Environment & Energy Research & Development Portfolio Overview

Prepared for: REDAC E&E Subcommittee

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Office of Environment and Energy
Federal Aviation Administration

Date: March 22, 2022

Presentation Outline

- **Office of Environment and Energy – Background & E&E Strategy Overview**
- **Highlights of R&D Program**
- **Direction of the E&E Portfolio**
  - Noise and Emissions
  - U.S. Aviation Climate Action Plan
  - International Support
- **Budget Profile for E&E Portfolio**
- **Summary**

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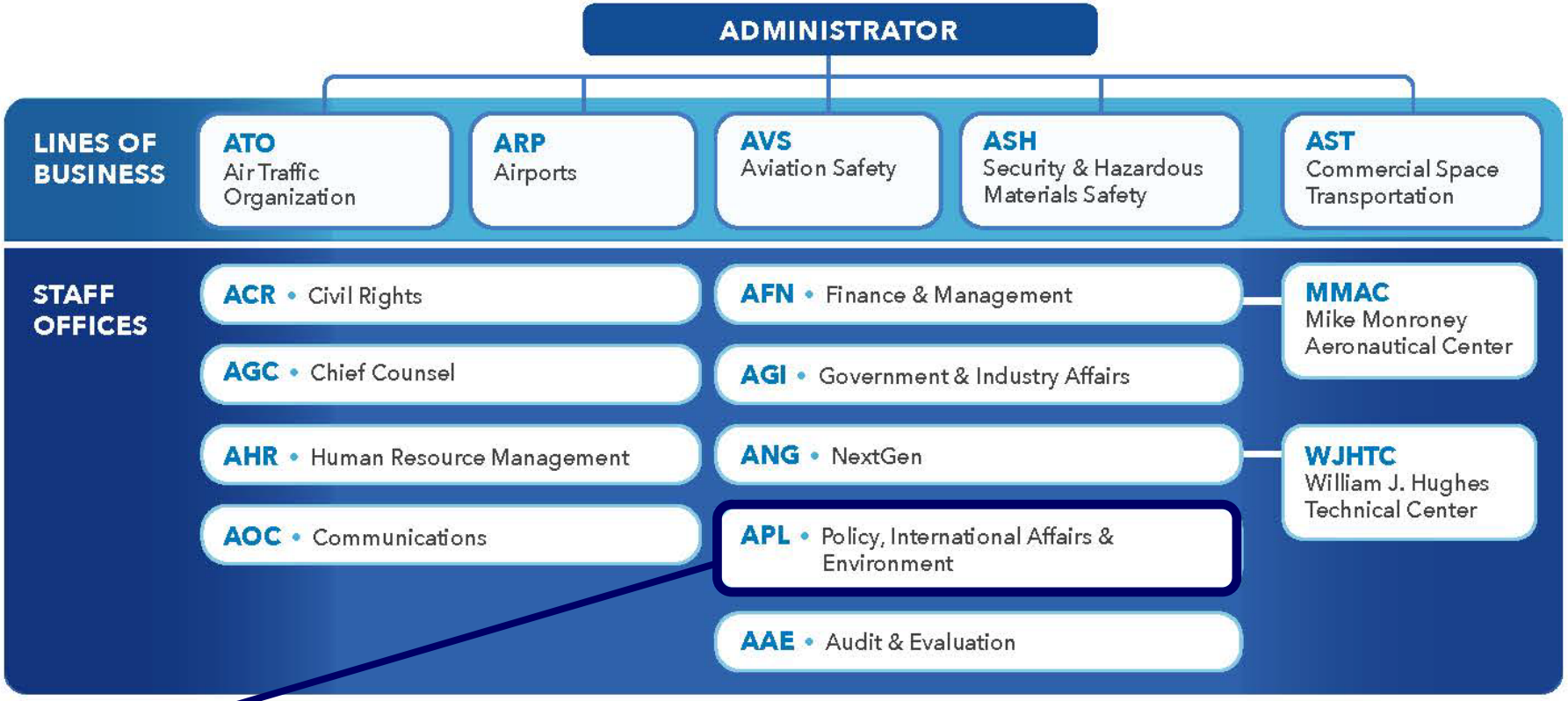
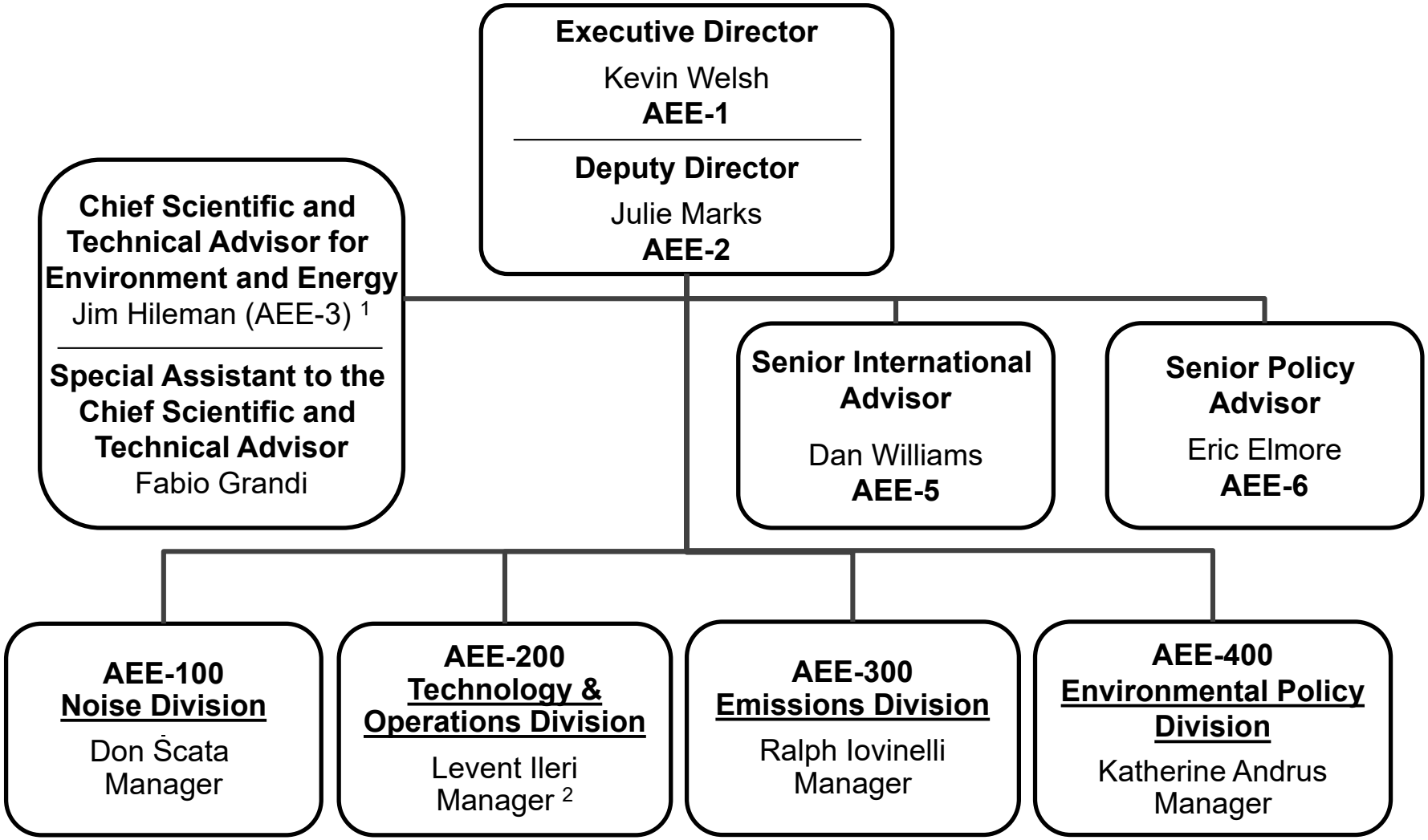
FAA Organizational Structure



Office of Environment and Energy (AEE)

- Office within APL, responsible for broad range of environmental policies
- About 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

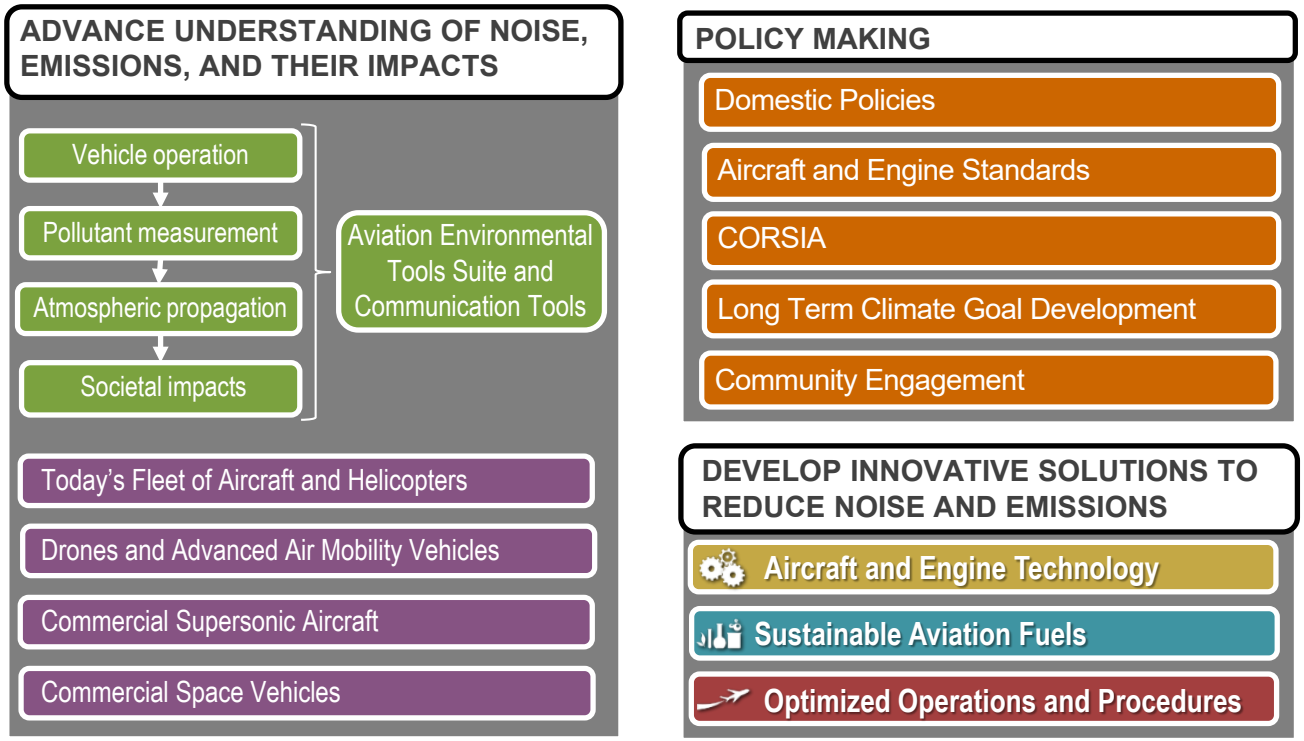
[2] CLEEN Program Manager, as a subset of his Division Manager duties

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 Program:



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

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

- ***Published U.S. Aviation Climate Action Plan to address CO_2 emissions***
- ***E&E R&D was at the core of the ICAO CAEP Long Term Aspirational Goal (LTAG) for international aviation CO_2 emissions***
- Research efforts continue to inform decision making
  Supporting other parts of FAA and EPA to address lead emissions
- Broad ASCENT research portfolio from impacts to innovation
- Technology maturation continues with 3rd Phase of CLEEN
- Sustainable Aviation Fuel Grand Challenge: CAAFI and ASCENT
- 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

