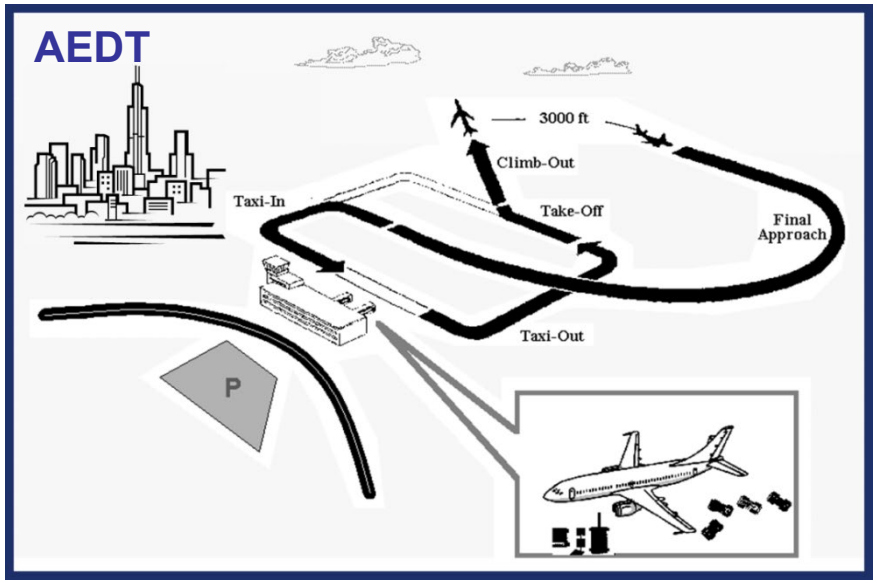


- Volpe Center and ASCENT Center of Excellence universities working directly with FAA to develop data and tools to inform decision making.

Efforts Relating to Analytical Tool Development

Aviation Environmental Design Tool (AEDT)

- Computes noise, fuel burn and emissions simultaneously
- Can analyze airport, regional, national, and global scales
- Required for all regulatory actions
- Also in use by 473 international users from 43 countries (as of Sept 2020)



AEDT Development Plan

- Have annual release cycle to continuously improve tool and ensure latest information is in use by aviation community
- Laying ground work for major upgrade in 2023 to improve noise modeling
- Developing noise screening tool to support NEPA process

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Biden Administration Commitment on Climate Change

- **Day One:** Took action to re-join the Paris Agreement
- **Executive Order 14008 on Tackling the Climate Crisis**
  - *"put the United States on a path to achieve net-zero emissions, economy-wide, by no later than 2050"*
- **Leaders Summit on Climate – April 23, 2021:**
  *"**Reducing emissions from international aviation.** The United States is committed to working with other countries on a vision toward reducing the aviation sector's emissions in a manner consistent with the goal of net-zero emissions for our economy by 2050, as well as on robust standards that integrate climate protection and safety. The United States intends to advance the development and deployment of high integrity sustainable aviation fuels and other clean technologies that meet rigorous international standards, building on existing partnerships, such as through ASCENT– the Aviation Sustainability Center – and pursue policies to increase the supply and demand of sustainable aviation fuels. In the International Civil Aviation Organization, we will engage in processes to advance a new long-term aspirational goal in line with our vision for reducing greenhouse gas emissions in the aviation sector, and continue to participate in the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)."*

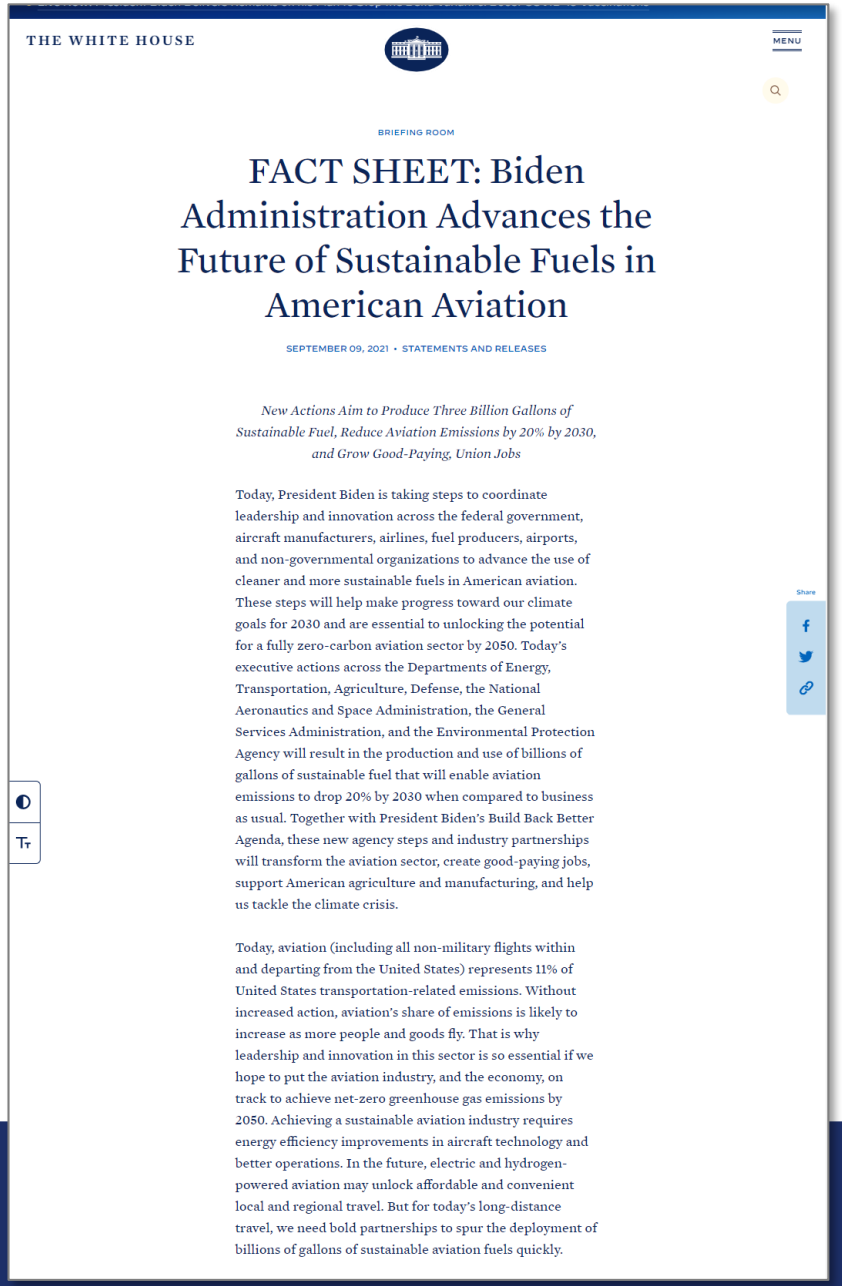
Fact sheet from President Biden's Leaders Summit on Climate: https://www.whitehouse.gov/briefing room/statements releases/2021/04/23/fact sheet president bidens leaders summit on climate/

White House Sustainable Aviation Event (1 of 2)

On September 9, 2021, government and industry leaders discussed actions being taken by the government and industry to federal actions and industry to “produce three billion gallons of sustainable fuel, reduce aviation emissions by 20% by 2030, and grow good-paying, union jobs.”

Speakers included the White House National Climate Advisor; Secretaries of Agriculture, Transportation, and Energy; NASA Administrator; Secretary of the USAF; Senator Brown; Representatives Schneider and Brownley; and CEOs for several trade associations and companies; among others.

