FAA Environment & Energy Research & Development Overview and SAF Grand Challenge

Prepared for: ASCENT Advisory Committee Meeting

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Office of Environment and Energy
Federal Aviation Administration

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Presentation Outline

- **Direction of the E&E Portfolio**
  - Overview
  - U.S. Aviation Climate Action Plan
  - SAF Grand Challenge
- **Budget Profile for E&E Portfolio**
- **Summary**
- **Backup Slides**
  - E&E Background
  - Details on U.S. Aviation Climate Action Plan
  - FY22 Budget Congressional Direction

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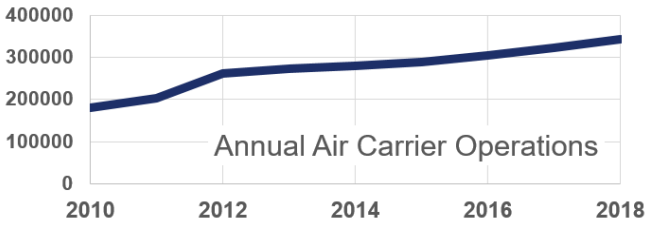
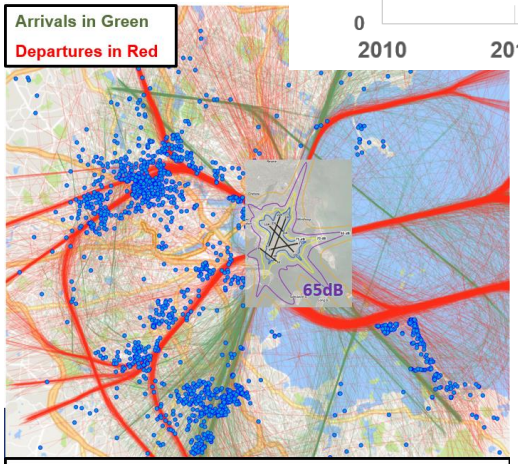
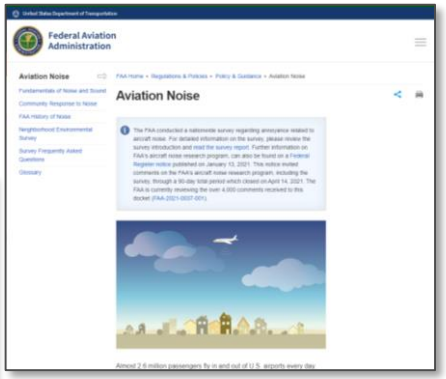
Aircraft Noise

- Recent efforts to modernize the national air transportation system have required changes in aircraft operational patterns leading 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
- New noise website, Federal Register Notice, and extensive outreach have been used to communicate and receive input on aircraft noise policy

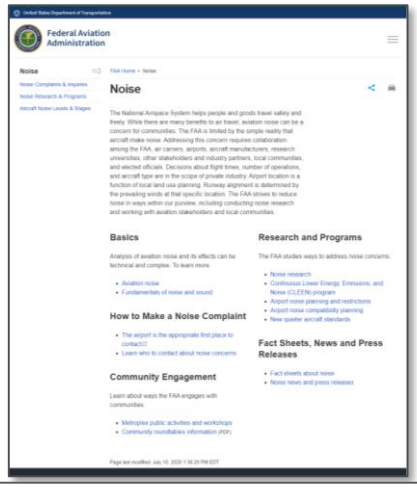




Each marker represents a unique complaint address



www.faa.gov/noise



www.faa.gov/go/aviationnoise

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

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

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

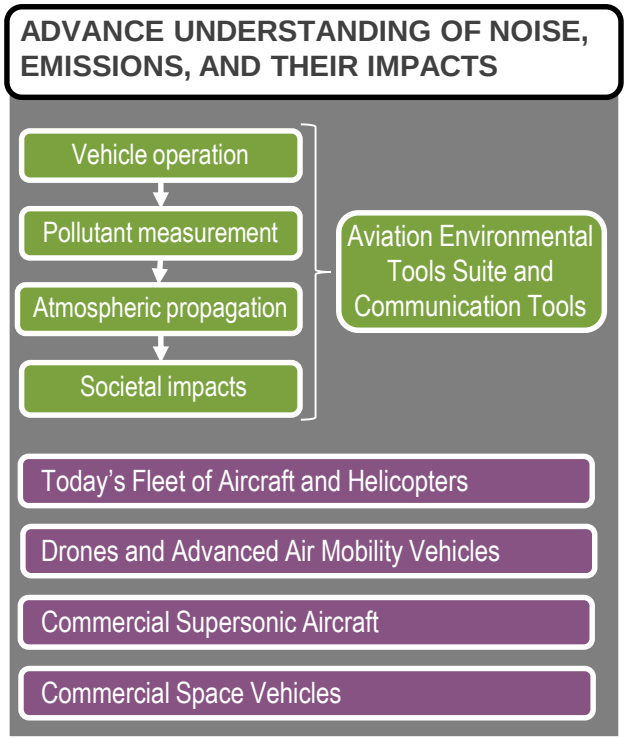
Federal Aviation Administration

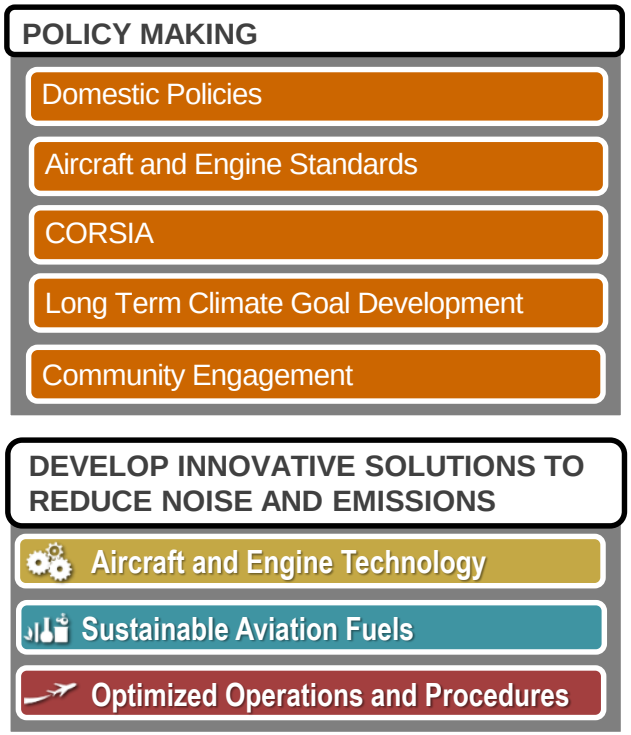
Environmental & Energy (E&E) Strategy

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/

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

CAAFI®
www.caafi.org/

the VOLPE center

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)

ASCENT Aviation Sustainability Center

CLEEN Continuous Lower Energy, Emissions & Noise Federal Aviation Administration

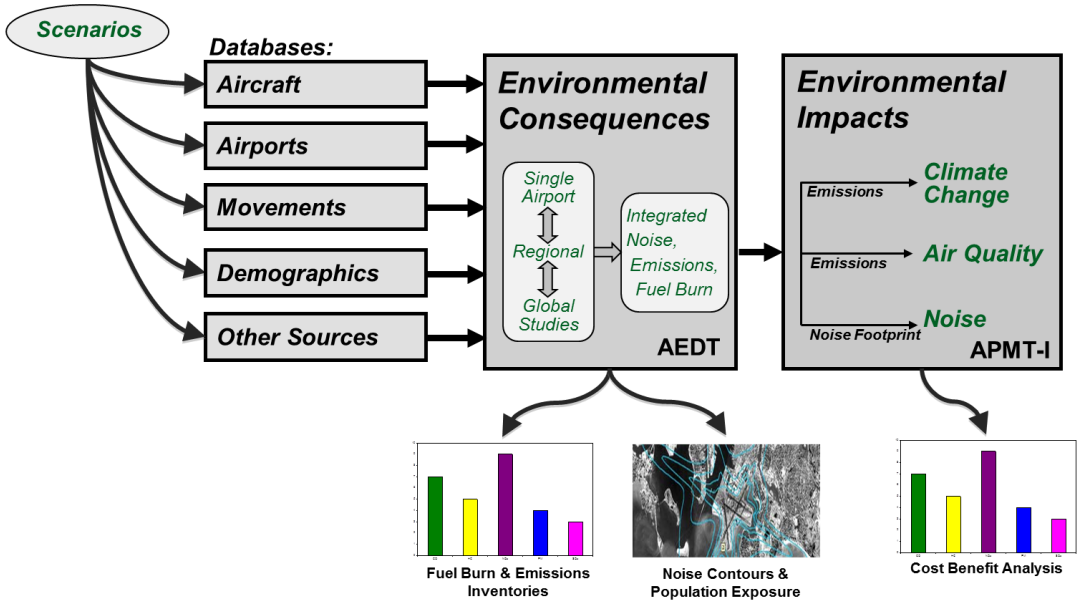
CAAFI

the VOLPE center

NextGEN

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:
  - *Dual Noise/CO2 stringency (NEW)*
  - *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.