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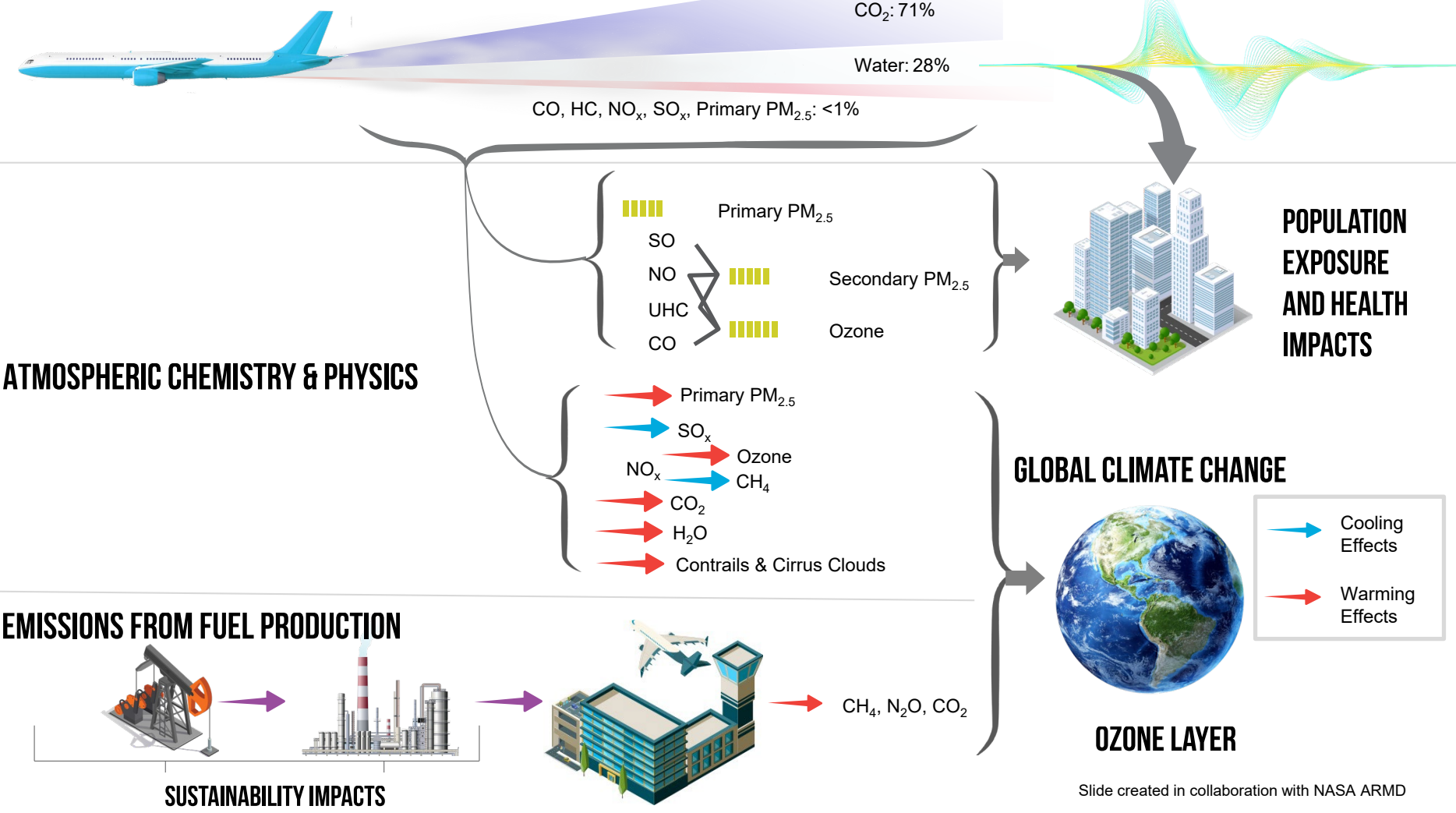
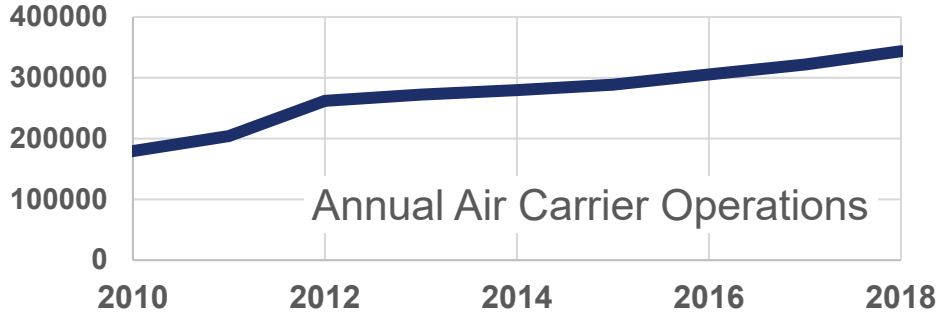
Environmental Impacts of Aviation

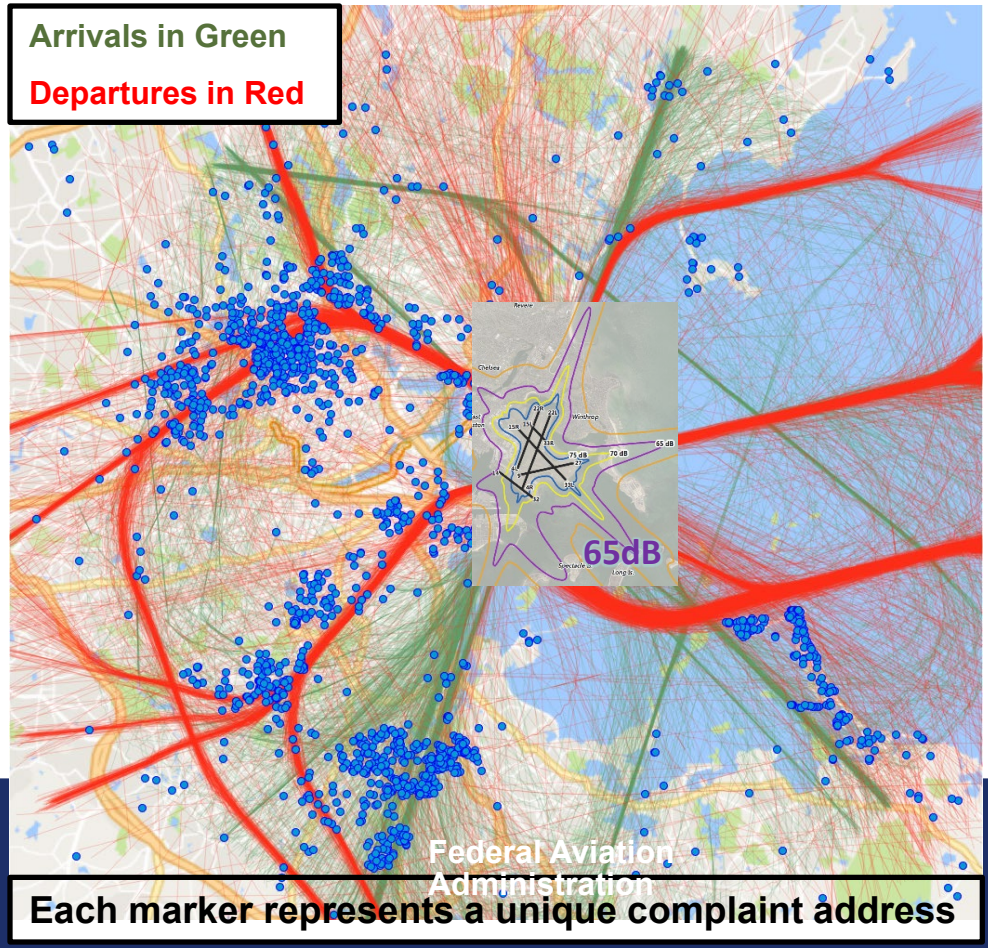


Slide created in collaboration with NASA ARMD

Aircraft Noise in the Last Decade

- Recent efforts to modernize the national air transportation system have required changes in aircraft operational patterns
- While modernization is needed to increase public safety and system efficiency, the changes in operational patterns have also led to increased concern about aircraft noise
- While air space redesigns have been taking place, operations by air carriers have also increased
- Airport communities that are outside the DNL 65 dB contour are expressing concerns about aircraft noise





Data Sources:

Brenner, M., Hansman, R. J., Comparison of Methods for Evaluating Impacts of Aviation Noise on Communities, 2017

FAA Data on Annual Air Carrier Operations for Boston Logan International Airport

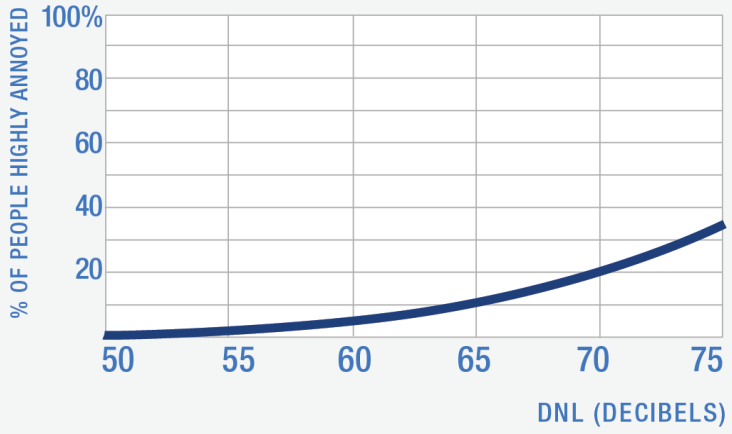
Neighborhood Environmental Survey

Aircraft Noise Annoyance Results

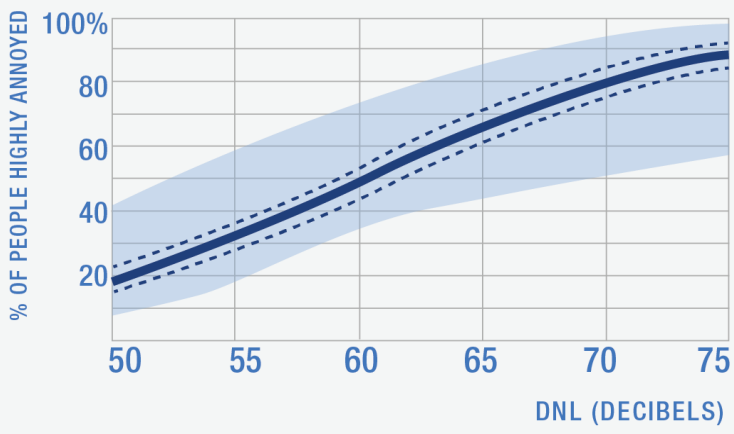
The NES results support an observed increase in Annoyance from Aircraft Noise:

- The results show a substantial increase in annoyance for the population living in the vicinity of airports
- The increase in annoyance is generally consistent across various levels of noise exposure

SCHULTZ CURVE



NATIONAL CURVE



The new Survey was designed to use a consistent approach across each airport community surveyed. This has allowed for an enhanced ability to provide additional statistical information about the new results, such as the 95% Confidence Limits and range of results from each of the 20 airports, as shown on the plot above. This was not possible with the older Schultz Curve.