Actions that are being undertaken are captured in a White House Fact Sheet



THE WHITE HOUSE

MENU

BRIEFING ROOM

FACT SHEET: Biden Administration Advances the Future of Sustainable Fuels in American Aviation

SEPTEMBER 09, 2021 • STATEMENTS AND RELEASES

New Actions Aim to Produce Three Billion Gallons of Sustainable Fuel, Reduce Aviation Emissions by 20% by 2030, and Grow Good-Paying, Union Jobs

Today, President Biden is taking steps to coordinate leadership and innovation across the federal government, aircraft manufacturers, airlines, fuel producers, airports, and non-governmental organizations to advance the use of cleaner and more sustainable fuels in American aviation. These steps will help make progress toward our climate goals for 2030 and are essential to unlocking the potential for a fully zero-carbon aviation sector by 2050. Today's executive actions across the Departments of Energy, Transportation, Agriculture, Defense, the National Aeronautics and Space Administration, the General Services Administration, and the Environmental Protection Agency will result in the production and use of billions of gallons of sustainable fuel that will enable aviation emissions to drop 20% by 2030 when compared to business as usual. Together with President Biden's Build Back Better Agenda, these new agency steps and industry partnerships will transform the aviation sector, create good-paying jobs, support American agriculture and manufacturing, and help us tackle the climate crisis.

Today, aviation (including all non-military flights within and departing from the United States) represents 11% of United States transportation-related emissions. Without increased action, aviation's share of emissions is likely to increase as more people and goods fly. That is why leadership and innovation in this sector is so essential if we hope to put the aviation industry, and the economy, on track to achieve net-zero greenhouse gas emissions by 2050. Achieving a sustainable aviation industry requires energy efficiency improvements in aircraft technology and better operations. In the future, electric and hydrogen-powered aviation may unlock affordable and convenient local and regional travel. But for today's long-distance travel, we need bold partnerships to spur the deployment of billions of gallons of sustainable aviation fuels quickly.

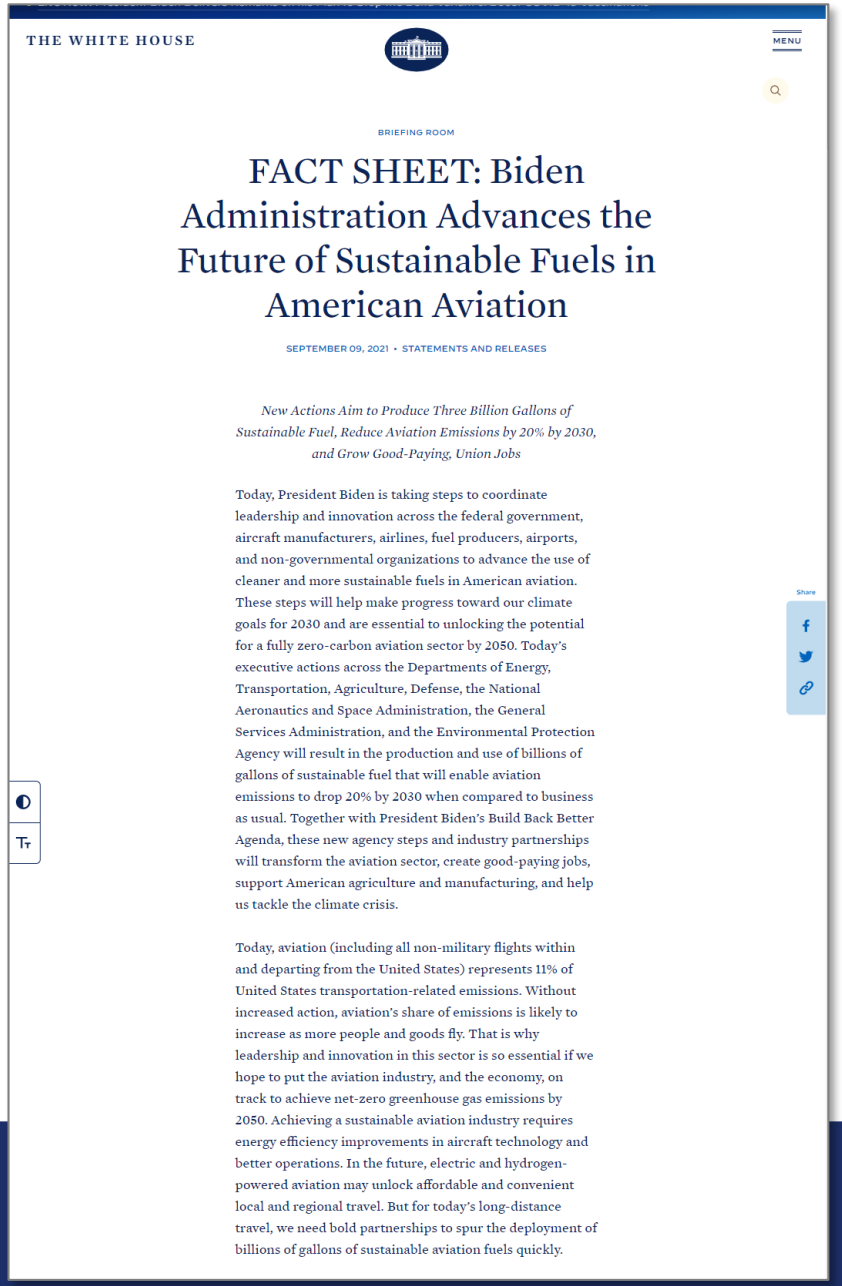
White House Sustainable Aviation Fact Sheet:
https://www.whitehouse.gov/briefing-room/statements-releases/2021/09/09/fact-sheet-biden-administration-advances-the-future-of-sustainable-fuels-in-american-aviation/

White House Sustainable Aviation Event (2 of 2)

Key federal actions include:

- A new Sustainable Aviation Fuel Grand Challenge to inspire the dramatic increase in the production of sustainable aviation fuels to at least 3 billion gallons per year by 2030;
- New and ongoing funding opportunities to support sustainable aviation fuel projects and fuel producers totaling up to $4.3 billion;
- An increase in R&D activities to demonstrate new technologies that can achieve at least a 30% improvement in aircraft fuel efficiency;
- Efforts to improve air traffic and airport efficiency to reduce fuel use, eliminate lead exposure, and ensure cleaner air in and around airports; and
- The demonstration of U.S. leadership both internationally and through the federal example.

Fact Sheet announces third phase of CLEEN and efforts in ASCENT on SAF and contrail avoidance as well as efforts related to ICAO and leaded aviation gasoline fuels.



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Climate Change - Direction of the R&D Portfolio

Background on Aviation and Climate Change

- Aviation has two primary contributors to climate change: CO_2 emissions and aviation-induced cloudiness
- Taking a holistic approach to de-carbonizing aviation (SAF, technology, operations, policy) and ensure international leadership from the U.S. on aviation climate issues