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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

*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

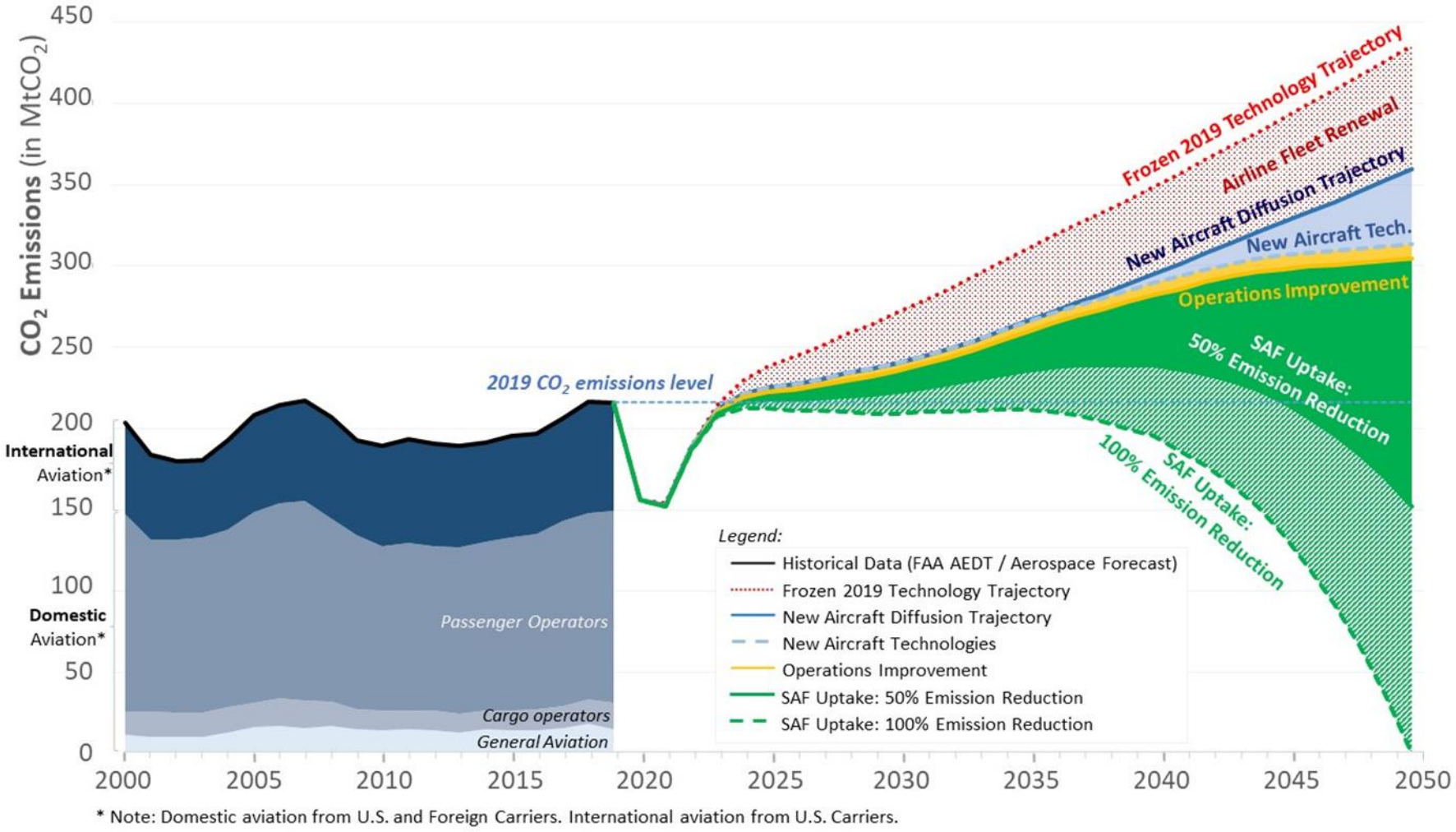
To be effective, a goal should be clear, achievable, and ambitious with specific actions that can be taken to achieve it. The goal outlined below contributes to the broader objective to achieve net-zero GHG emissions economy-wide by 2050.

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 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

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SAF Grand Challenge Roadmap

- **Identify and define what needs to be done in the next decade**
  - to achieve a goal of 3 billion gallons of U.S. SAF production in 2030 and put the U.S. on a trajectory to 35 billion gallons/year by 2050
- **Create a multi-agency plan of federal actions that will set a foundation for industry to build the SAF supply**
  - Derisk technology, supply chains and markets; reduce barriers:
    - 1) leverage existing government support for research, development, demonstration, deployment, commercialization and policy;
    - 2) accelerate new research, development, demonstration, and deployment support; and,
    - 3) implement a supporting policy framework
- **Engage USG and industry stakeholders to catalyze synergy and collaboration – cannot reach the goals without joint implementation**

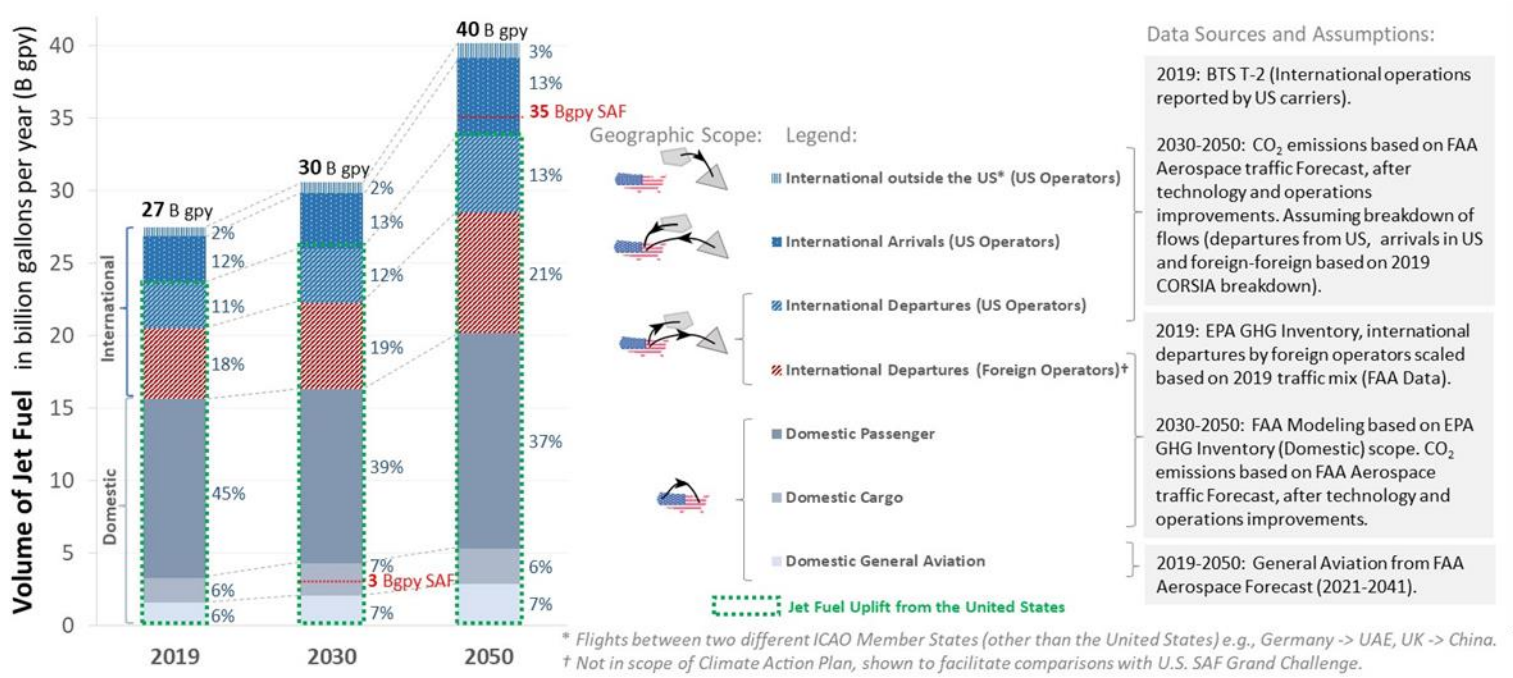
SAF GC Roadmap –Proposed Action Area Definitions

1. **Feedstock Innovation** - R&D on sustainable feedstock supply system innovations across the range of SAF relevant feedstocks and identify optimization to reduce cost, reduce technology uncertainty and risk, increase yield and sustainability, and optimize SAF precursors.
2. **Conversion Technology Innovation** - Focus ongoing and future R&D on a multi-generational pipeline of conversion technologies to reduce cost of production while increasing conversion efficiency, sustainability, and volume of fuels produced.
3. **Building Regional SAF Fuel production Supply Chains** – Support SAF production expansion through regional supply chains ensuring R&D transitions, field validation, demonstration projects, supply chain logistics, public-private partnerships, bankable business model development, and collaboration with regional, state and local stakeholders.
4. **Enabling End Use** - Facilitate the use of SAF by enabling the efficient evaluation of fuel engine performance and safety through advancement of certification and qualification processes, collection and analysis of data, addressing existing blend limits and understanding combustion emissions and impacts.
5. **Policy and Valuation Analysis** - Provide data, tools, and analysis to support policy decisions and maximize social, economic, and environmental value of SAF including alignment of existing and new policies.
6. **Communicating Progress & Building Support** – Monitor and measure progress against SAF GC goals and communicate the public benefits of the SAF GC to critical stakeholders.