For additional information on the noise survey:

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

Federal Aviation Administration

Noise R&D Overview

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

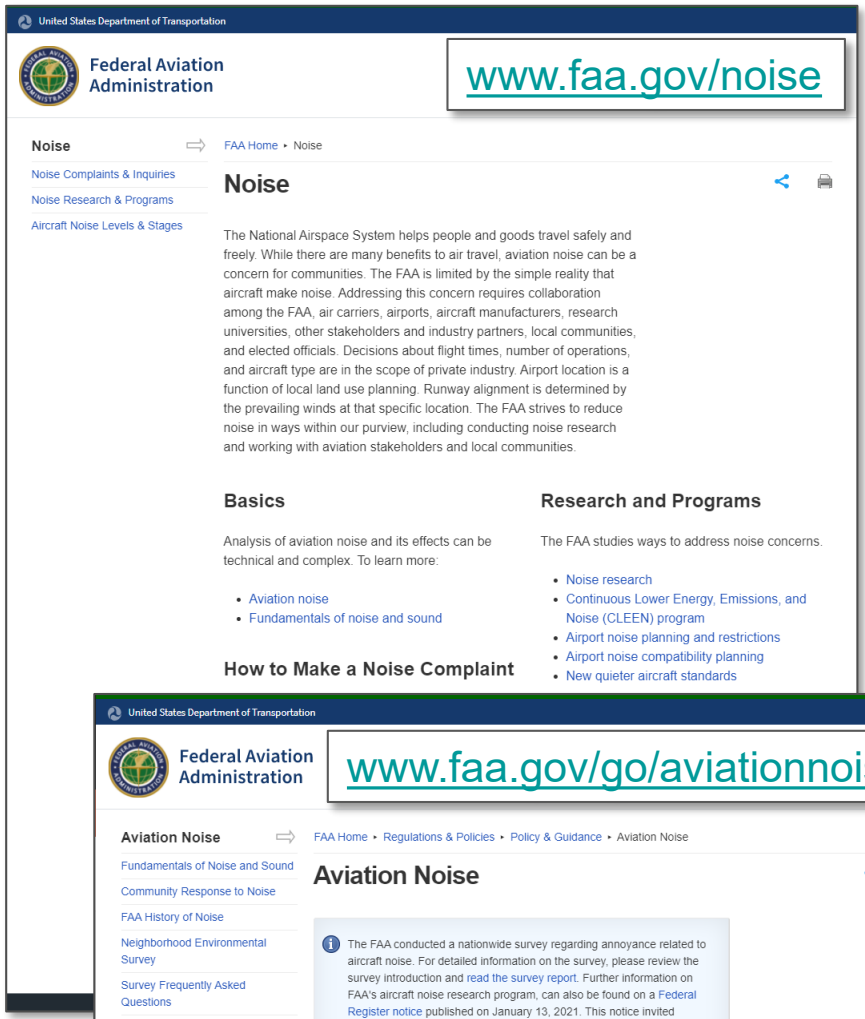
https://www.regulations.gov/docket/FAA-2021-0037

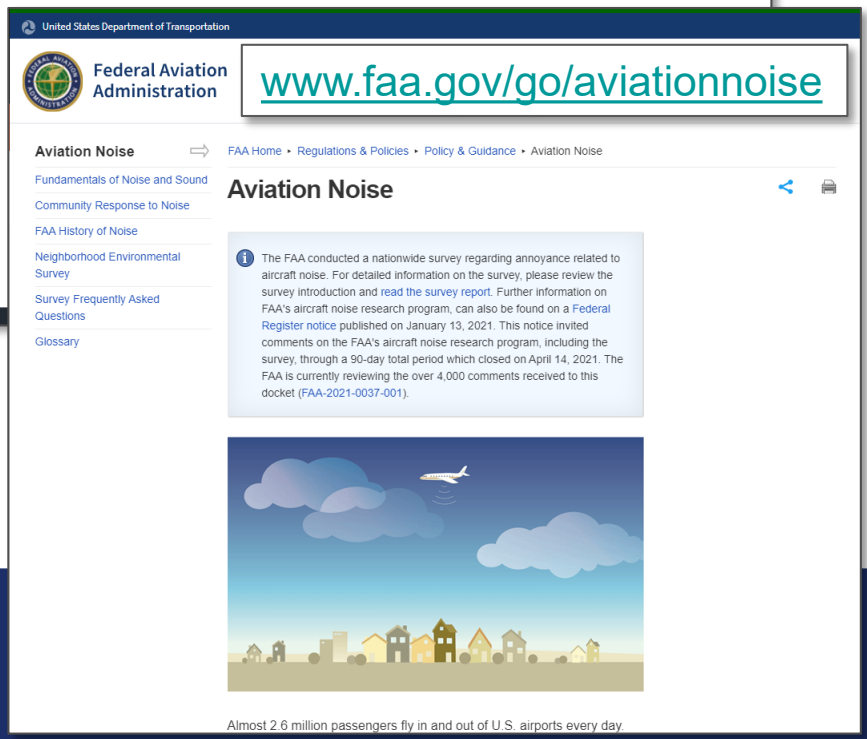
Expanded the aviation noise website to include details on the noise survey

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

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 and certification of all vehicles
- Standing up new research efforts on noise (and life cycle emissions)

Helicopters

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

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 FY23 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

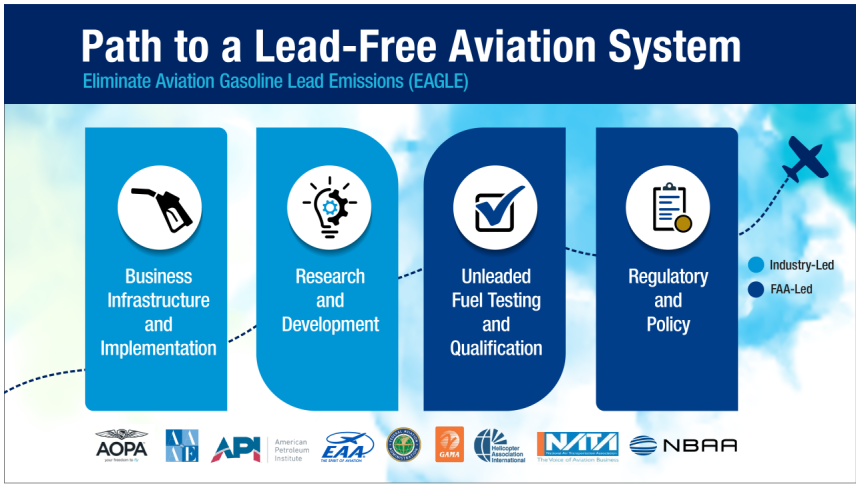
- Aircraft technologies and architecture
- Modifications to fuel composition
- Vehicle operations
- Engine standard (NO_X, CO_2, and PM standards)
- Future trends analysis
- *Working across agency to address lead emissions*

Mitigation

- Alternative fuel sources
- Policy measures (CORSIA)

Eliminate Aviation Gasoline Lead Emissions

- On Feb 23, 2022 FAA announced a new initiative to safely eliminate the use of leaded aviation fuel by the end of 2030 without adversely affecting the existing piston-engine fleet.
- Effort will be based on four pillars of action that involve FAA, EPA, fuel suppliers and distributors, airports, engine and aircraft manufacturers, research institutions, associations, environmental experts, communities and other key stakeholders.



1) **Develop Unleaded Fuels Infrastructure and Assess Commercial Viability**: Industry stakeholders will coordinate production of commercially viable unleaded fuels and establish necessary infrastructure, efficient distribution channels and widespread usage of these fuels.

2) **Support Research & Development and Technology Innovations**: FAA and industry stakeholders will support research and testing of piston engine modifications and/or engine retrofits necessary for unleaded fuel operations. They will also focus on new technology development and the application/adaptation of those technologies, including electric/hybrid engine technologies to enable transition to a lead free General Aviation fleet.

3) **Continue to Evaluate and Authorize Safe Unleaded Fuels**: FAA will address fleet-wide authorization of unleaded aviation fuels of different octane levels. Piston Aviation Fuel Initiative will continue to evaluate, test and qualify high-octane aviation unleaded fuels with objective to ultimately transition fleet to unleaded aviation fuel.

4) **Establish Any Necessary Policies**: EPA is evaluating whether emissions from piston-engine aircraft operating on leaded fuel contribute to air pollution that endangers public health or welfare. EPA plans to issue a proposal for public review and comment in 2022 and take final action in 2023. If the EPA issues regulations on lead emissions from piston-engine aircraft, the FAA would subsequently publish regulations that certify piston engine modifications, new piston engines that do not require leaded aviation fuel, and regulate fuel components for aviation fuels. FAA will consider policies/programs to support unleaded fuel infrastructure.

https://www.faa.gov/newsroom/faa-industry-chart-path-eliminate-lead-emissions-general-aviation-end-2030

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Aviation Climate Action Plan

- International Civil Aviation Organization (ICAO) – “State Action Plans”
- Plan builds on ongoing FAA Environment & Energy Program – long-term focus on reducing climate impacts of aviation
- Administration focus on climate – Achieving net zero emissions economy-wide by 2050

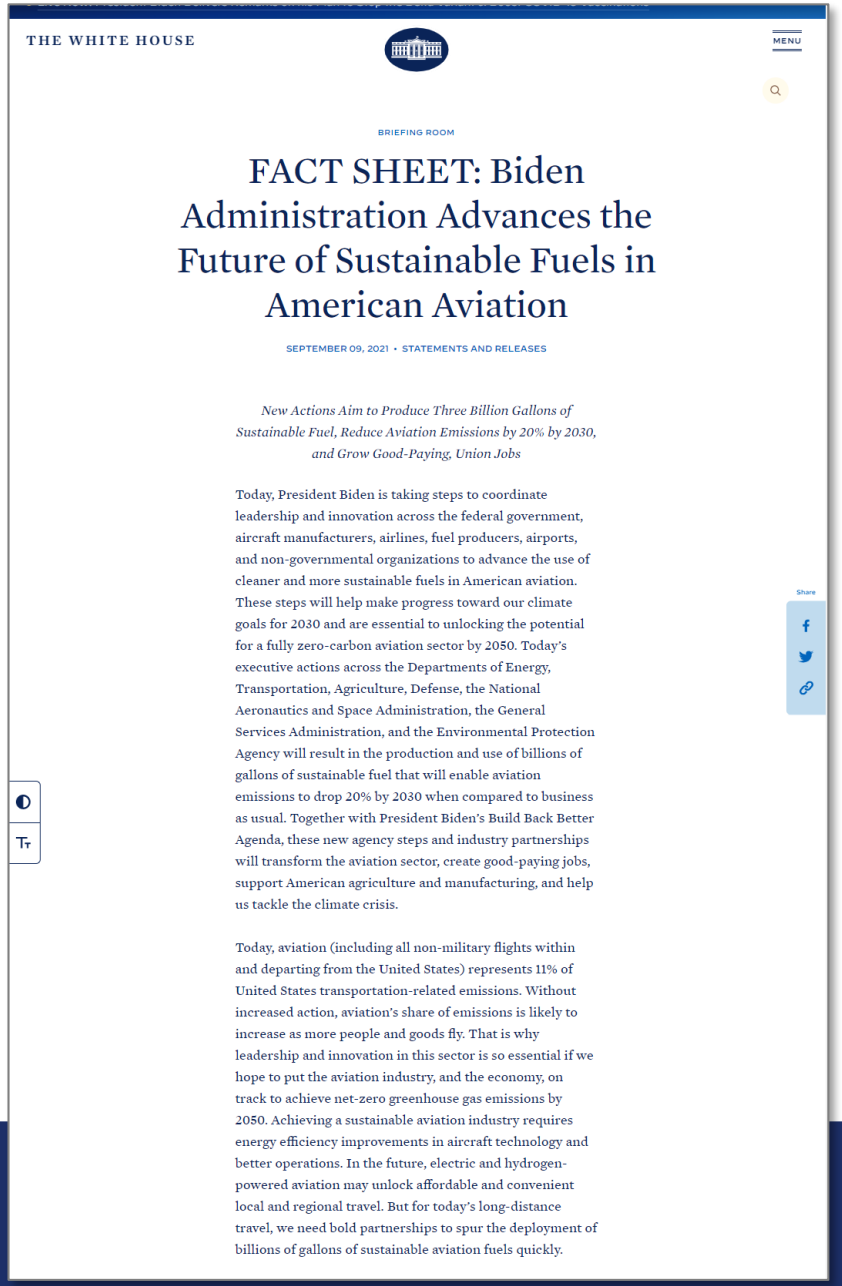
- Climate Action Plan Press Release: https://www.faa.gov/newsroom/us-releases-first-ever-comprehensive-aviation-climate-action-plan-achieve-net-zero
- Climate Action Plan Document: https://www.faa.gov/sites/faa.gov/files/2021-11/Aviation_Climate_Action_Plan.pdf

U.S. Announcements and Action

On September 9, 2021, United States government and industry leaders convened to announce key actions to address aviation's impact on climate.