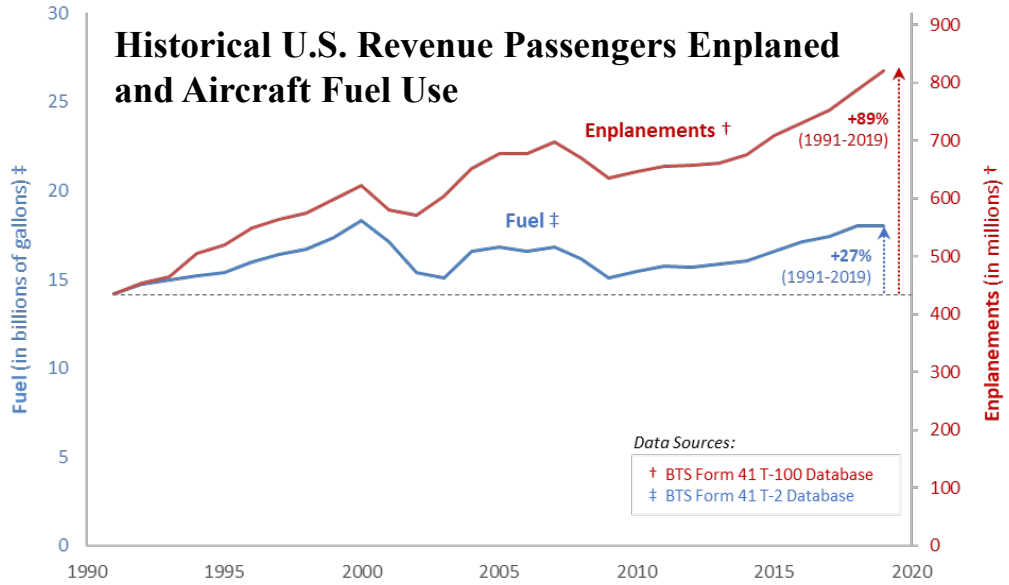
Climate Research Portfolio Direction

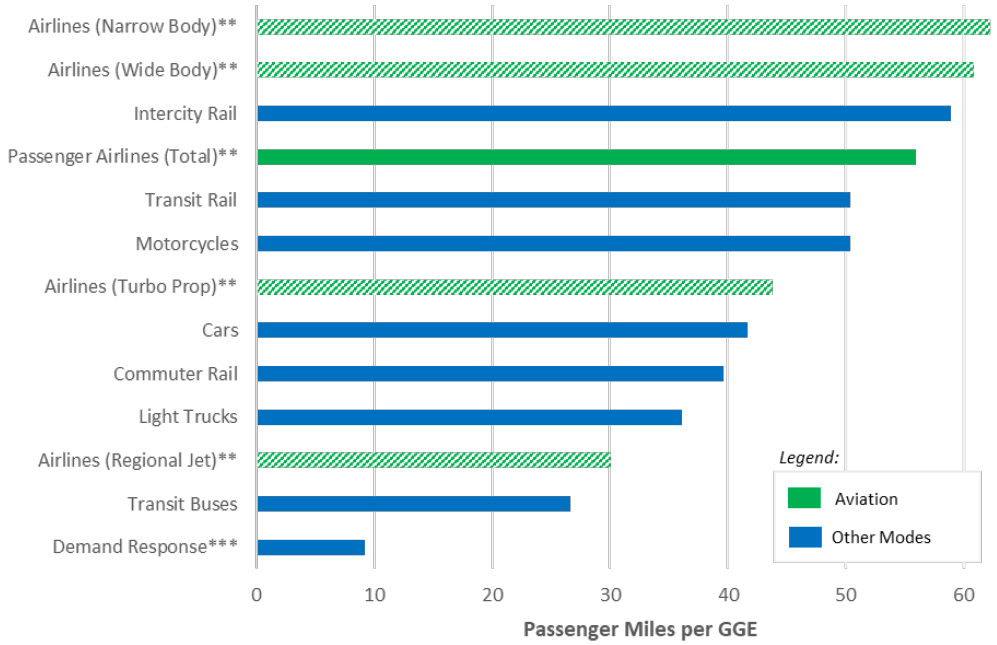
- Technology Development: required for to address climate crisis and noise challenge
- Sustainable Aviation Fuels: most promising near to medium-term means to reduce aviation CO_2 emissions, critical to decarbonization in the long term
- Operational Procedures: seeking opportunities to reduce fuel use and laying ground work to develop decision support tools to address aviation induced cloudiness
- International leadership: R&D program provides the scientific data and analyses that are required for the U.S. to lead direction of international aviation climate negotiations
- Advancing Understanding: conducting research to better understand the impacts of non-CO_2 combustion emissions from all flight vehicles
- Analytical Tools: providing the models that are used across the globe to quantify aviation fuel burn and emissions
- Emerging Technologies and Energy Sources: need to give appropriate consideration to emerging technologies and concepts, but avoid looking for a “silver bullet”

Domestic Fuel Efficiency

National Airspace System (NAS) is operating much more efficiently today than 30 years ago —moving more passengers on the same amount of energy.

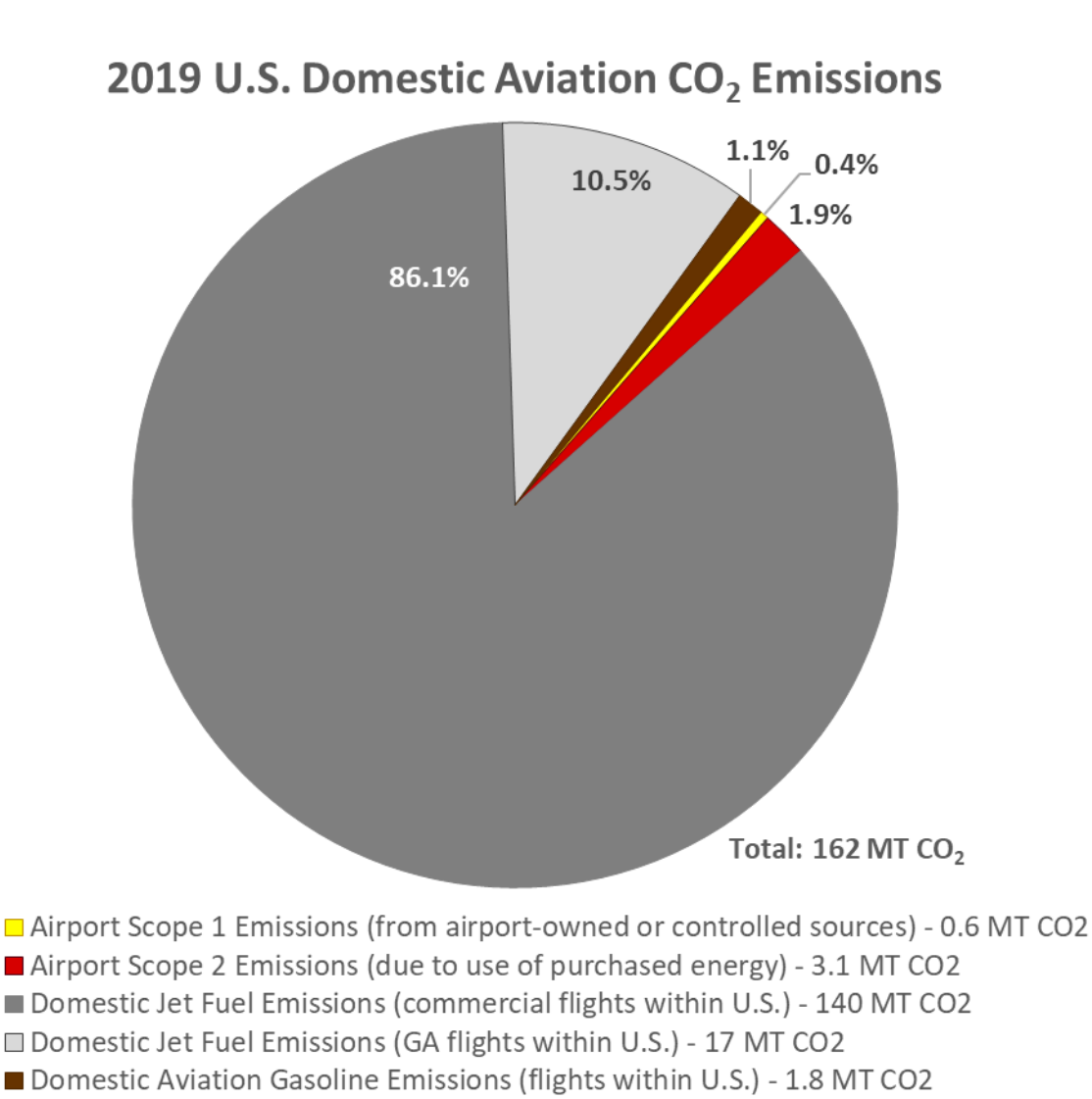
Today's fleet of aircraft has an average fuel efficiency of 57.5 passenger-miles per gallon of fuel; for comparison, a modern Toyota Prius hybrid, which has a fuel economy of 54 miles per gallon (MPG).