SAF Grand Challenge Roadmap Next steps

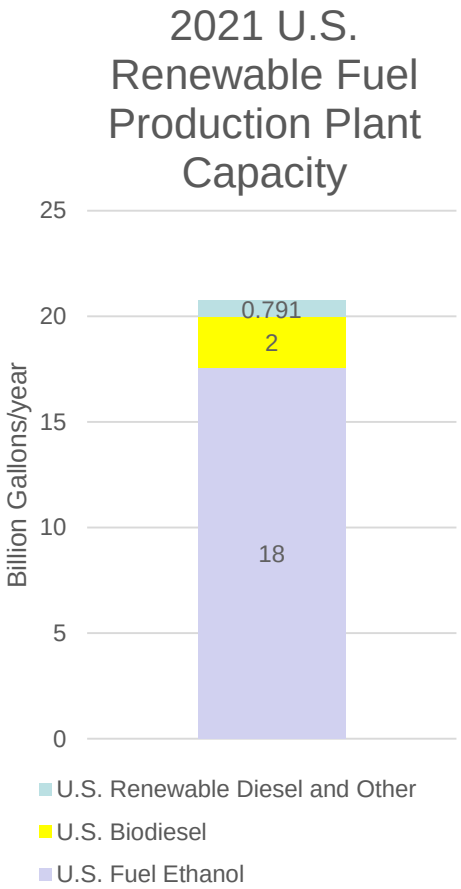
- **DOT/FAA, DOE and USDA leading process**
- **Biomass Board SAF Interagency Working Group**
- **Status**
  - Two brainstorming sessions held with federal experts
  - One session held with DOE national labs, ASCENT and USDA researchers
  - Industry/NGO/Regional stakeholder session April 15
  - Writing/development underway
- **Roadmap discussion at the CAAFI General Meeting June 1-3, 2022.**

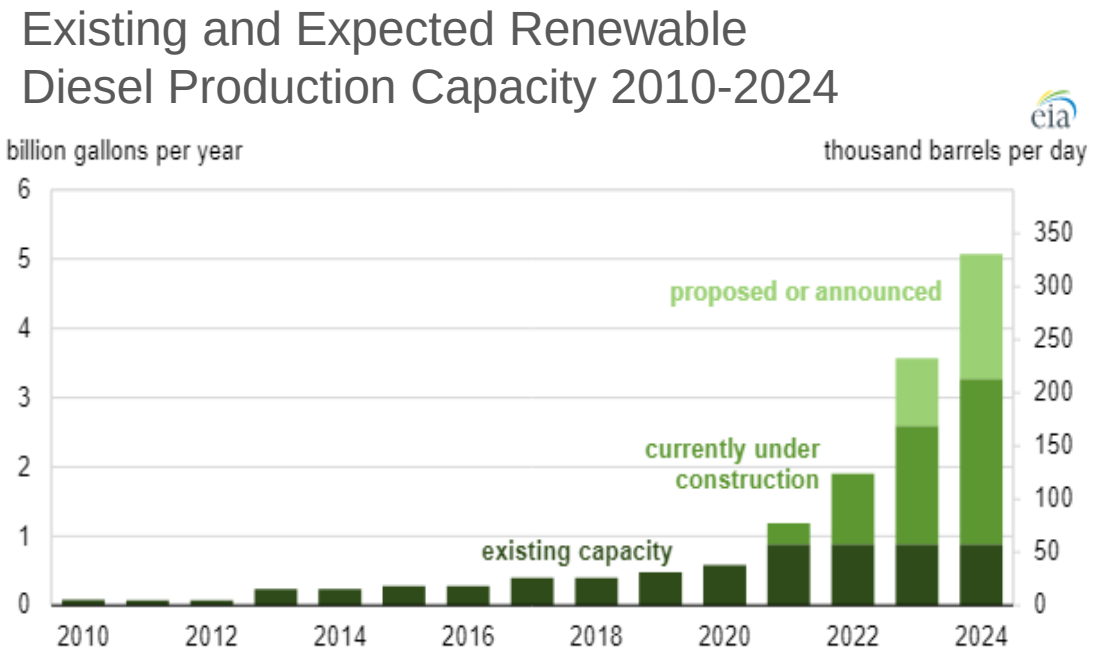
SAF Grand Challenge Goals Relative to Projected Demand



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.

Existing & expected U.S. renewable fuel production





Source: U.S. Energy Information Administration (EIA)
https://www.eia.gov/todayinenergy/detail.php?id=48916

Source: U.S. Energy Information Administration (EIA)
https://www.eia.gov/biofuels/biodiesel/capacity/

https://www.eia.gov/biofuels/renewable/capacity/

https://www.eia.gov/petroleum/ethanolcapacity/

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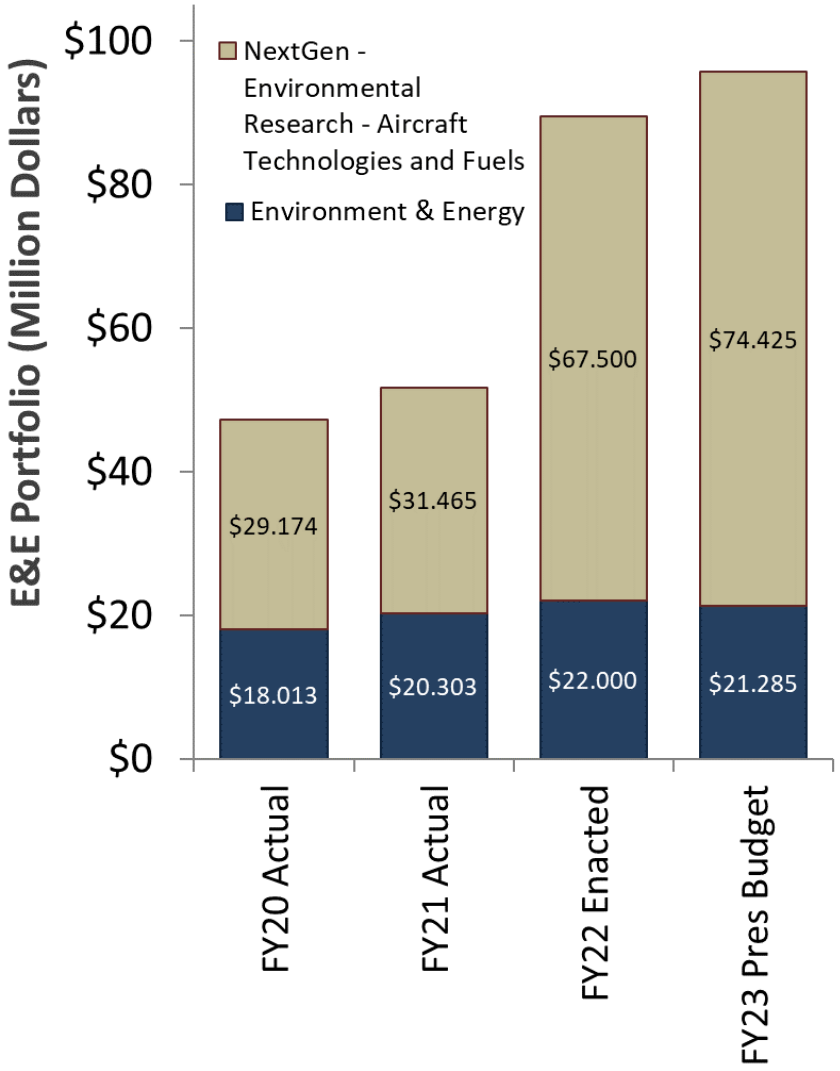
Environmental & Energy R&D Portfolio