Key federal actions include:

- Sustainable Aviation Fuel Grand Challenge
- New and ongoing funding opportunities to support sustainable aviation fuel projects and fuel producers totaling up to $4.3 billion;
- By 2030 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
- Intent to release an aviation climate action plan for submission to the International Civil Aviation Organization.



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/

U.S. Aviation Climate Goal

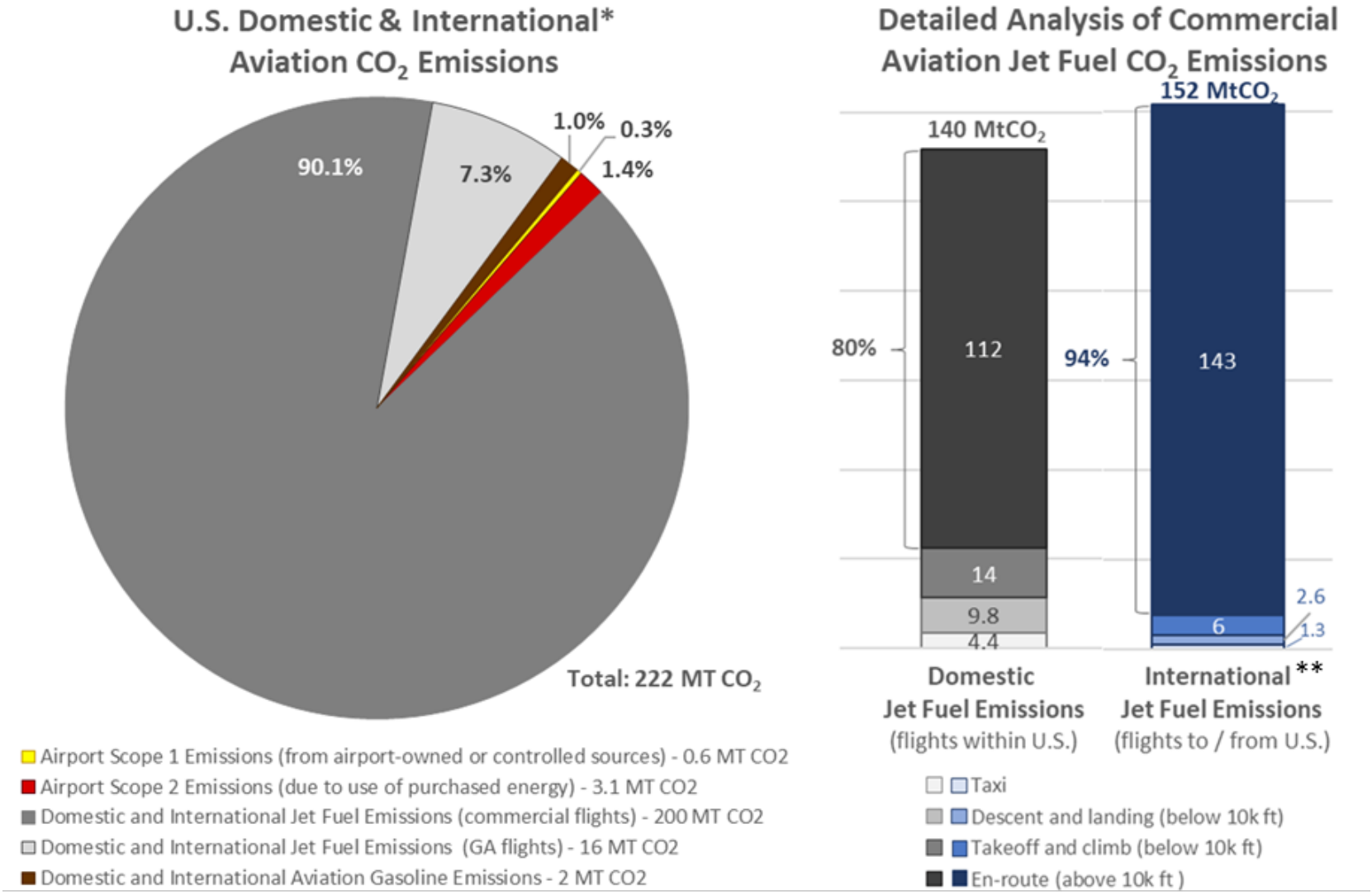
To be effective, a goal should be clear, achievable, and ambitious with specific actions that can be taken to achieve it. The goal outlined below contributes to the broader objective to achieve net-zero GHG emissions economy-wide by 2050.

U.S. Aviation Climate Goal:
Net-Zero GHG Emissions* from U.S. Aviation Sector** by 2050

* Aviation GHG emissions include life cycle carbon dioxide (CO_2), nitrous oxide (N_2O), and methane (CH_4) emissions. Aircraft engines produce negligible amounts of nitrous oxides and methane, so this plan has a focus on aviation combustion CO_2 emissions and well-to-tank life cycle GHG emissions (CO_2, N_2O, and CH_4). The U.S. Aviation 2050 Goal is based on emissions that are measurable and currently monitored. Research is ongoing into the climate impacts of aviation-induced cloudiness and the indirect climate impacts of aviation combustion emissions (see section 7 for details on the climate impacts of aviation non-CO_2 combustion emissions).

** This U.S. aviation goal encompasses CO_2 emissions from (1) domestic aviation (i.e., flights departing and arriving within the United States and its territories) from U.S. and foreign operators, (2) international aviation (i.e., flights between two different ICAO Member States) from U.S. operators, and (3) airports located in the United States.

Analysis of U.S. Aviation CO_2 Emissions in 2019

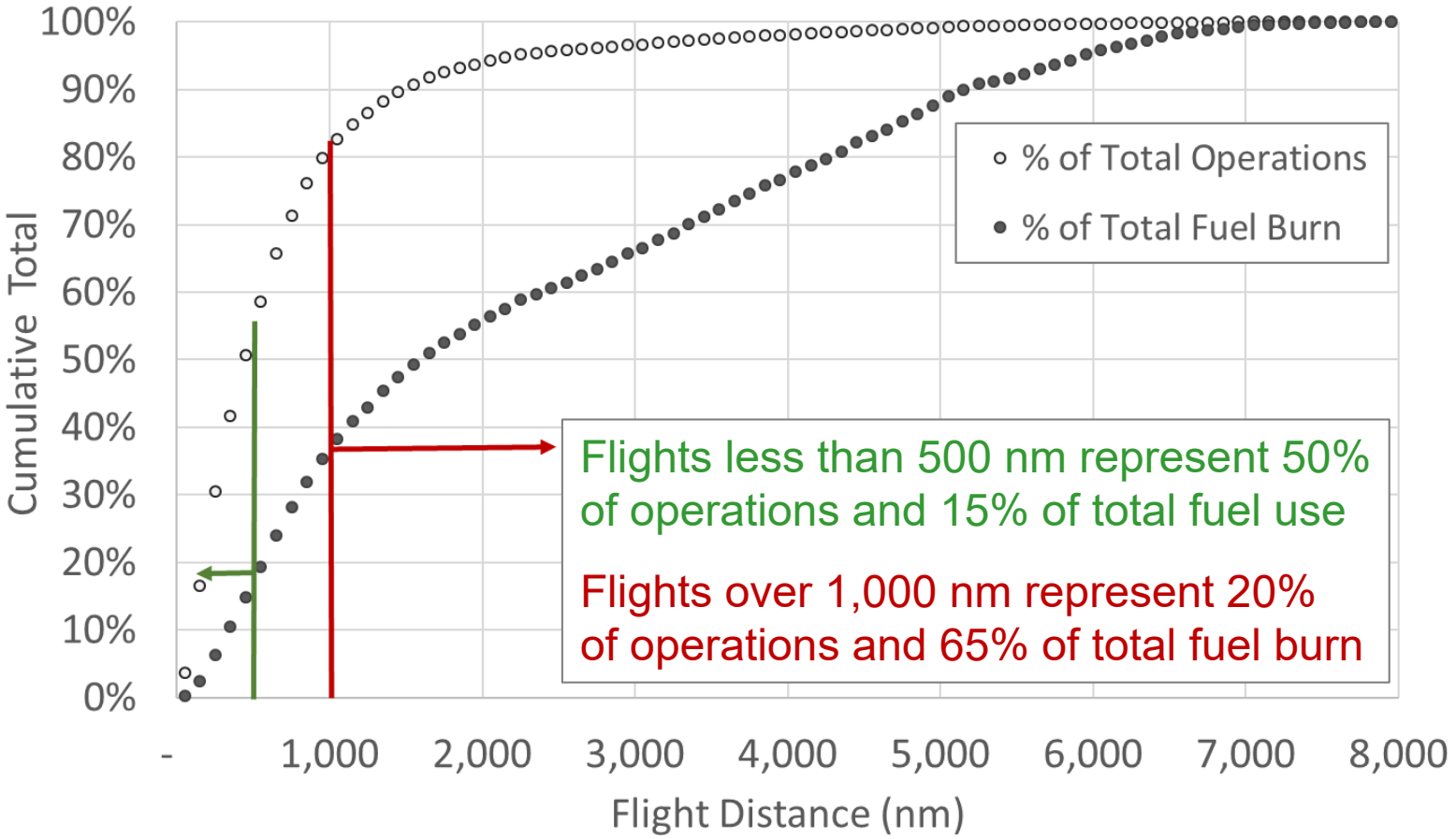


* CO_2 emissions from (1) domestic aviation (i.e., flights departing and arriving within the United States and its territories) from U.S. and foreign operators and (2) international aviation (i.e., flights between two different ICAO Member States) from U.S. operators (only). Airport scopes 1 and 2 added for this specific analysis (figure).

** International aviation to / from the United States, regardless of the operator of the flights i.e., including both U.S. and foreign operators.

Global Jet Fuel Use

- Global jet fuel use is driven by long-haul aviation
- SAF only option through 2050 for long distances



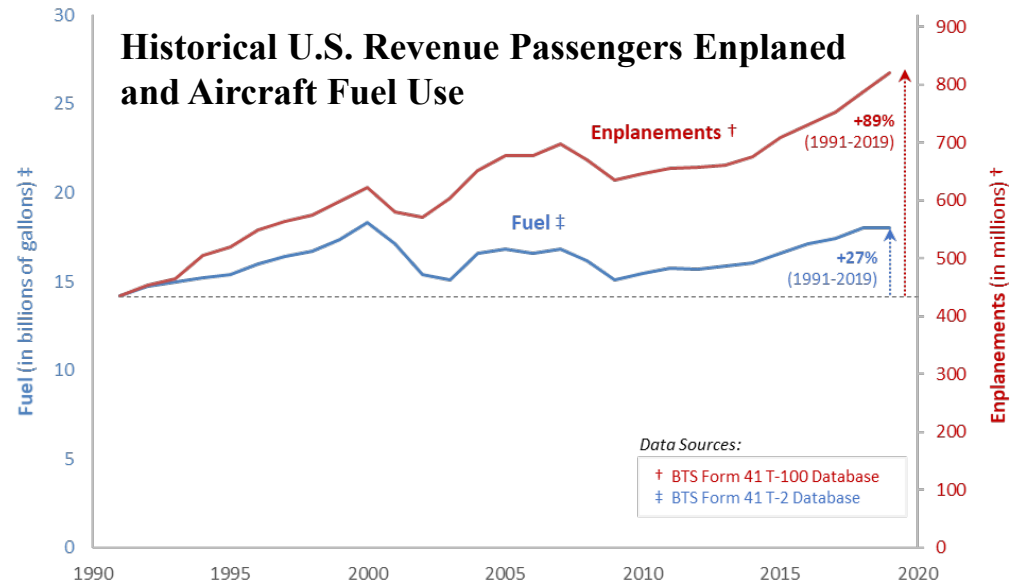
Data analysis conducted by the U.S. DOT Volpe Center using the Aviation Environmental Design Tool (AEDT)