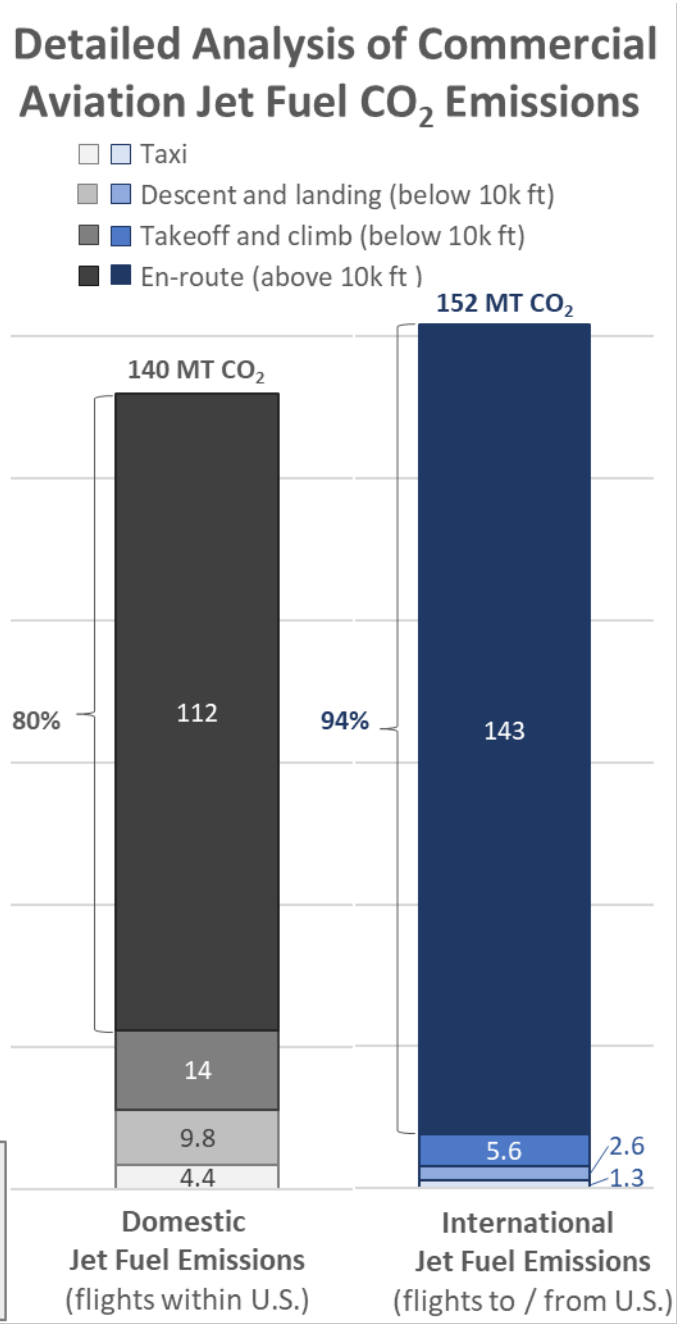




Notes: * Gasoline-Gallon Equivalents (GGE) are used to compare gasoline, diesel, and electricity on a level basis. Alterations to the source data were made to account for the inefficiencies of electricity production. This impacts rail the most because it has the highest level of electric power.
** Domestic flights only. All fuel use is attributed to passengers, none to cargo that might be using the same airplane.
*** Includes passenger cars, vans, and small buses operating in response to calls from passengers to the transit operator who dispatches the vehicle.

Domestic Aviation Emissions





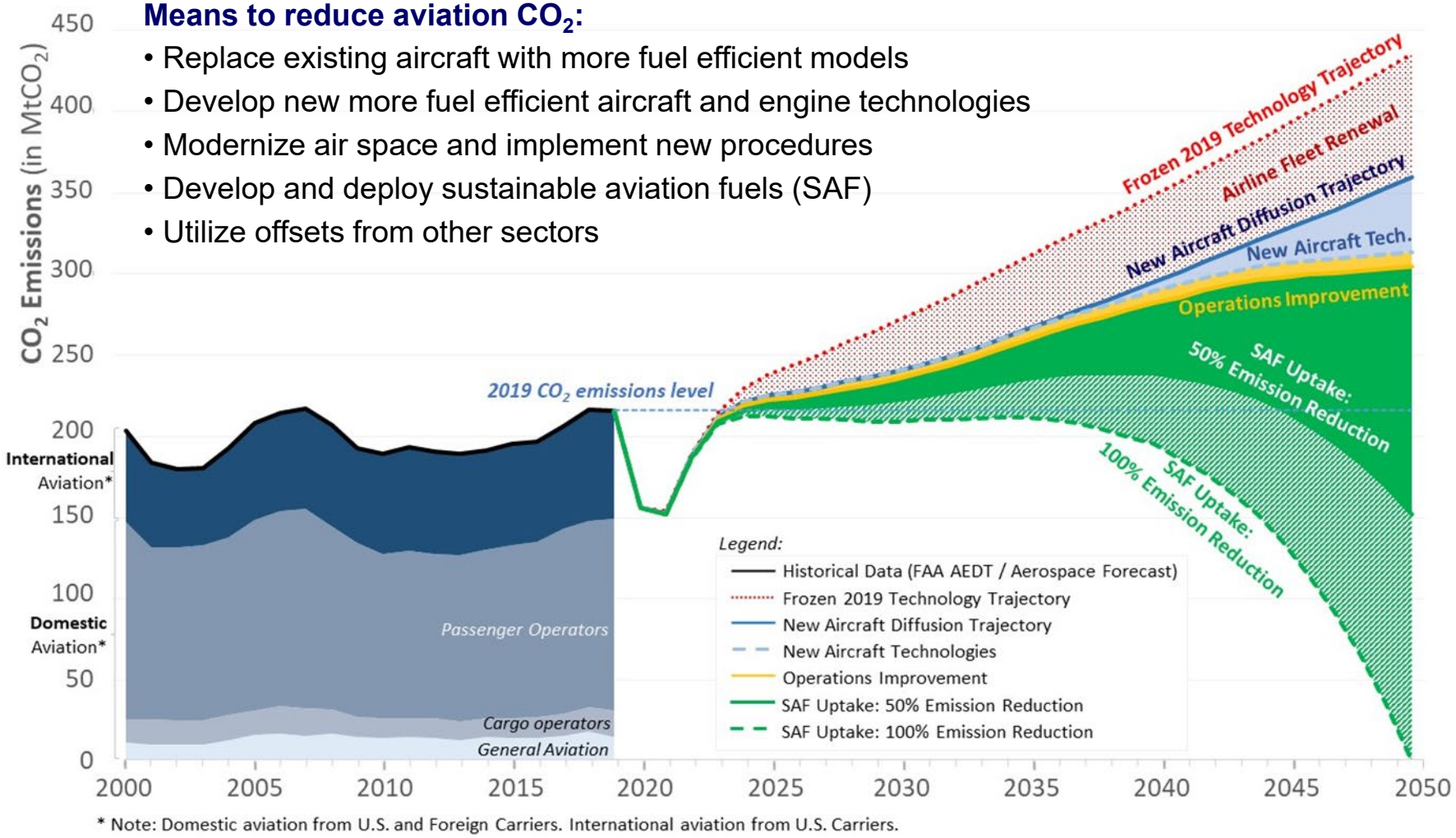
Notes:
- Airport scope 1 and 2 emissions from ACI 2021 Long-Term Carbon Goal Study for Airports (Fig 23)
- Jet fuel and aviation gasoline emissions based on FAA Aerospace Forecast (2020-2040) (Table 23)
- Detailed analysis of commercial aviation jet fuel emissions based on AEDT analysis
- International jet fuel emissions includes U.S., international, and foreign airspace

Actions to Reduce U.S. Aviation CO_2 Emissions

Working to accelerate industry action to lower CO_2 emissions trajectory

Means to reduce aviation CO_2:

- Replace existing aircraft with more fuel efficient models
- Develop new more fuel efficient aircraft and engine technologies
- Modernize air space and implement new procedures
- Develop and deploy sustainable aviation fuels (SAF)
- Utilize offsets from other sectors



* Note: Domestic aviation from U.S. and Foreign Carriers. International aviation from U.S. Carriers.

NOTE: Graphic developed by Philippe Bonnefoy of Blue Sky based on ongoing analysis efforts supported by the FAA Office of Environment & Energy (AEE).