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

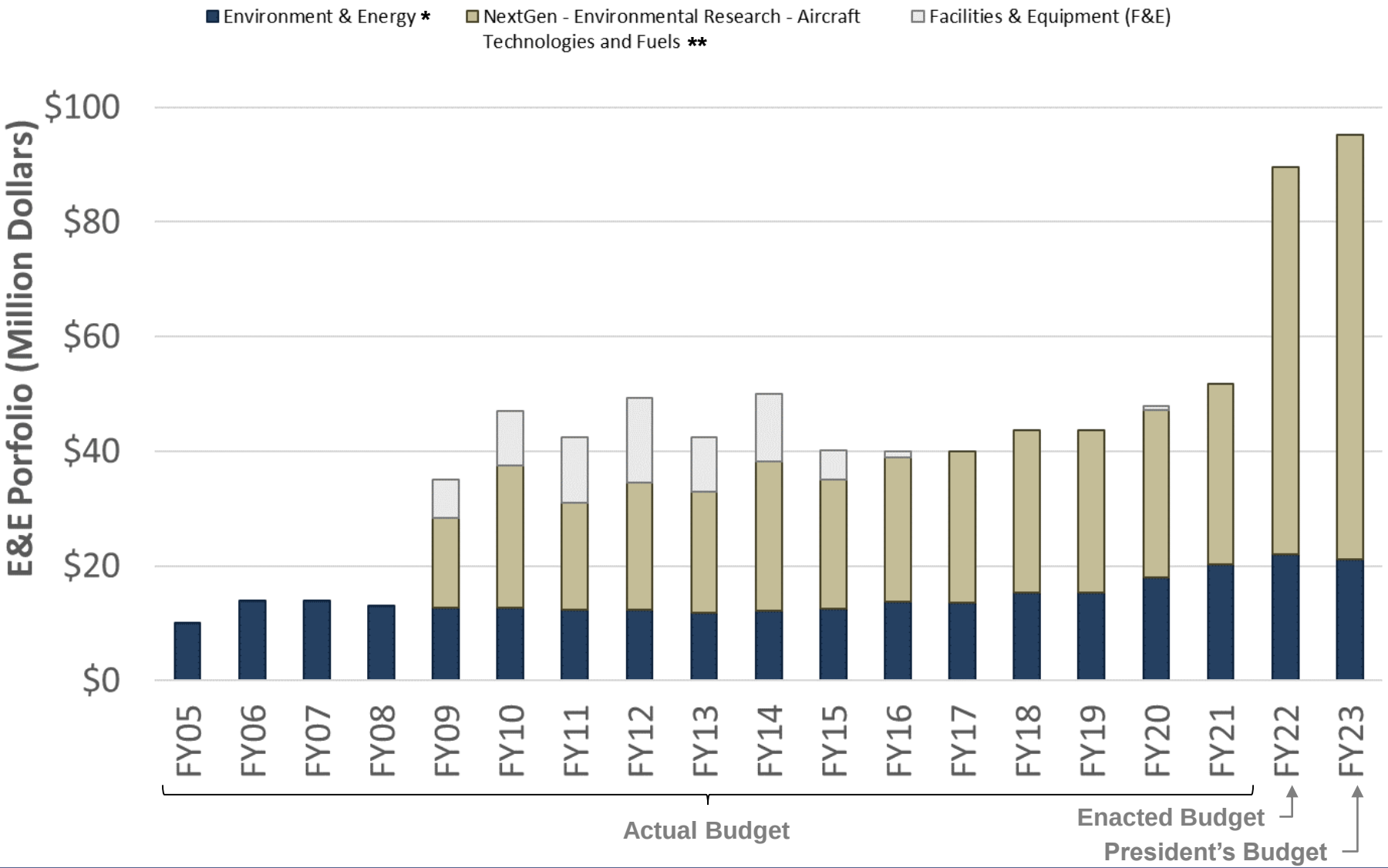


*Budget Line Items: A12.a (FY20), A.T (FY21), A11.u (FY22), A11.T (FY23)

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

FY23 President's Budget: https://www.faa.gov/about/budget

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



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FY23 President's Budget: https://www.faa.gov/about/budget

Federal Aviation Administration

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

CLEEN / ASCENT Budgets

	FY21 Actual	FY22 President's Budget	FY22 Enacted	FY23 President's Budget
A11.s Environment and Energy				
CLEEN	$0	$0	$0	$0
ASCENT	$7,500,000	$7,500,000	$8,500,000	$7,500,000
Other	$12,803,000	$12,836,000	$13,500,000	$13,785,000
Total	$20,303,000	$20,336,000	$22,000,000	$21,285,000
A11.t NextGen – Environmental Research – Aircraft Technologies and Fuels				
CLEEN	$19,000,000	$20,000,000	$37,500,000	$42,000,000
ASCENT	$9,500,000	$10,000,000	$26,565,000	$27,000,000
Other	$3,965,000	$3,476,000	$3,435,000	$5,425,000
Total	$32,465,000	$33,476,000	$67,500,000	$74,425,000

*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)

FY23 President's Budget: https://www.faa.gov/about/budget

FY23 Major Activities

Major Activities	Objective	Expected Outputs	Value Statement	Timeframe
Advance Scientific Understanding of Environmental Impacts of Noise and Emissions	Expand the scientific understanding of the impacts of noise and emissions on people, the environment, and climate.	Knowledge and data on the environmental impacts of noise and emissions.	Provides the understanding of the issues on which technological and operational solutions can be developed	On-going
Aviation Environmental Design Tool (AEDT) Development	Continue expanding the AEDT capabilities of integrated assessment of noise, fuel burn and emissions impacts from commercial aviation by integrating the latest scientific knowledge.	Public release of a new version of the AEDT software.	Provide the analytical capabilities needed for environmental reviews and standards development	On-going effort with annual AEDT releases
Decision Making on Standard Setting, Certification, and Policy	Provide the data and analysis necessary to support the development of appropriate certification procedures, standards, and policies for conventional aircraft, drones, advanced air mobility vehicles and supersonic aircraft.	Analyses and data to support decision making.	Develop the data and information needed to support decision making on both domestic policy and international environmental standards at ICAO CAEP	Second year of a recurring 3-year cycle

FY23 Major Activities (1 of 2)

Major Activities	Objective	Expected Outputs	Value Statement	Timeframe
CLEEN Phase III	Support the maturation of airframe and engine technologies to reduce civil aviation fuel burn, emissions, and noise impacts via one-to-one cost share partnership with manufacturers.	Accelerated maturation of new technologies that could reduce noise, emissions and fuel burn.	CLEEN technologies will produce noise, fuel burn, and emissions benefits throughout the fleet over many years	Year two of the five year CLEEN Phase III Program
ASCENT Technology Innovation	Examine the use of novel technologies and other forms of innovation to reduce noise, emissions, and fuel burn in commercial aircraft.	Improved methods and data to enable the development of technologies and innovative solutions with lower noise, emissions, and fuel burn from subsonic and supersonic commercial aircraft.	The knowledge provided by ASCENT will aid industry in developing solutions to enable quiet, clean, and efficient air transportation.	On-going
Ensure Novel Jet Fuels are Safe for Use	Support the approval of novel jet fuel pathways within the ASTM International certification process through testing and coordination to ensure these fuels are safe for use	Research reports to demonstrate the safety of novel jet fuel pathways for certification by ASTM Intl and streamline the ASTM certification process to reduce the time and cost of certification	The development and approval of new fuel pathways will expand the opportunities to move towards environmental sustainability in a cost-effective manner.	On-going

FY23 Major Activities (2 of 2)

Major Activities	Objective	Expected Outputs	Value Statement	Timeframe
Move Beyond the 50% SAF Blend Wall to Enable 100% SAF Use	Develop and test sustainable aviation fuels through ASCENT, CAAFI, and CLEEN that could be used safely in jet engines without blending with conventional petroleum-based jet fuel	Research reports to demonstrate the safety of sustainable aviation fuel pathways that can be used without blending for certification by ASTM Intl	Eliminate current limitations on environmental benefits of SAF due to current blending constraints	On-going
Maximize environmental benefits of sustainable aviation fuels	Evaluate aviation fuel supply chains within ASCENT to reduce the cost to produce sustainable aviation fuels and maximize their environmental benefits	Analyses and data to support actions by industry and government to cost-effectively produce sustainable aviation fuels with minimal life cycle GHG emissions	Enable aviation industry to cost effectively reach net zero CO_2 emissions through the use of sustainable aviation fuels	On-going
Support inclusion of Sustainable Aviation Fuels in ICAO CORSIA	Support the inclusion of sustainable aviation fuels created from waste and renewable feedstocks, and lower carbon aviation fuels created from fossil feedstocks, within the ICAO CORSIA framework	Develop robust lifecycle greenhouse gas emissions values and methods for alternative fuel pathways and sustainability criteria for use in ICAO CORSIA	High integrity international standards are needed to ensure that sustainable aviation fuels provide CO_2 reductions in a sustainable manner.	On-going

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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.

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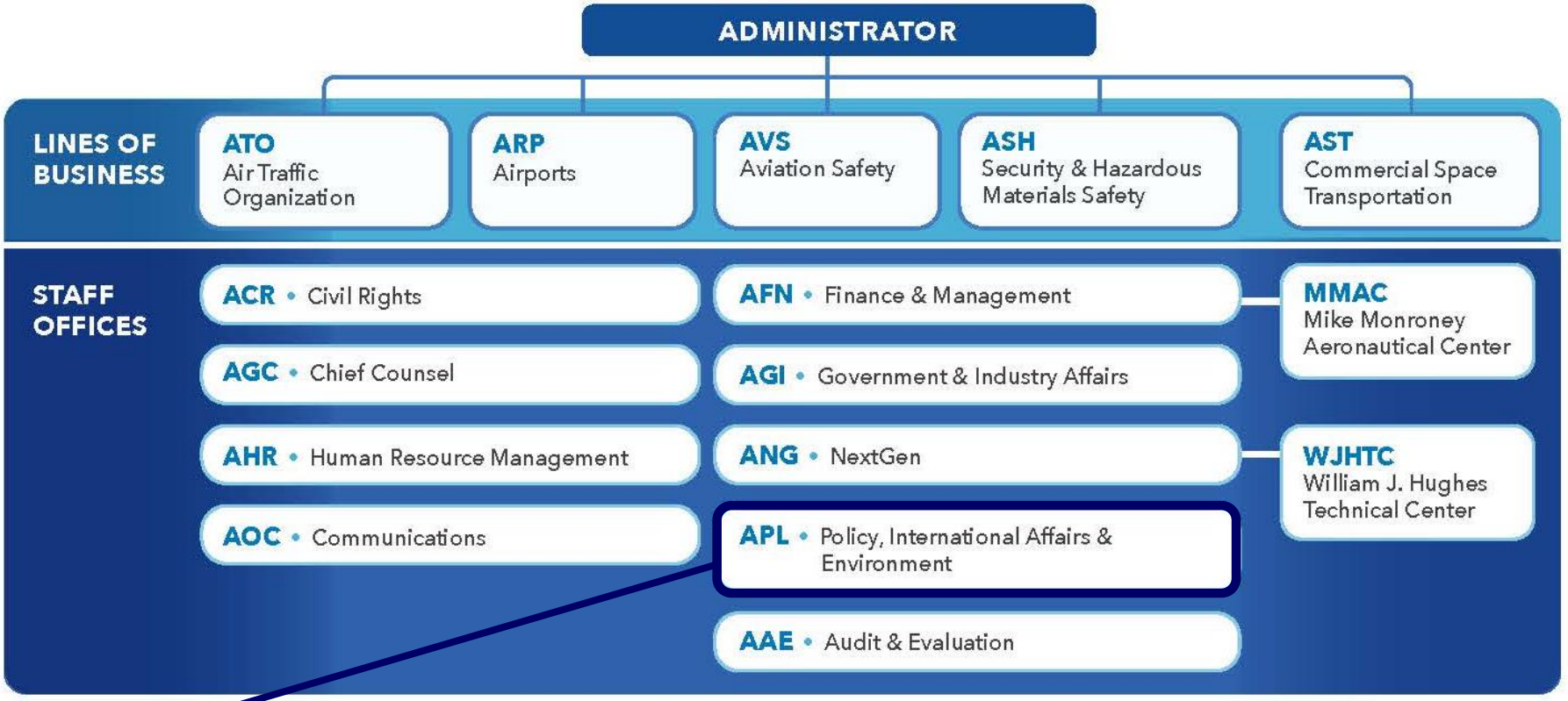
Backup Slides – E&E Background