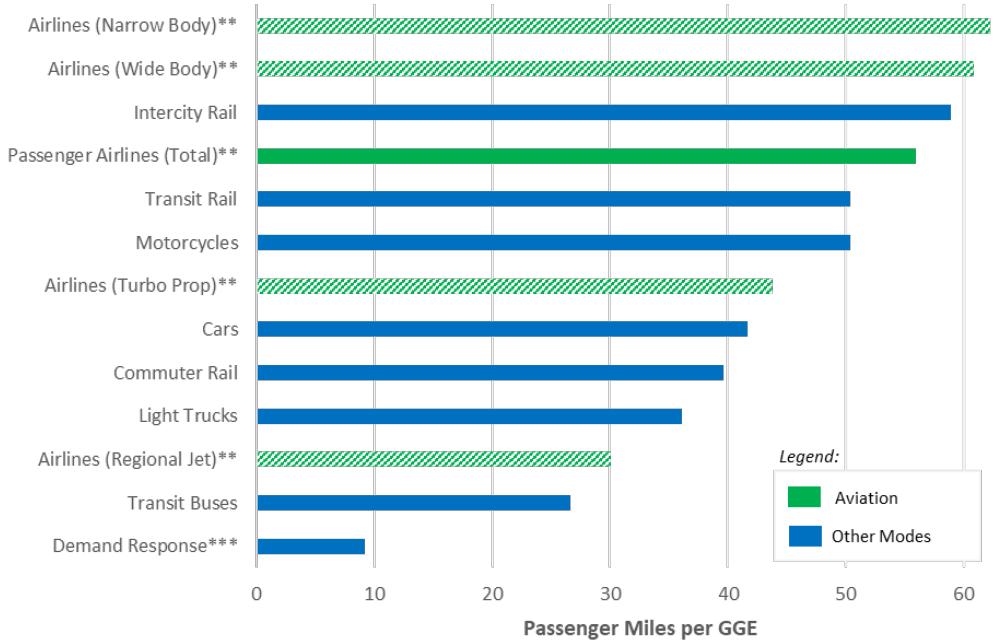
Federal Aviation Administration

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.

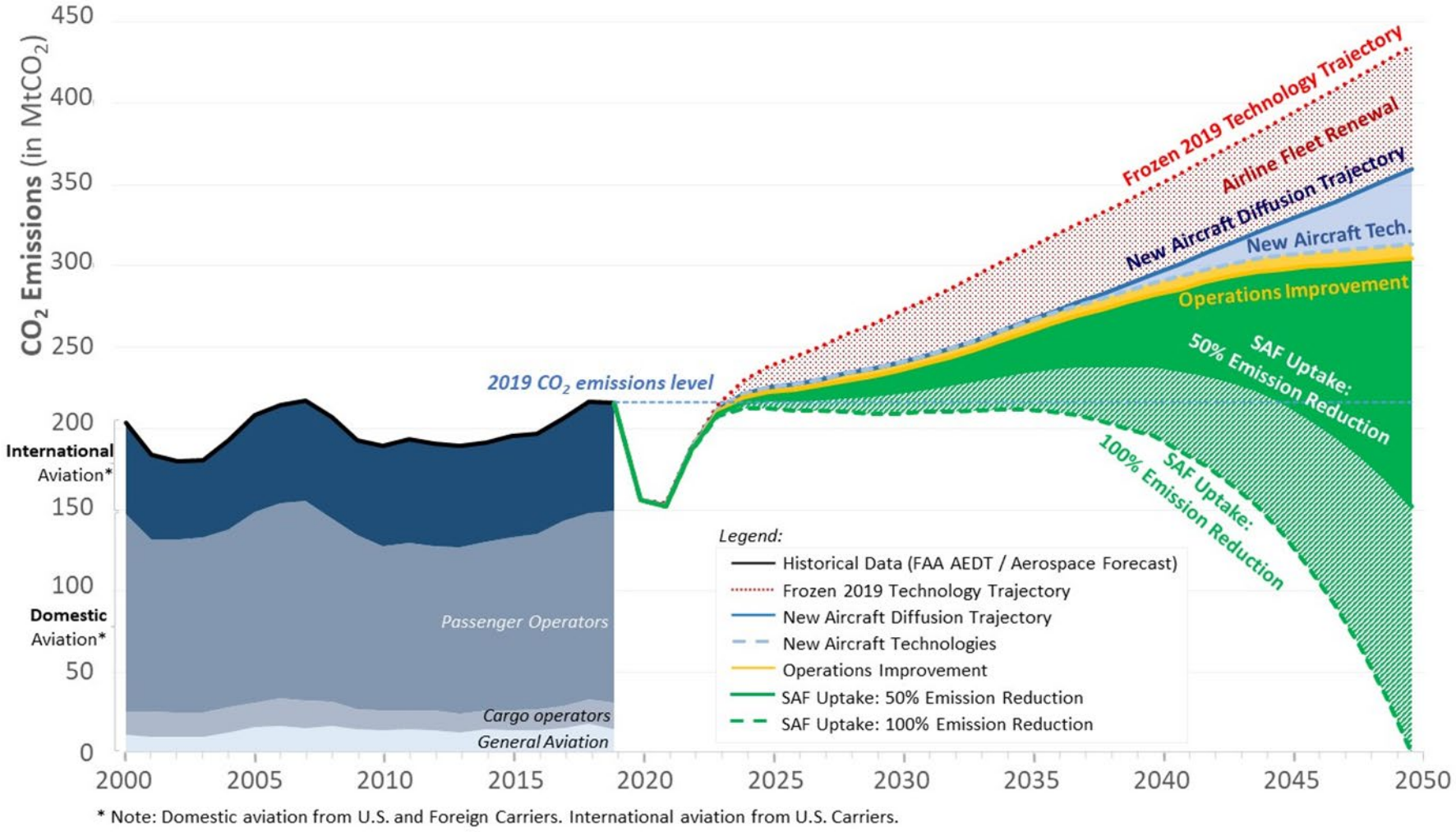
Today's fleet of aircraft has an average fuel efficiency of 57.5 passenger-miles per gallon of fuel; for comparison, a modern Toyota Prius hybrid has a fuel economy of 54 miles per gallon (MPG).





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.

Analysis of Future Domestic and International Aviation CO_2 Emissions



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

NOTE: Analysis conducted by BlueSky leveraging FAA Aerospace Forecast and R&D efforts from the FAA Office of Environment & Energy (AEE) regarding CO2 emissions contributions from aircraft technology, operational improvements, and SAF

Full Report Contents

https://www.faa.gov/sites/faa.gov/files/2021-11/Aviation_Climate_Action_Plan.pdf

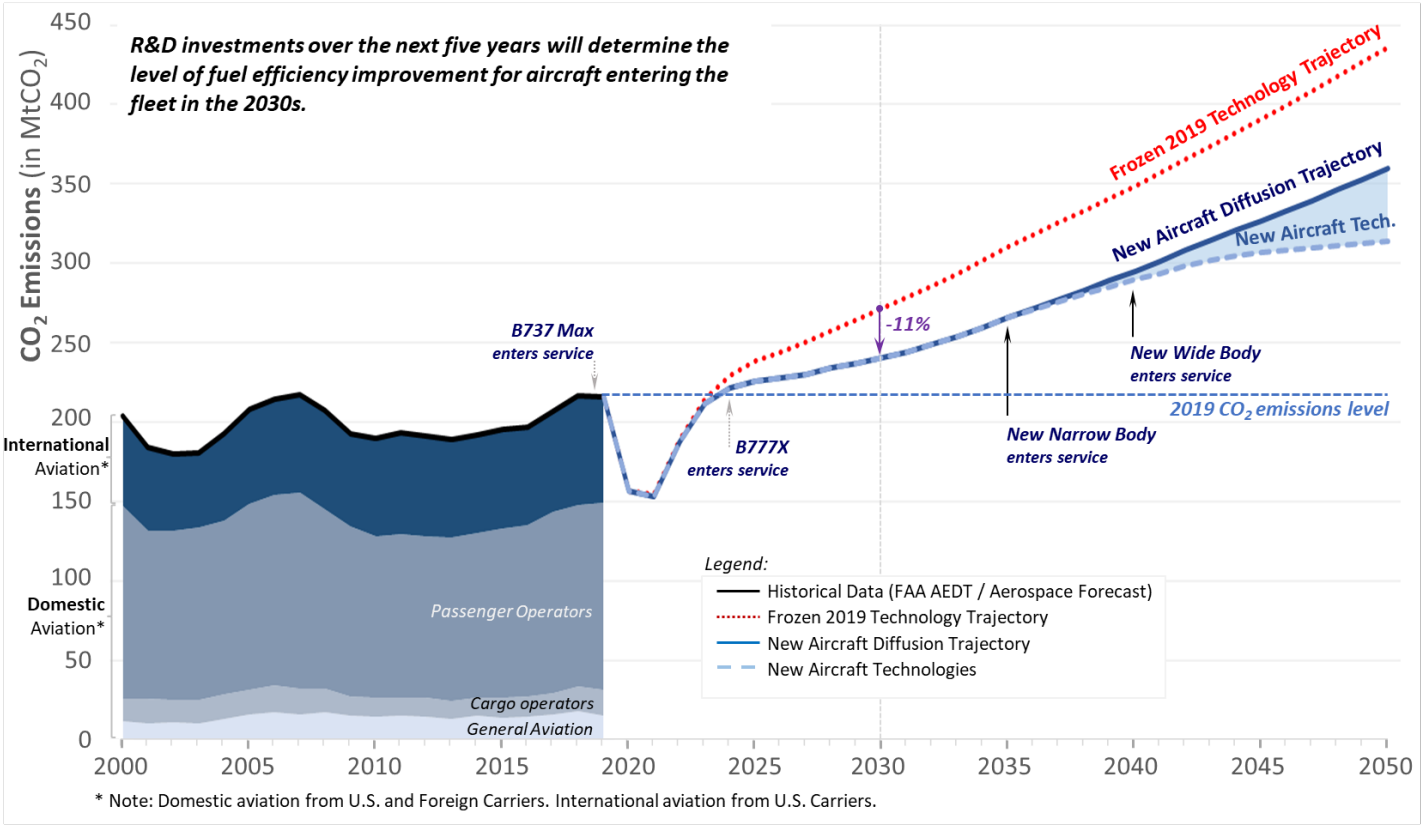
- Introduction
- Climate Goals and Approach
- Aircraft and Engine Technology Development
- Operational Improvements
- Sustainable Aviation Fuels
- International Leadership and Initiatives
- Airport Initiatives
- FAA Leadership on Climate, Sustainability and Resilience
- Non-CO_2 Impacts of Aviation on Climate
- Policy and Measures to Close the Gap

Aircraft and Engine Technology Development

The evolution of modern, more efficient airframes and engines has historically produced the most significant aviation emissions reductions; the Sustainable Flight National Partnership (SFNP) will continue to drive emissions reductions in the future.

Summary of Actions

- Utilize the SFNP to conduct ground and flight tests to demonstrate aircraft and engine technologies and designs that can deliver a step change improvement in environmental performance.
- Pursue ambitious international standards that incentivize the most effective technologies to safely limit the growth of, and ensure reductions in, aircraft emissions.