ICAO CAEP Long Term Aspirational Goal (LTAG) Support

- FAA providing staffing and researchers to support CAEP exploration of feasibility of a long term aspirational goal for CO_2 emissions from international aviation
- Engaging directly across all aspects of this work (tech, fuels, operations, scenarios) to support assessment of current, foreseen, innovative measures to contribute to CO_2 reduction under various future scenarios
- Leveraging multiple efforts to provide analysis support
  - ASCENT Projects 1 & 52 providing fuel analysis
  - ASCENT Project 64 providing technology
  - Considerable support from other USG agencies, Volpe and Blue Sky

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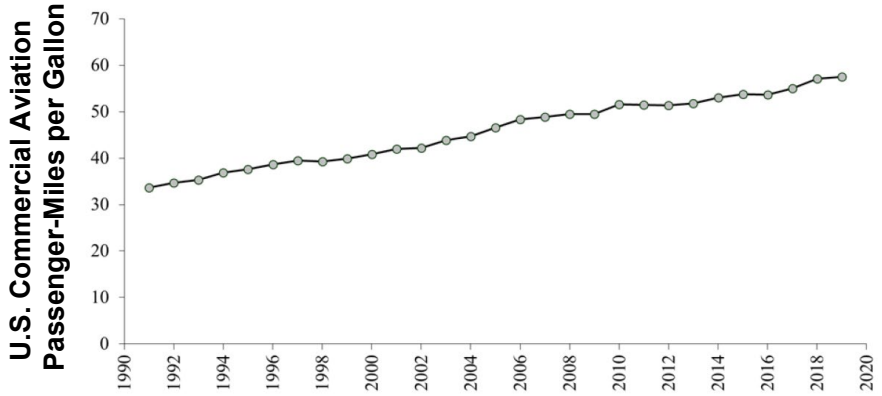
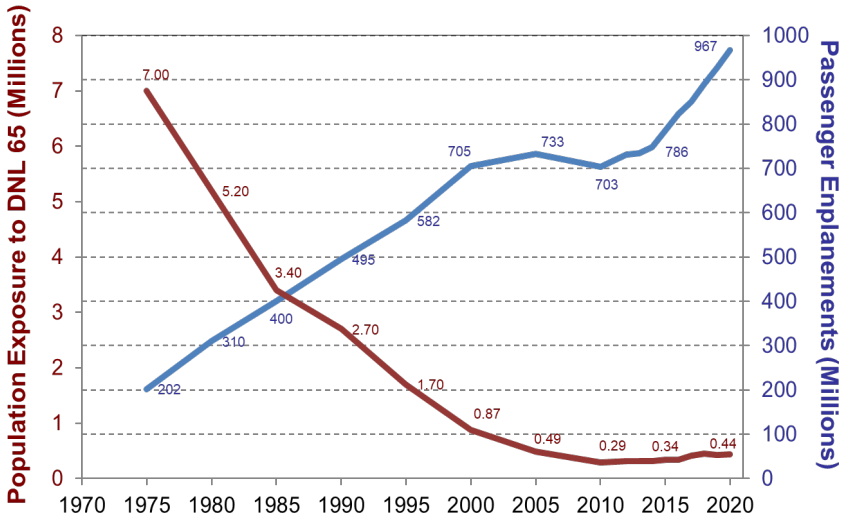
Rationale for Investing in Aircraft Technology

- Historically, advances in aircraft technology have been the main factor in reducing aviation's environmental impact
- Manufacturers have limited financial incentive to develop technologies to reduce noise and emissions
- Continued improvements come with large technological risk
- COVID-19 pandemic has hit the aerospace sector particularly hard and the industry has considerably reduced ability to undertake research to advance new technologies
- Government resources help mitigate technological risk and incentivize aviation manufacturers to invest in and develop cleaner, quieter technology





Finding Opportunity in These Challenging Times

Accelerate technology maturation to enable a step change improvement in environmental performance

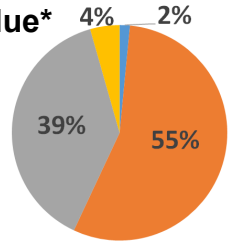
- R&D since FY10 (NASA, FAA); ~ $2,300M (NASA); $262M (FAA)
- Target 25 to 30% lower GHG re: Best in Class (e.g., A320neo / B737Max)
- Technologies need to be scalable from Single to Twin aisle aircraft
- GHG reductions need to be achieved WITH commensurate reductions in noise and emissions impacting air quality
- NASA / FAA Partnership for Flight Demo key for tech maturation

"Clean sheet" *Single Aisle* Aircraft focus for Flight Demo

- 55% of Global Market Value ($)
- 40% of CO2 emissions from Global commercial operators
- 61% of US population exposure to significant noise (65 DNL) during CY 2019

Global Market Value*

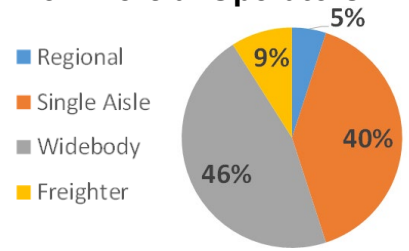
2020-2039 $6.8T



**boeing.com/commercial/market/commercial-market-outlook/*

Estimated CO_2 Emissions from Global Commercial Operators**

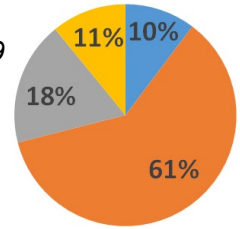
(2018)



****Volpe Preliminary Data - used with permission**
final data to be published in Chapter 1 of 2022 ICAO Environmental Report

Population Exposed to Significant Noise ***

65 DNL, U.S. CY 2019



***** F. Grande, AEDT3c, CY 2019 U.S. inventory, 18March2021*

Opportunity: Clean Sheet Single Aisle in Early 2030's


COMAC C919


UAC MC-21


Airbus A321

Future Products

* COMAC C919
* UAC MC-21
* Airbus A321XLR
A320 Family Improvement
A320 Family Replacement

2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035

Tech Development

2020 2021 2022 2023 2024 2025 2026 2027 2028

NASA/FAA/OEM Tech Dev

Tech Ready (TRL6)

Demonstrators / Flight Test

Risk Burn-down necessary

Product Development

U.S. Clean Sheet SA

25-30% Lower GHG
10-15 EPNdB cum Quieter

Relative to: Best in Class

- **Market opportunity for next major airplane to be a *Step Change Improvement*, rather than evolutionary.**
- **Leverage over a decade of closely aligned NASA/FAA/Industry research and development to mature technologies.**
- **Opportunity to target the dominant aircraft class by number of aircraft, operations, CO_2 emissions, and noise.**