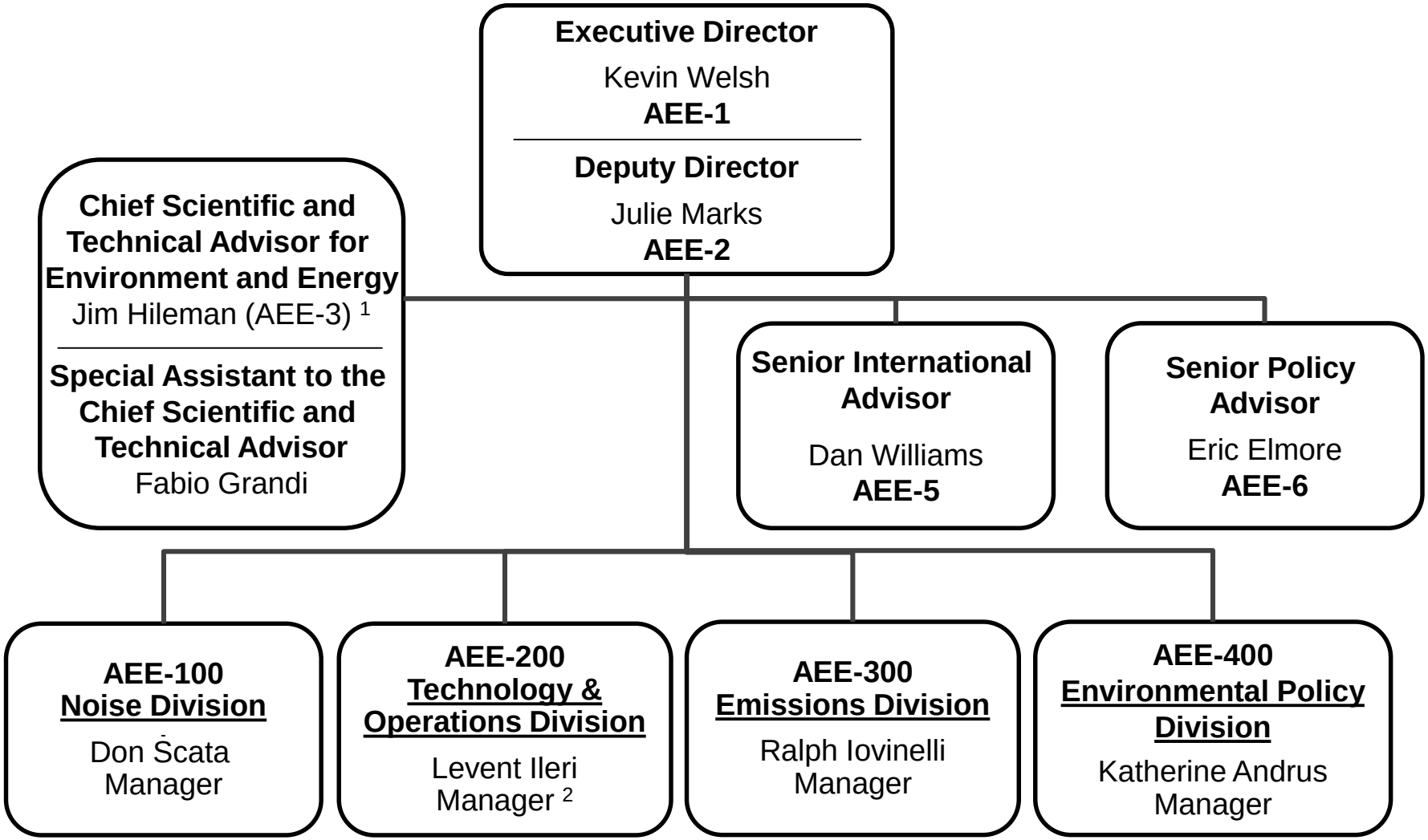
FAA Organizational Structure



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

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

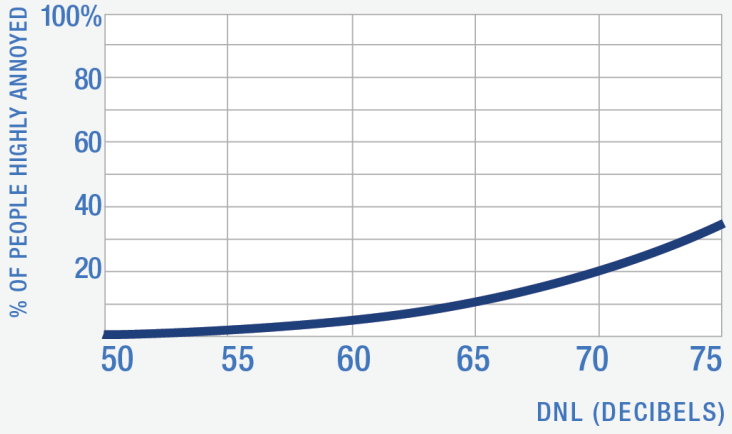
Neighborhood Environmental Survey

Aircraft Noise Annoyance Results

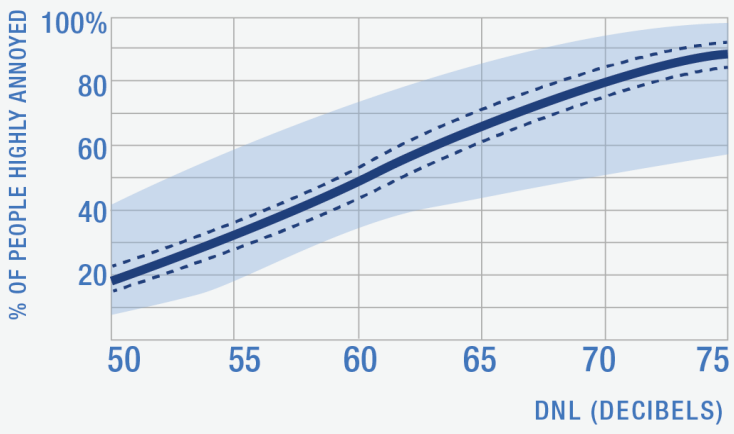
The NES results support an observed increase in Annoyance from Aircraft Noise:

- 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

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.