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

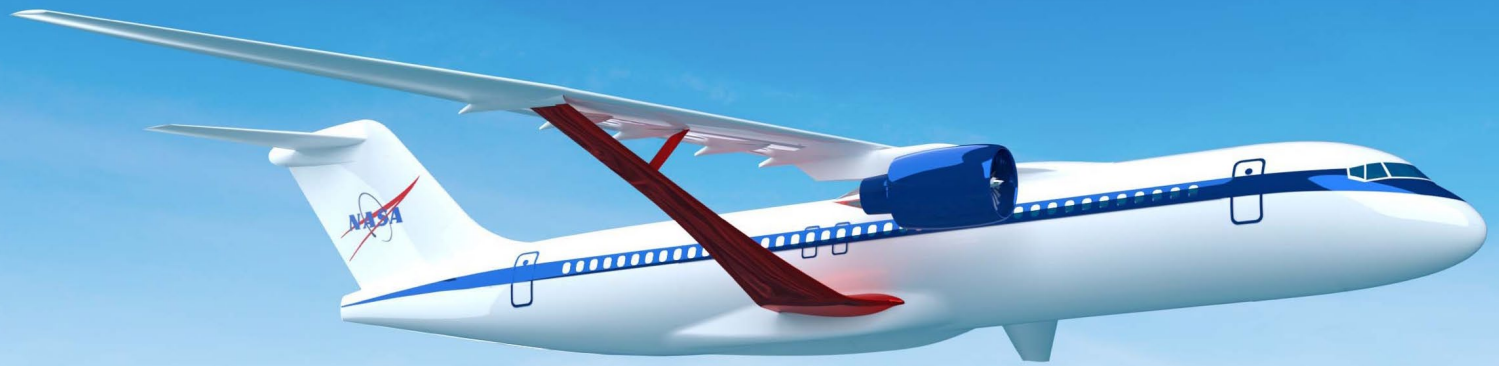
Sustainable Flight National Partnership

A sustained major technology development initiative, under which NASA and the FAA will work with industry, to accelerate the maturation of aircraft and engine technologies that enable a step-change reduction in fuel burn, emissions, and noise, (i.e., 25-30% lower fuel burn and 10-15 decibel noise reduction relative to best-in-class aircraft today).

SNFP will build upon successful cooperation among FAA, NASA, and industry:

- NASA's investments under the SFNP include a suite of integrated, large-scale aircraft and propulsion flight and ground technology demonstrations, including ultra-efficient wings (such as transonic truss-braced wings), small-core gas turbines, electrified and hybrid electric aircraft propulsion system(s), and new manufacturing techniques such as high-rate composite manufacturing to enable rapid production of such new aircraft.
- FAA R&D is focused on engine technologies, low-emissions combustion, and aircraft technologies that enable future operational concepts. At the FAA, these technology development efforts will be executed primarily under the CLEEN Program and the ASCENT Center of Excellence.

SFNP will initially target narrow-body aircraft family as it accounts for 55% of future global market value ($3.7 trillion), 40% of CO_2 emissions from commercial operators globally, and 60% of domestic population exposure to significant noise.



Aircraft Technology

Through the Continuous Lower Energy, Emissions, and Noise (CLEEN) Program, FAA are working in a public-private partnership with industry to accelerate maturation of certifiable aircraft and engine technologies.

- Technological innovation will be essential to enable environmentally sustainable growth and maintain U.S. global leadership.

- FAA have been operating CLEEN Program since 2010 (initially set up during Bush administration)

- FAA announced CLEEN Phase III on Sept 9, 2021

- Summary of CLEEN accomplishments over first two phases (10+ years) available online

CLEEN Phase III Technologies

For more information on CLEEN program: http://www.faa.gov/go/cleen

For the CLEEN Phase 3 Press Release:
https://www.faa.gov/newsroom/faa-awards-100m-develop-next-generation-sustainable-aircraft-technology

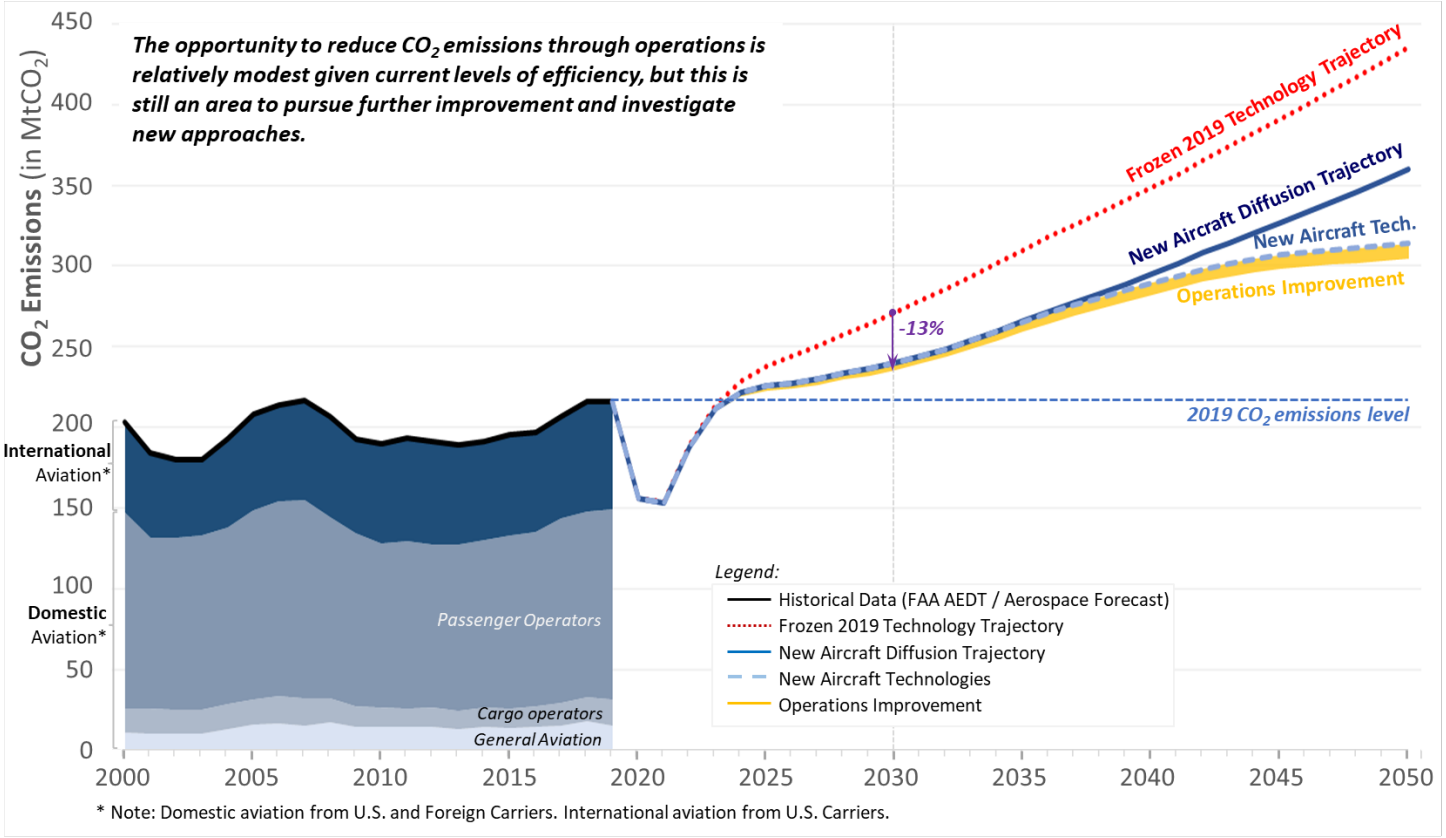
For a summary of CLEEN Accomplishment:
https://www.faa.gov/newsroom/continuous-lower-energy-emissions-and-noise-cleen-program?newsId=22534

Operational Improvements

Efficiencies can be gained through every phase of flight, helping to reduce fuel burn and emissions from aviation; improvements in trans-oceanic flights could provide substantial benefits.

Summary of Actions

- Continue to operationalize NextGen to realize the full potential of modernized infrastructure and systems, including through the transformation of the NAS to trajectory-based operations.
- Enhance data quality and information distribution to enable operators to fly more fuel-efficient trajectories, especially during the cruise phase of flight, in U.S.-controlled airspace.



Sustainable Aviation Fuels

Sustainable Aviation Fuels (SAF) will be critical to the long-term decarbonization of aviation. Through a range of policy instruments, including the SAF Grand Challenge, the USG will work with industry to rapidly scale up SAF production with the goal of meeting the fuel needs of U.S. aviation by 2050.

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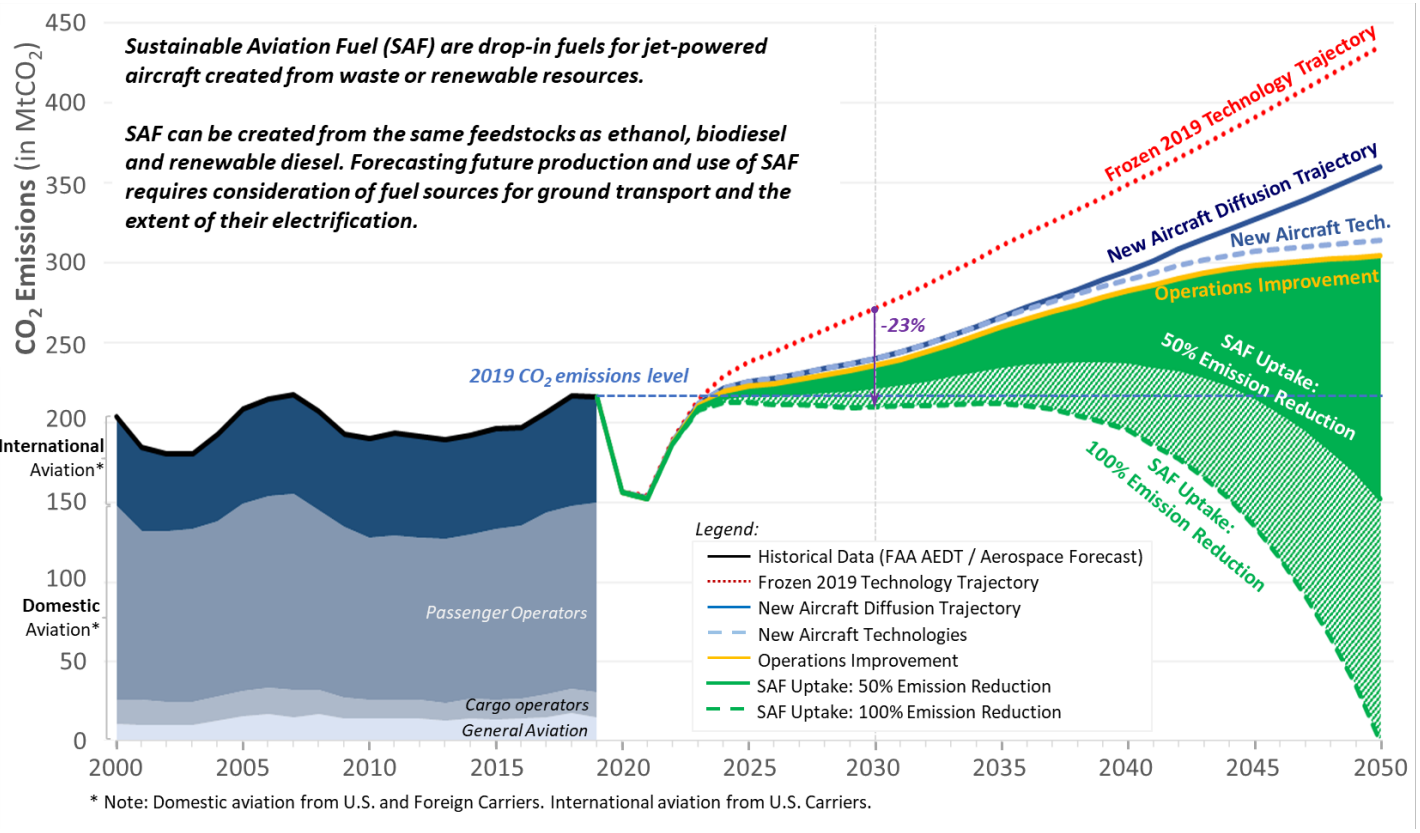