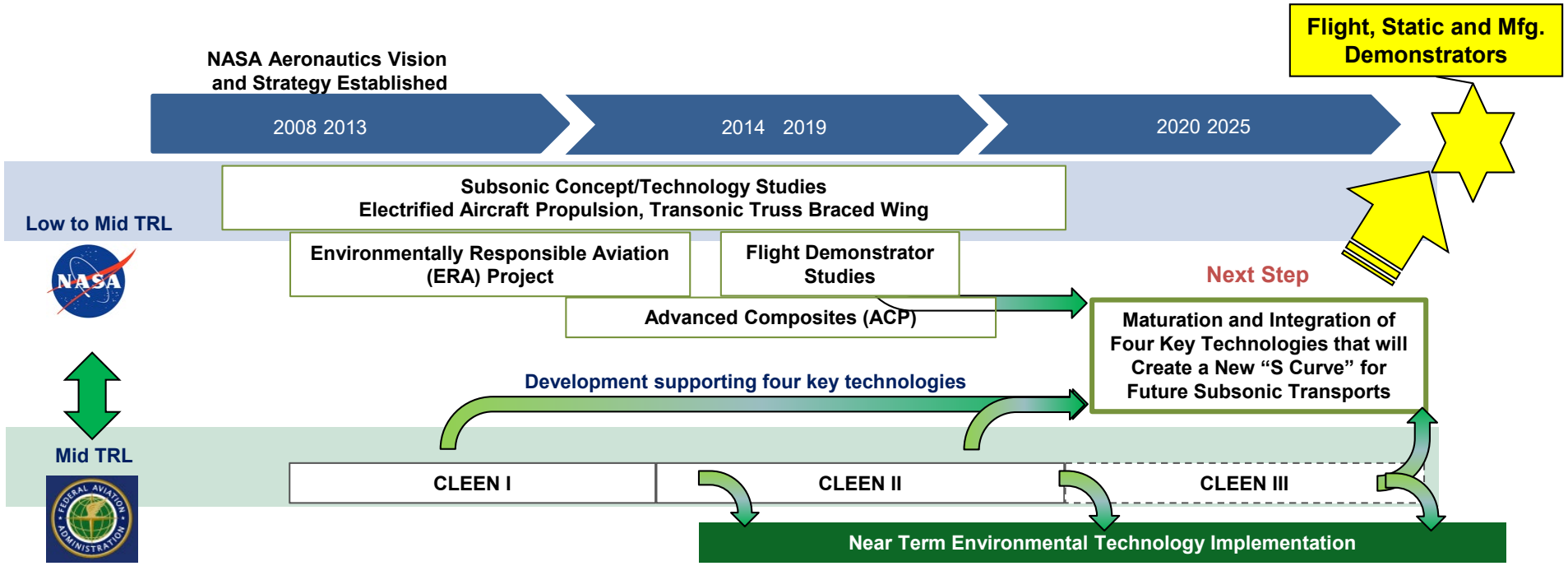
Success will reduce environmental impacts for decades to come

* Projected entry into service

Image credit
COMAC C919 Weimeng
UAC MC 21 Denis Fedorko
Airbus A321 Huy Bùi

Federal Aviation Administration

Complementary NASA & FAA Technology Maturation

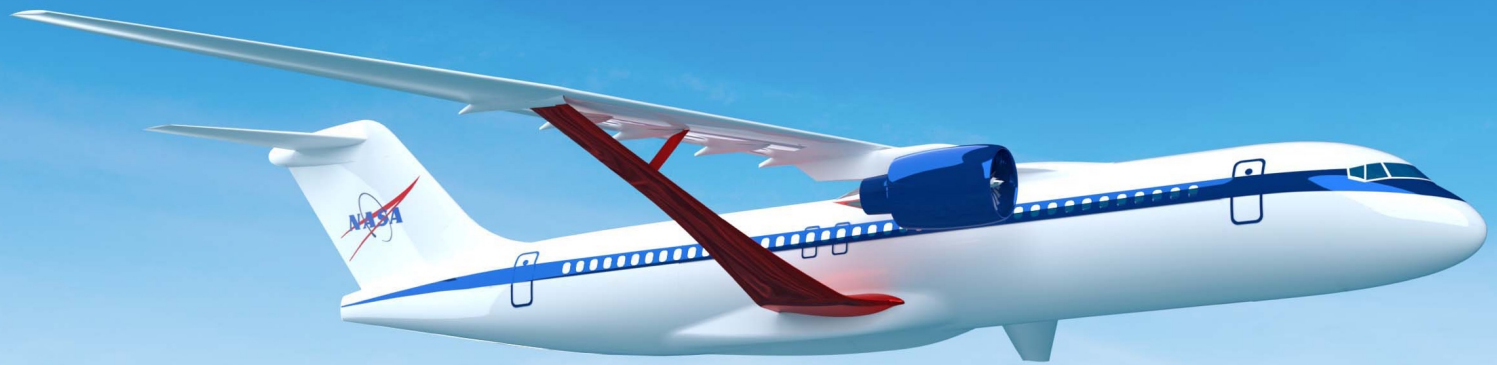


- NASA and FAA have pursued a consistent and complementary strategy for over a decade of research, concept and technology development, and Government-Industry Partnership.
- NASA and FAA work feeds focused Technology Maturation of key technologies using Sustainable Flight National Partnership (SFNP). SFNP includes several Flight, Static and Mfg TRL6 Demonstrations.
- In parallel, FAA CLEEN Programs continue to provide near term wins for environmental technology implementation in industry.

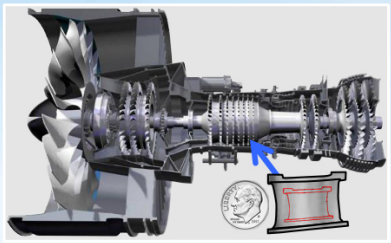
NASA/FAA Sustainable Flight National Partnership (SFNP)

Critical to establish the new "S Curve" for the next 50 years of transports

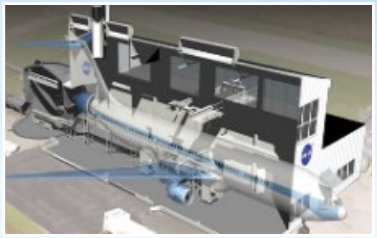
Demonstrate a 'step change reduction' in GHG emissions relative to best in class aircraft



Transonic Truss-Braced Wing
5-10% fuel burn benefit



Small Core Gas Turbine
5-10% fuel burn benefit



Electrified Aircraft Propulsion
~5% fuel burn and maintenance benefit

High-Rate Composite Manufacturing
4x-6x manufacturing rate increase

Press Release and Website

www.faa.gov/go/CLEEN

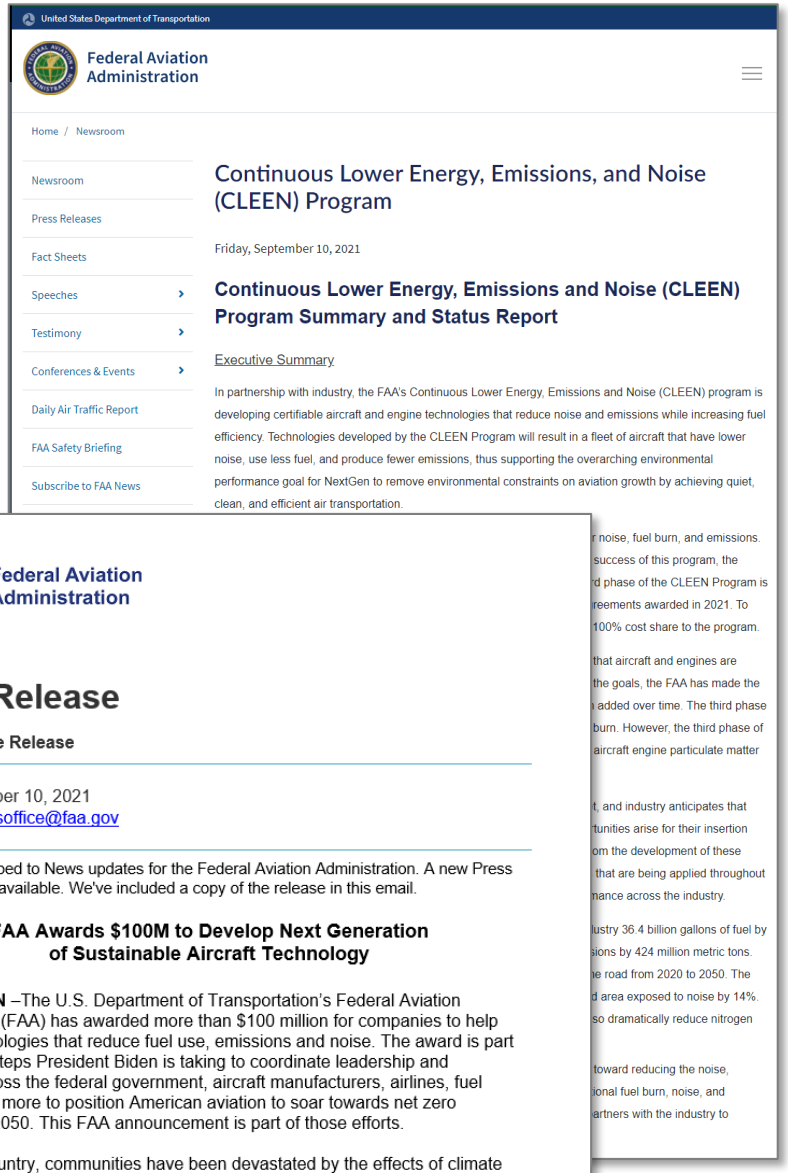
Press release on Phase 3 was released on Sept 10, 2021