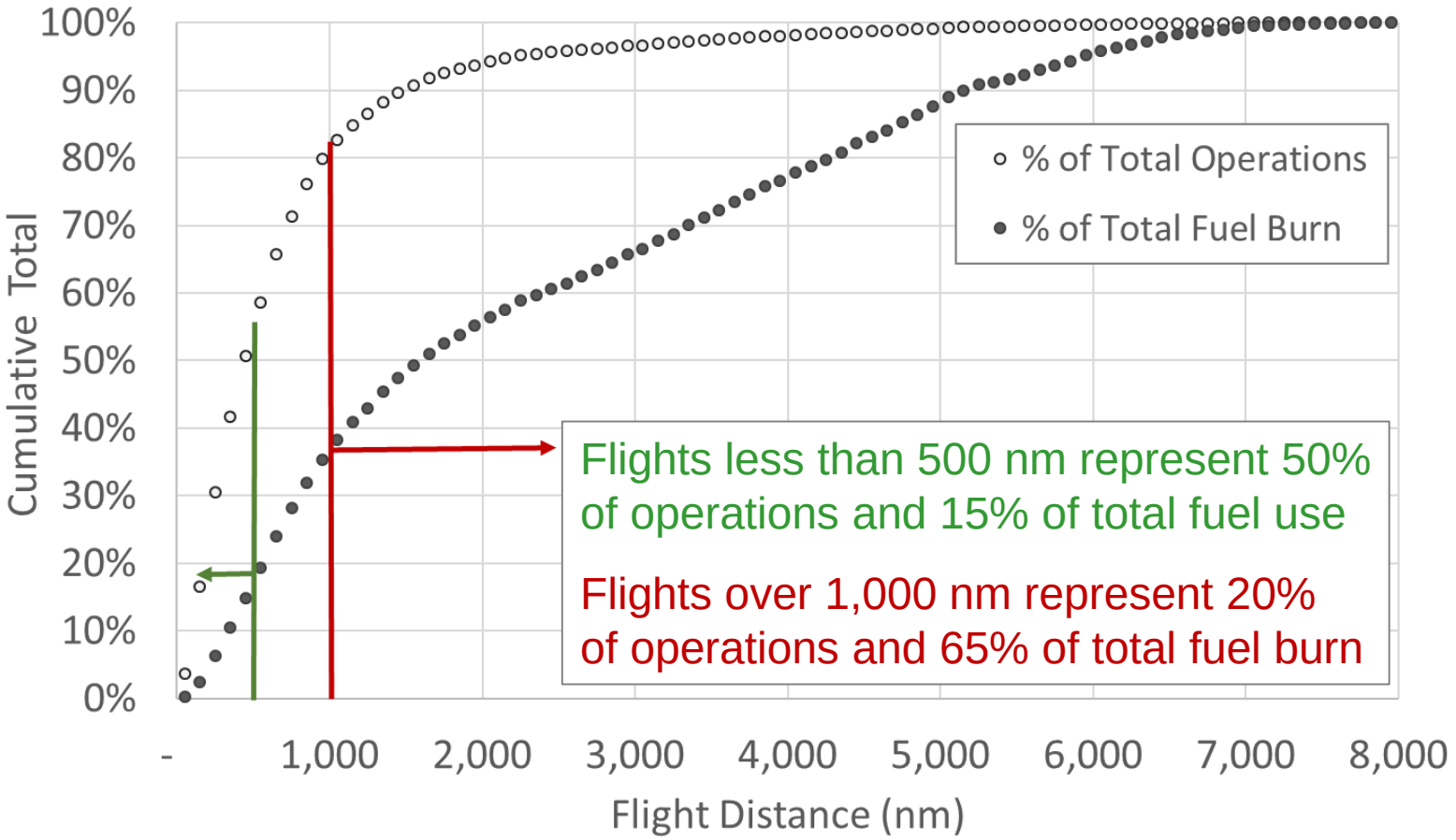
4) **Establish Any Necessary Policies**: EPA is evaluating whether emissions from piston-engine aircraft operating on leaded fuel contribute to air pollution that endangers public health or welfare. EPA plans to issue a proposal for public review and comment in 2022 and take final action in 2023. If 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

Backup Slides – Details on Climate Action Plan

Global Jet Fuel Use

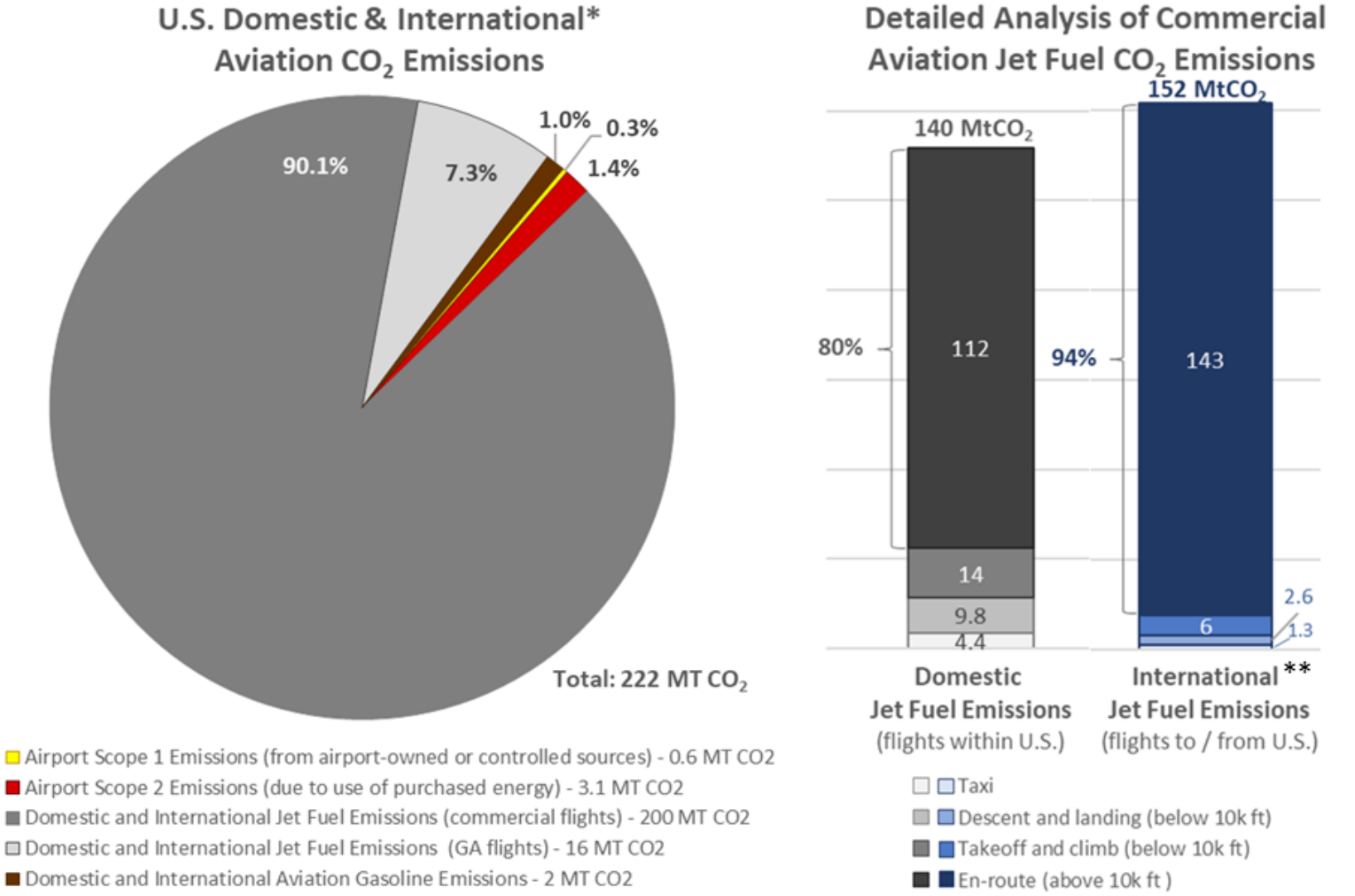
- Global jet fuel use is driven by long-haul aviation
- SAF only option through 2050 for long distances



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

Federal Aviation Administration

Analysis of U.S. Aviation CO_2 Emissions in 2019



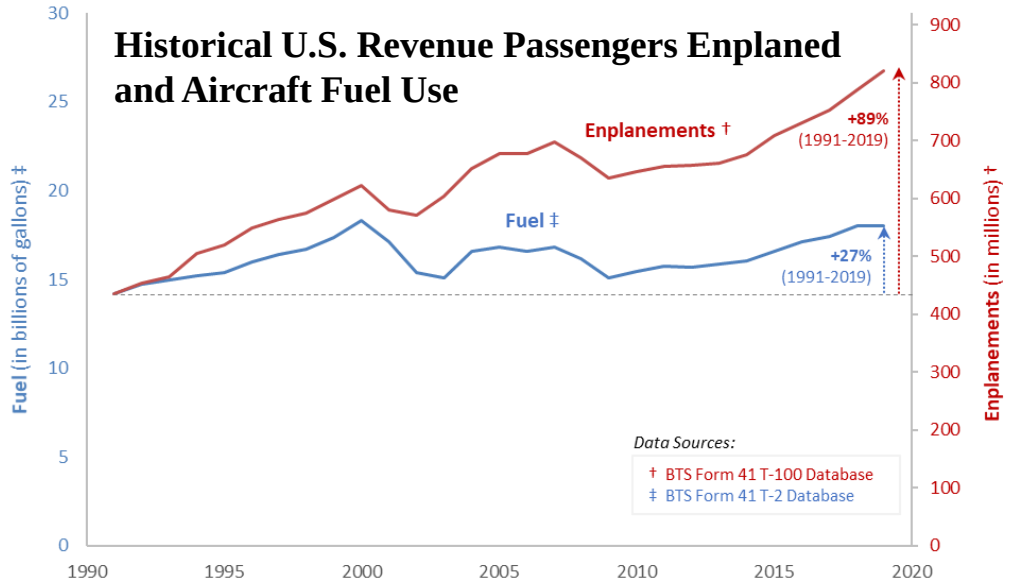
* CO_2 emissions from (1) domestic aviation (i.e., flights departing and arriving within the United States and its territories) from U.S. and foreign operators and (2) international aviation (i.e., flights between two different ICAO Member States) from U.S. operators (only). Airport scopes 1 and 2 added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