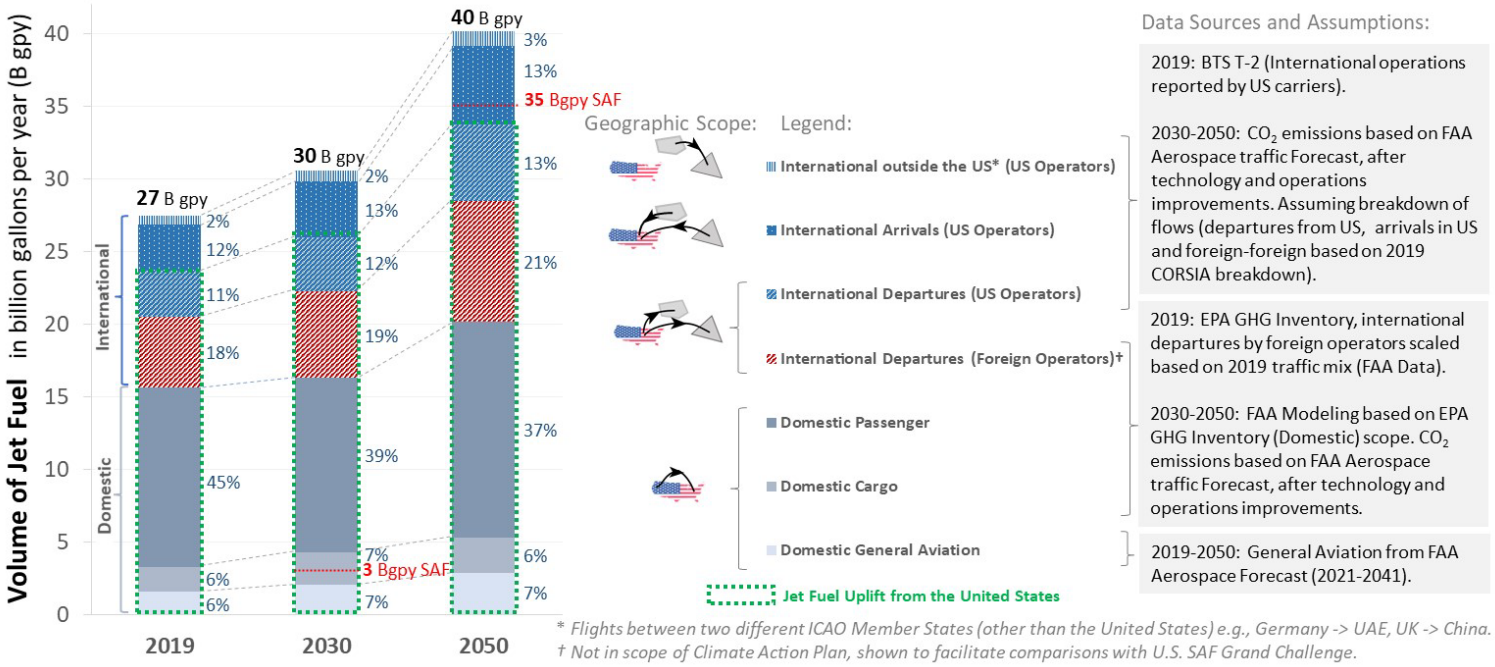
SAF Grand Challenge

https://www.energy.gov/eere/bioenergy/sustainable-aviation-fuel-grand-challenge

The US Government has identified the development and deployment of SAF as a key aviation climate priority. The USG has established a multi-agency effort led by the DOT, DOE, and USDA to implement the "SAF Grand Challenge" to reduce cost, enhance sustainability, and expand production and use of SAF that achieves a minimum of a 50% reduction in life cycle GHGs compared to conventional fuel.

SAF Grand Challenge will include development of a multi-agency roadmap in order to:

- Reduce the cost of SAF
- Enhance sustainability of SAF
- Expand SAF supply and end use



Potential demand for jet fuel in gallons per year (gpy) across domestic operations (by U.S. and Foreign Carriers), international departures from foreign carriers and international operations by U.S. carriers. Red text indicates SAF Grand Challenge volumetric production goals.

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

Working to develop SAF Grand Challenge Roadmap (Nate Brown is FAA POC)

* SAF Grand Challenge Memorandum of Understanding (MOU) available at: https://energy.gov/sites/default/files/2021-09/S1-Signed-SAF-MOU-9-08-21.pdf

International Leadership and Initiatives

Continuing a long tradition of leadership on noise and environmental standards in ICAO, the United States is providing technical and policy leadership on climate in ICAO.

Summary of Actions

- Continue to provide technical leadership to ICAO/CAEP and its Working Groups.
- Undertake rulemaking to implement CORSIA to the extent possible under existing authority.
- Negotiate internationally to maintain the environmental integrity of CORSIA, enhance CORSIA's ambition, strengthen ICAO's aircraft CO_2 emissions standard, and adopt medium- and long-term global goals that drive aviation climate action world-wide.
- Pursue mutually-beneficial climate protection provisions in aviation bilateral and multi-lateral agreements.

ICAO Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)

In 2016, ICAO Member States reached agreement on CORSIA, a global market-based measure to address international aviation's CO_2 emissions. In the simplest terms, CORSIA requires aircraft operators purchase emissions offsets or use CORSIA Eligible Fuels (CEF) to reduce international CO_2 emissions above a defined baseline. There are two types of CORSIA Eligible Fuels, Sustainable Aviation Fuels created from renewable or waste feedstocks, and Lower Carbon Aviation Fuels, created from fossil feedstocks. As an international program, CORSIA enables the development of harmonized standards for both emissions offsets and CEF to ensure their robustness and sustainability and creates a marketplace for their use. This harmonization establishes global certainty for all stakeholders involved. The USG has played a leadership role in the development of all aspects of CORSIA and continues work ensuring CORSIA's environmental integrity.

ICAO CORSIA Website: https://www.icao.int/environmental-protection/CORSIA/Pages/default.aspx

Airport Initiatives

While their CO_2 emissions are relatively small in comparison to those from the combustion of jet fuel, airports are playing an important role in addressing climate change.

Summary of Actions

- Continue to fund grants for authorized emission reduction programs and develop guidelines for other programs authorized but not funded or implemented.
- Develop a resilience framework through research and potential grant funding.

FAA Leadership on Climate, Sustainability, and Resilience

Summary of Actions

- Establish climate, sustainability and resilience as an agency priority initiative with measurable targets and timelines, in line with Executive Orders and related agency requirements.
- Reduce climate impacts from FAA facilities and operations by lowering the agency's carbon footprint, with specific and measurable milestones and targets.
- Increase the resilience of critical FAA facilities and assets, with specific and measurable milestones and targets.
- Update agency policies and orders related to sustainability, energy/water efficiency, and waste reduction, to reflect best practices and ensure long-term implementation

Non-CO_2 Impacts of Aviation on Climate

Aircraft combustion emissions also have non-CO2 impacts on the climate. The primary concern is the impact of aviation induced cloudiness.

Summary of Actions

- Improve the scientific understanding of the impacts of non-CO2 aircraft emissions to enable the development of cost-beneficial solutions to address both air quality and climate impacts.
- Develop decision support tools that could be used by industry to cost-effectively mitigate the overall climate impacts of aviation via contrail mitigation.

Policies and Measures to Close the Gap

The Aviation sector is a challenge to decarbonize. The use of robust offsets including carbon capture can support the sector's goals by leveraging emissions reductions elsewhere.

Summary of Actions

- Examine policy options that incentivize innovations in lower-emitting aviation.
- Examine policy options that help close the gap for emissions from domestic flights, by providing access to and use of emission reductions that come from outside the sector.

Presentation Outline

- Office of Environment and Energy – Background & E&E Strategy Overview
- Highlights of R&D Program
- **Direction of the E&E Portfolio**
  - Noise and Emissions
  - U.S. Aviation Climate Action Plan
  - **International Support**
- Budget Profile for E&E Portfolio
- Summary

ICAO CAEP Long Term Aspirational Goal (LTAG) Support

- FAA provided staffing and researchers to support CAEP exploration of feasibility of a long term aspirational goal for CO_2 emissions from international aviation
- Led most aspects of this work (tech, fuels, operations, scenarios) to support assessment of CO_2 emissions under various future scenarios
- Leveraged multiple efforts to provide analysis support
  - ASCENT Projects 1 & 52 provided fuel analysis
  - ASCENT Project 64 provided technology analysis
  - Volpe conducted integrated analysis (using AEDT)
  - Blue Sky provided costing and supported integrated analysis
  - Coordinated considerable support from across U.S. government

Standard Setting Support in ICAO

Standing up two new ASCENT Projects to support standard setting in ICAO CAEP

- Integrated noise and CO_2 standard (Georgia Tech, MIT, and Blue Sky)
- Metric for cruise NO_X emissions (MIT)

Continuing to support the development of supersonic standards for landing and takeoff noise, cruise noise, and emissions (Penn State, Georgia Tech, and MIT)

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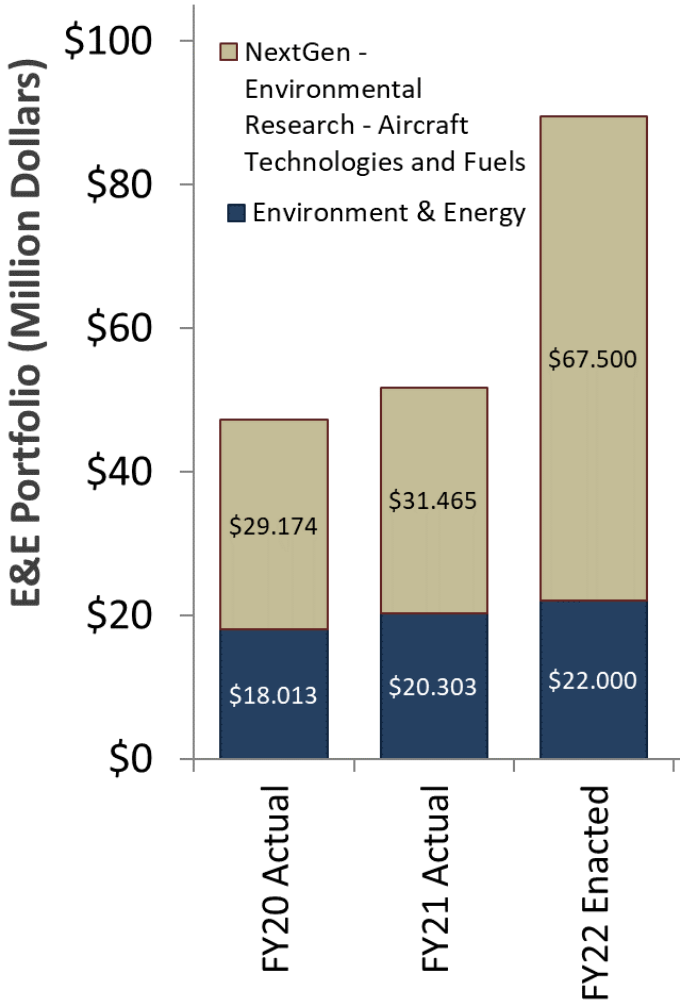
Environmental & Energy R&D Portfolio

RE&D Environment & Energy Budget Line Item*

- Improved understanding of noise and emissions and their impacts
- Analytical tool development
- Analysis to inform decision making

RE&D NextGen – Environmental Research – Aircraft Technology and Fuels Budget Line Item**