Comprehensive report on CLEEN Program accomplishments has been uploaded as an FAA Fact Sheet

Website: https://www.faa.gov/newsroom/faa-awards-100m-develop-next-generation-sustainable-aircraft-technology

Materials should aid communications about the CLEEN Program

Website: https://www.faa.gov/newsroom/continuous-lower-energy-emissions-and-noise-cleen-program?newsId=22534


United States Department of Transportation

Federal Aviation Administration

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Continuous Lower Energy, Emissions, and Noise (CLEEN) Program

Friday, September 10, 2021

Continuous Lower Energy, Emissions and Noise (CLEEN) Program Summary and Status Report

Executive Summary

In partnership with industry, the FAA's Continuous Lower Energy, Emissions and Noise (CLEEN) program is developing certifiable aircraft and engine technologies that reduce noise and emissions while increasing fuel efficiency. Technologies developed by the CLEEN Program will result in a fleet of aircraft that have lower noise, use less fuel, and produce fewer emissions, thus supporting the overarching environmental performance goal for NextGen to remove environmental constraints on aviation growth by achieving quiet, clean, and efficient air transportation.

Federal Aviation Administration

Press Release

For Immediate Release

Date: September 10, 2021
Contact: pressoffice@faa.gov

You are subscribed to News updates for the Federal Aviation Administration. A new Press Release is now available. We've included a copy of the release in this email.

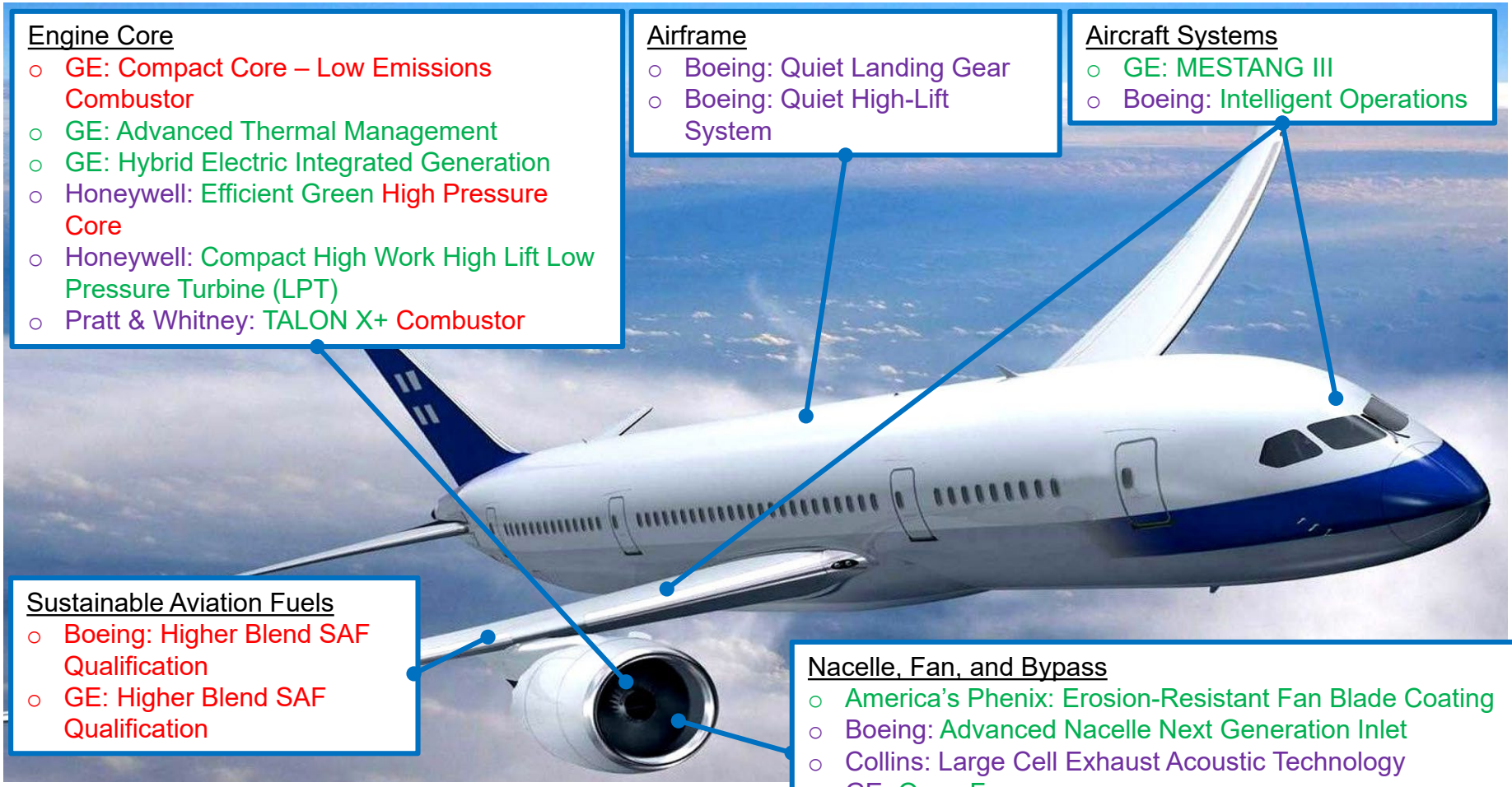
FAA Awards $100M to Develop Next Generation of Sustainable Aircraft Technology

WASHINGTON –The U.S. Department of Transportation's Federal Aviation Administration (FAA) has awarded more than $100 million for companies to help develop technologies that reduce fuel use, emissions and noise. The award is part of a series of steps President Biden is taking to coordinate leadership and innovation across the federal government, aircraft manufacturers, airlines, fuel producers and more to position American aviation to soar towards net zero emissions by 2050. This FAA announcement is part of those efforts.

"Across the country, communities have been devastated by the effects of climate change – but, if we act now, we can ensure that aviation plays a central role in the solution," **said Transportation Secretary Pete Buttigieg**. "These awards will help America lead the world in sustainable aviation."

The Continuous Lower Energy, Emissions and Noise (CLEEN) Program is a public-private partnership that began in 2010 and is a key part the FAA's overall strategy to tackle the global challenge of climate change and lower the impact aviation has on communities. The program requires the companies receiving the contracts to match or exceed the FAA's investment, bringing the total to at least $200 million over a five-year period. The awards are the third phase of the FAA's CLEEN program.

CLEEN Phase III Technologies



Engine Core
- GE: Compact Core – Low Emissions Combustor
- GE: Advanced Thermal Management
- GE: Hybrid Electric Integrated Generation
- Honeywell: Efficient Green High Pressure Core
- Honeywell: Compact High Work High Lift Low Pressure Turbine (LPT)
- Pratt & Whitney: TALON X+ Combustor

Airframe
- Boeing: Quiet Landing Gear
- Boeing: Quiet High-Lift System

Aircraft Systems
- GE: MESTANG III
- Boeing: Intelligent Operations

Sustainable Aviation Fuels
- Boeing: Higher Blend SAF Qualification
- GE: Higher Blend SAF Qualification

Nacelle, Fan, and Bypass
- America's Phenix: Erosion-Resistant Fan Blade Coating
- Boeing: Advanced Nacelle Next Generation Inlet
- Collins: Large Cell Exhaust Acoustic Technology
- GE: Open Fan
- GE: Advanced Acoustics
- Honeywell: Highly Efficient Fan Module
- Pratt & Whitney: Ultra-Quiet Reduced-Loss Fan Stage