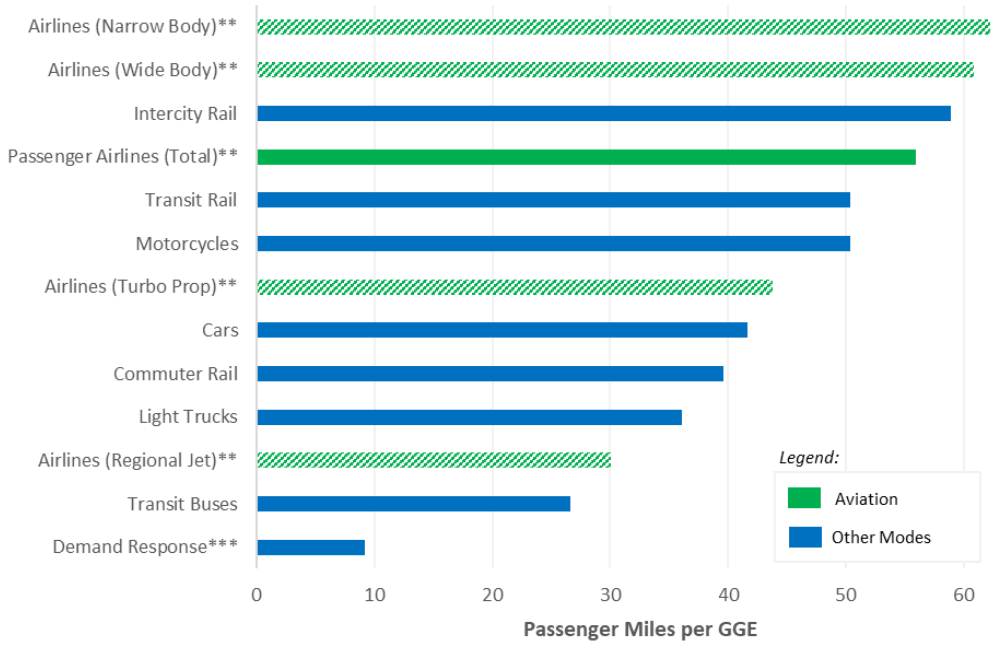
** International aviation to / from the United States, regardless of the operator of the flights i.e., including both U.S. and foreign operators.

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).





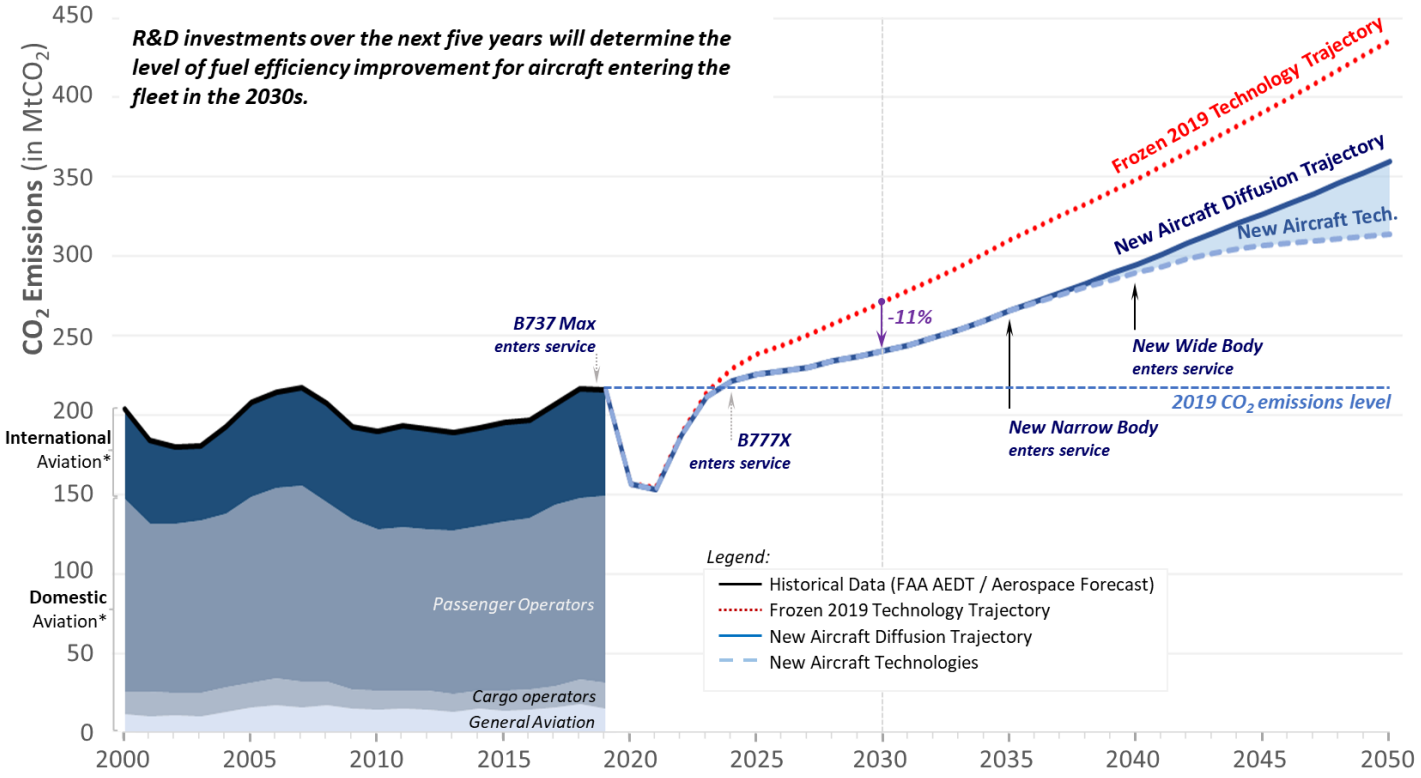
Notes: * Gasoline-Gallon Equivalents (GGE) are used to compare gasoline, diesel, and electricity on a level basis. Alterations to the source data were made to account for the inefficiencies of electricity production. This impacts rail the most because it has the highest level of electric power.
** Domestic 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.

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.

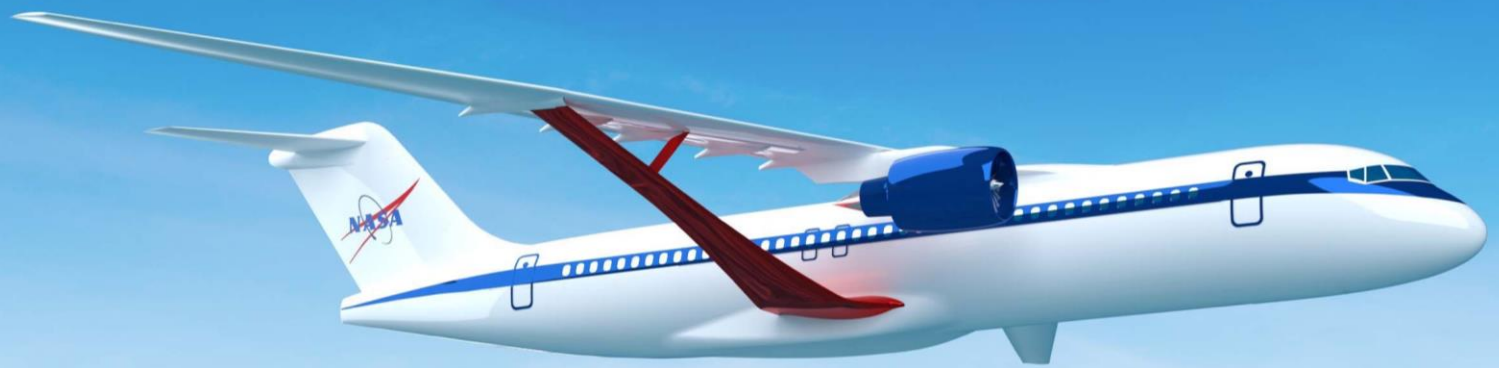
Sustainable Flight National Partnership

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

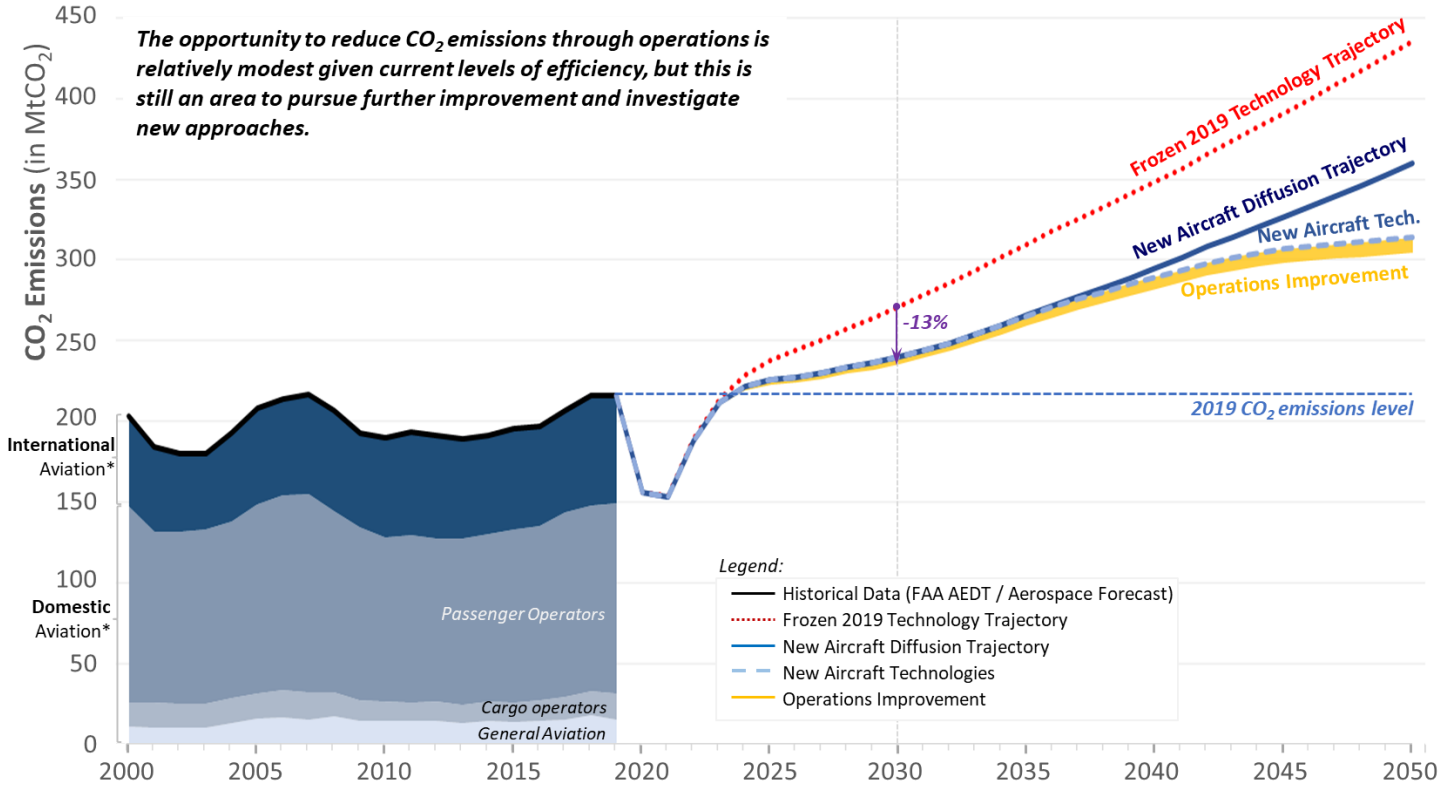
For a summary of CLEEN Accomplishment:
https://www.faa.gov/newsroom/continuous-lower-energy-emissions-and-noise-cleen-program?newsId=22534