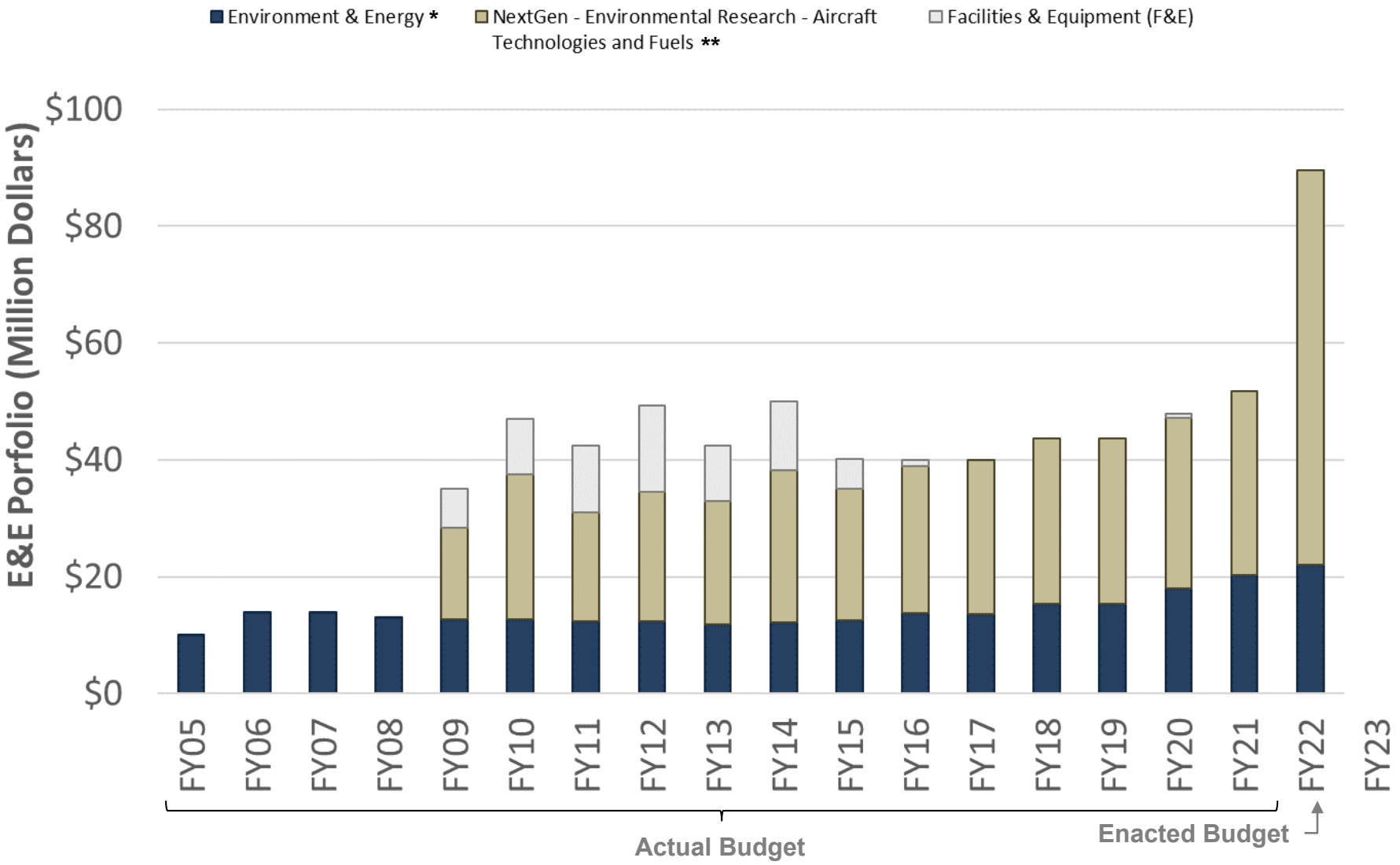
- Accelerated development of aircraft and engine technologies with reduced fuel burn, noise and emissions
- Testing, analysis and coordination activities related to Sustainable Aviation Fuels



*Budget Line Items: A12.a (FY20), A.T (FY21), A11.u (FY22), A11.T (FY23)

** Budget Line Items: A12.b (FY20), A.U (FY21), A11.v (FY22), A11.U (FY23)

Long Term Trends in E&E R&D Portfolio Budget



*Budget Line Items: A12.a (FY20), A.T (FY21), A11.u (FY22), A11.T (FY23)

** Budget Line Items: A12.b (FY20), A.U (FY21), A11.v (FY22), A11.U (FY23)

Federal Aviation Administration

FY22 Omnibus – RE&D Congressional Direction

Aviation emissions and noise. -The agreement provides an increase of $37,732,000 above fiscal year 2021 for research on reducing aviation emissions and noise.

The agreement includes $22,000,000 for Environment and Energy, of which $8,500,000 is to conduct research within the aviation sustainability center [ASCENT] COE. The increase in funding shall be used to better understand the impact of non-carbon dioxide emissions from aviation on climate change and to identify means to cost-effectively reduce these impacts.

The agreement includes $67,500,000 for NextGen-Environmental Research-Aircraft Technologies and Fuels, of which $26,565,000 is for ASCENT (of which not less than $2,000,000 is to study the impact of aviation noise), and of which $37,500,000 is for the continuous lower energy, emissions, and noise [CLEEN] program in order to accelerate the development of aircraft and engine technologies.

The increased funding should be used by ASCENT to go beyond the current 50 percent sustainable aviation fuel [SAF] blending limit and identify means to cost effectively reduce the lifecycle greenhouse gas emissions from SAF production and use, and continue its supply chain analysis work to help establish robust domestic supply chains for SAFs. ASCENT is also directed to continue working with the National Renewable Energy Laboratory on quantifying emissions reduction impacts of policies that could drive demand for SAFs. The FAA should also quantify the non-carbon climate benefits of these fuels.

In addition to the work on SAFs, ASCENT is also directed to work on quantifying the ultrafine particulate and other public health impacts of aviation on airsheds, particularly for communities near airports.

The agreement directs the FAA, in collaboration with the Departments of Energy and Agriculture and other Federal agencies, to conduct an interagency review and update of the 2016 Federal Alternative Jet Fuels Research and Development Strategy to address key scientific and technical challenges that inhibit the development, wide scale production, and use of economically viable SAF. The revised strategy should identify and prioritize specific research and development activities in order to accelerate SAF utilization.

FY22 Omnibus – Ops Congressional Direction

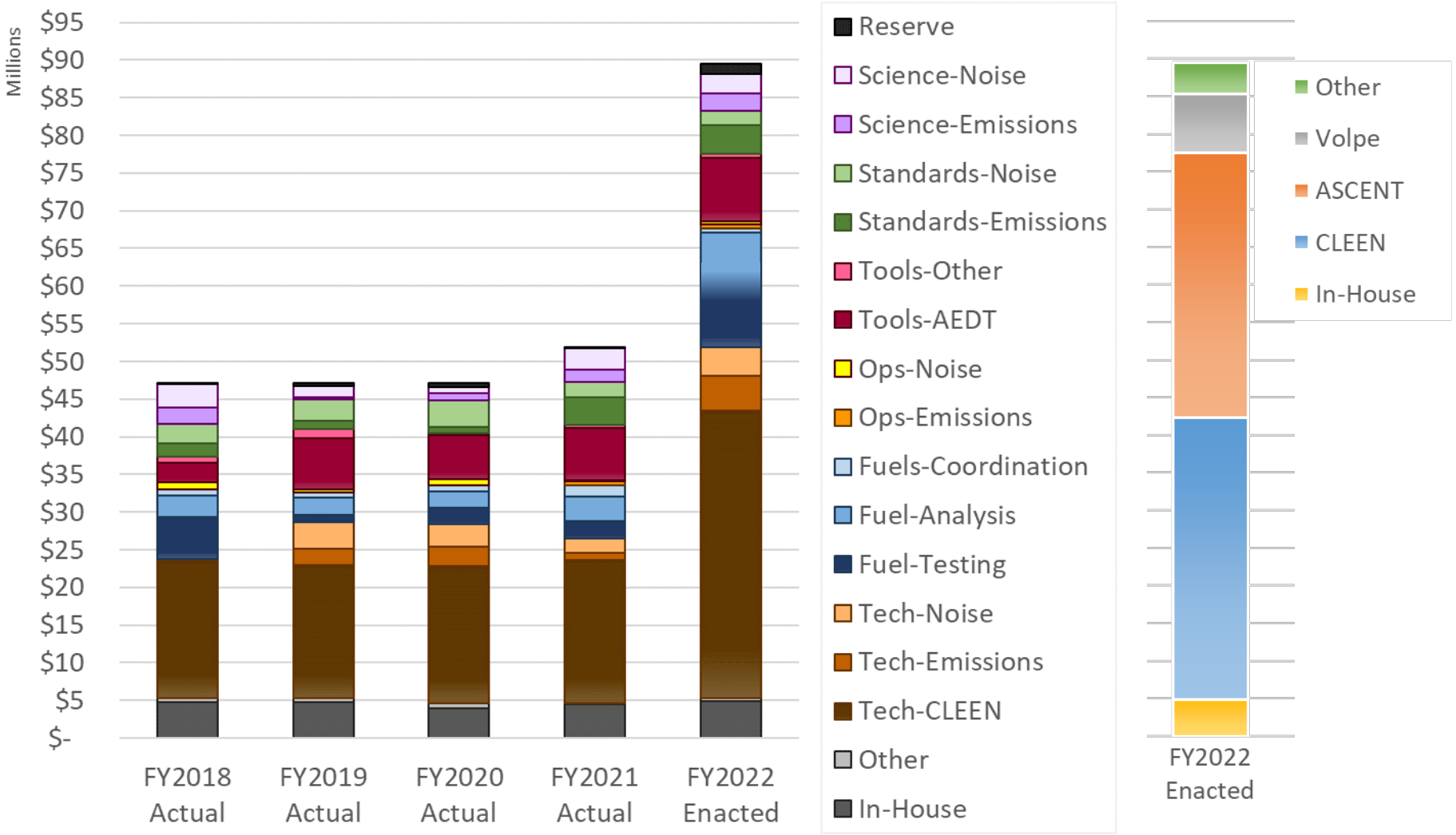
Community engagement and noise. - The agreement provides not less than $8,000,000 under this heading to support regular engagement with communities affected by aviation noise, including technical and analytical support for communities that may not have such expertise. Not less than 90 days after the date of enactment of this act, the FAA shall also provide the House and Senate Committees on appropriations with a timeline for implementation of the new tools and systems related to noise in the budget request. The FAA's comprehensive review of its noise policy is also expected to focus on day-night level [DNL] standards and to be inclusive of all relevant stakeholders, including, but not limited to, communities near airports, other Federal departments and agencies, and airports.

Global environmental standards for supersonic aircraft.-The agreement urges the FAA to continue its efforts to develop global environmental standards for supersonic aircraft by working through the International Civil Aviation Organization's Committee on Aviation Environmental Protection. The FAA should develop these standards while also addressing challenges with noise, environmental and climate impacts, and data limitations.

CLEEN / ASCENT Budgets

	FY21 Actual	FY22 President's Budget	FY22 Enacted
A11.s Environment and Energy			
CLEEN	$0	$0	$0
ASCENT	$7,500,000	$7,500,000	$8,500,000
Other	$12,803,000	$12,836,000	$13,500,000
Total	$20,303,000	$20,336,000	$22,000,000
A11.t NextGen – Environmental Research – Aircraft Technologies and Fuels			
CLEEN	$19,000,000	$20,000,000	$37,500,000
ASCENT	$9,500,000	$10,000,000	$26,565,000
Other	$3,965,000	$3,476,000	$3,435,000
Total	$32,465,000	$33,476,000	$67,500,000

Environment and Energy R&D Portfolio Broken out by Research Area & Funding Vehicle



New Projects / Directions for FY22

ASCENT COE

- SAF testing to go beyond the current 50% SAF blending limit
- Identify means to cost effectively reduce lifecycle GHG emissions from SAF production and use through supply chain analysis
- Effects of SAF and combustor tech on non-volatile Particulate Matter emissions and evaluation of non-carbon climate benefits
- Noise impacts research including evaluating white noise as countermeasure for effects of noise
- Standard setting support
- UAS/AAM: Lifecycle Emissions Impacts Evaluation and Improved Noise Modeling
- Technological innovation

CLEEN Program

- Execute CLEEN Phase III options

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Recent Successes - Capabilities and Solutions Helping Today

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

- Research team provided analysis at the core of the U.S. Aviation Climate Action Plan
- 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)*.
- Measurement technique and data provided foundation for 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.

FAA Portion of the Remaining Agenda

Subject	Presenters
Sustainable Aviation Fuels Research	N. Brown and A. Oldani
Emissions Research	R. Iovinelli and D. Jacob
Noise Research	D. Scata and S. Doyle
Aircraft Technology Research	L. Ileri and A. Orton
Research on Operational Procedures	C. Dorbian
Analysis & Tool Development	F. Grandi, M. Majeed, and J. DiPardo

Dr. Jim Hileman

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