Fuel
Emissions
Noise

Presentation Outline

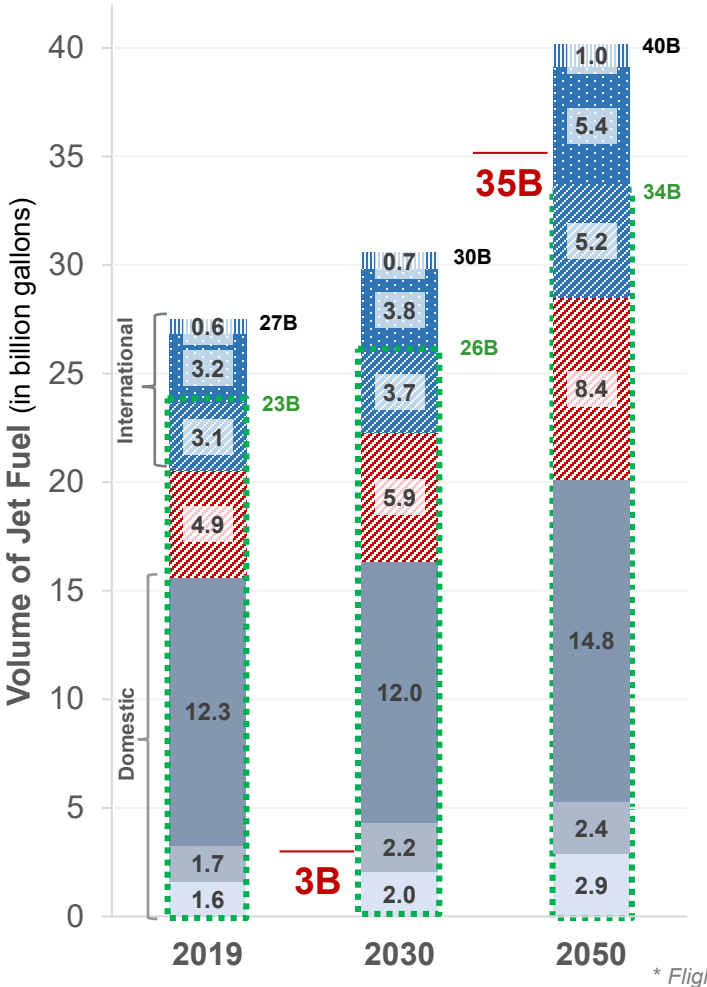
- Office of Environment and Energy – Background & E&E Overview
- Highlights of R&D Program
- **Direction of the E&E Portfolio**
  - Noise and Emissions
  - Overview of Climate Change Efforts
  - Sustainable Flight National Partnership
  - **SAF Grand Challenge**
- Summary

The SAF Grand Challenge

U.S. government-wide effort to reduce the cost, enhance the sustainability, and expand the production and use of Sustainable Aviation Fuel (SAF) to meet 100% of aviation fuel demand by 2050

- **Establishes SAF as a key priority** in a broader set of actions by the U.S. Government and the private sector to **reduce the aviation sector's emissions in a manner consistent with the goal of net-zero emissions**
- Sets an **ambitious vision** and affirm to industry that the **USG is committed to SAF research, development, and deployment**
- **Announcement** and signing with White House and agency Secretaries on September 9, 2021
- **Memorandum Of Understanding (MOU) among DOE, DOT and USDA** to jointly lead the initiative and commit resources to research, development, and deployment

SAF Grand Challenge Goals Relative to Projected Demand



Geographic Scope: Legend:

- International outside the US* (US Operators)
- International Arrivals (US Operators)
- International Departures (US Operators)
- International Departures (Foreign Operators)†
- Domestic Passenger
- Domestic Cargo
- Domestic General Aviation
- Jet Fuel Uplift within the United States

Data Sources and Assumptions:

2019: BTS T-2 (International operations reported by US carriers)

2030-2050: CO_2 emissions based on FAA Aerospace traffic Forecast, after technology and operations improvements. Assuming breakdown of flows (departures from US, arrivals in US and foreign-foreign based on 2019 CORSIA breakdown).

2019: EPA GHG Inventory, international departures by foreign operators scaled based on 2019 traffic mix (FAA Data)

2030-2050: FAA Modeling based on EPA GHG Inventory (Domestic) scope. CO_2 emissions based on FAA Aerospace traffic Forecast, after technology and operations improvements.

2019-2050: General Aviation from FAA Aerospace Forecast (2020-2041).

** Flights between two different ICAO Member States (other than the United States) e.g., Germany -> UAE, UK -> China.*

† Not in scope of Climate Action Plan, shown to facilitate comparisons for SAF Grand Challenge.

SAF Grand Challenge Roles (in MOU)

DOE

- Continue investments and develop expertise in sustainable technologies to develop cost effective low carbon liquid fuels and enabling coproducts from renewable biomass and waste feedstocks.
- Continue a significant multi-year SAF scale-up strategy committed to in FY21.
- Conduct R&D aimed at creating new pathways toward higher specificity of SAF Production.

DOT/FAA

- Develop overall strategy to decarbonize aviation
- Coordinate ongoing SAF testing and analysis
- Work with standards organizations to ensure safety and sustainability of SAF
- Continue International technical leadership
- Promote end use of SAF
- Support infrastructure and transportation systems that connect SAF feedstock producers, SAF refiners, and aviation end users.

USDA

- Continue investments and build expertise in sustainable biomass production systems
- Decarbonize supply chains
- Invest in bio-manufacturing capability
- Workforce development
- Community and individual education
- Extension/outreach/ technology transfer
- Commercialization support

Next Step: Develop SAF Grand Challenge Roadmap (details in Fuels Briefing)

Presentation Outline

- Office of Environment and Energy – Background & E&E Overview
- Highlights of R&D Program
- Direction of the E&E Portfolio
- **Summary**

FY22 Funding

- **Operating under budget uncertainty**

- **Expect to use any funding increases to:**
  - Expand efforts on aircraft technology maturation in CLEEN and ASCENT
  - Develop SAF that could be used in jet engines without blending with conventional petroleum-based jet fuel
  - Evaluate aviation fuel supply chains to reduce the cost to produce SAF and maximize environmental benefits
  - Obtain the data and develop the analytical tools to support evaluation and certification of new vehicle types

Recent Successes - Capabilities and Solutions Helping Today

Informing Decision Making to Support U.S. Leadership on International Aviation Climate Issues

- Research team at forefront of informing the development of a *long term aspirational goal for international aviation CO_2 emissions* within International Civil Aviation Organization (ICAO).
- Provided critical support to development of *Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)*.
- Analytical tools and data provided foundation for ICAO CAEP *Aircraft CO_2 Standard* being promulgated domestically.
- Measurement technique and data provided foundation for new ICAO CAEP *non-volatile particular matter engine standard* that will replace the existing smoke number standard in 2023.

Supporting the Development of Sustainable Aviation Fuels (SAF)

- *Certification of seven alternative jet fuel pathways and two co-processing pathways* enabling multiple airlines to use SAF in LAX, SFO, and elsewhere. Efforts have also *significantly reduced fuel volumes required for new approvals*.
- Research efforts were critical for the *inclusion of sustainable aviation fuels within CORSIA*.

Accelerating Technological Innovation and the Development of Improved Operational Procedures

- *CLEEN aircraft and engine technologies appearing in new aircraft* with some technologies retrofitted into today's fleet. These technologies and knowledge gained by industry will reduce noise, emissions, and fuel use for decades to come.
- Research efforts are supporting the *introduction of unmanned aircraft systems, advanced air mobility vehicles, and supersonic aircraft* into the air space.
- Developing operational procedure concepts and communication tools at Boston Logan that could *help address noise concerns nationwide*.

Advancing Our Understanding of Noise, Emissions, and their Impacts

- Released *Federal Register Notice on noise research portfolio* with comprehensive community noise annoyance survey quantifying community perceptions on noise. Work is ongoing to understand *impacts of noise on sleep and health*.
- Researchers are advancing our understanding of the impacts of aviation emissions on human health and welfare via *air quality, global climate change, and changes to the ozone layer*.
- Aviation Environmental Design Tool (AEDT) is being used extensively globally to quantify aviation noise and emissions.

Dr. Jim Hileman

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Federal Aviation Administration
Office of Environment and Energy

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