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.



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

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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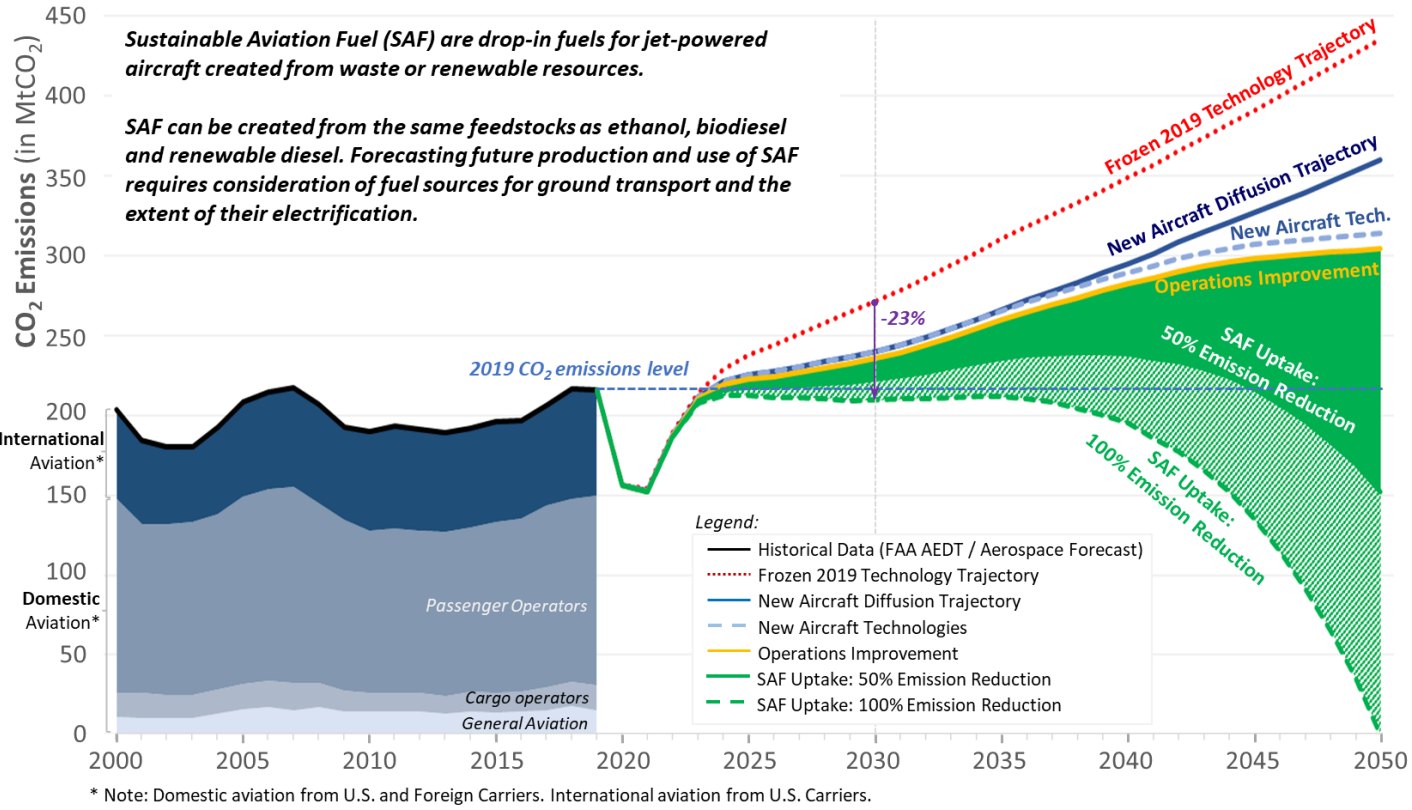


* Note: Domestic aviation from U.S. and Foreign Carriers. International aviation from U.S. Carriers.

SAF Grand Challenge

- **A U.S. federal agency initiative led by the U.S. Departments of Transportation (DOT), Energy (DOE), and Agriculture (USDA)**

- **Commitment by USG to work with industry to:**
  - Reduce the cost of SAF
  - Enhance sustainability of SAF
  - Expand SAF supply

- **Goals:**
  - U.S. SAF production of **3 billion** gallons per year by **2030**
  - 100% of aviation fuel demand by **2050** (projected **35 billion** gallons per year)

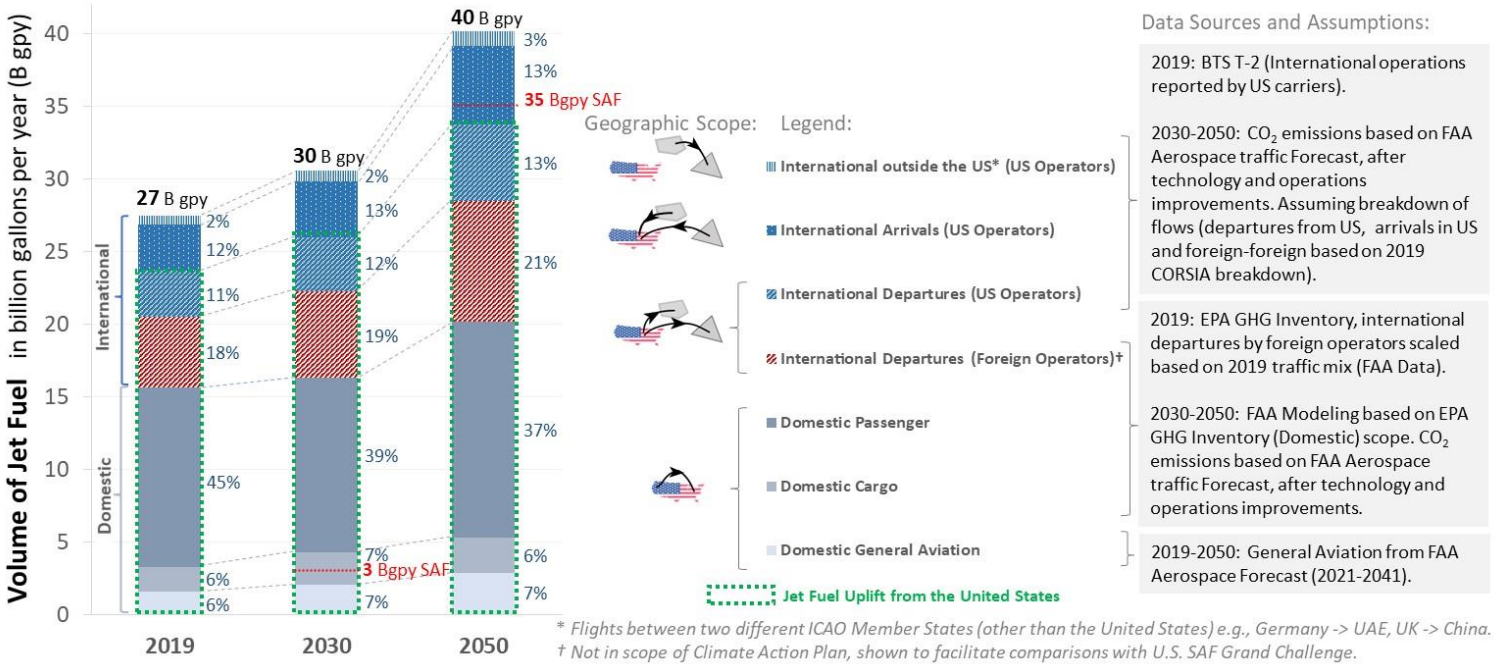
SAF Grand Challenge

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

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)

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.

Backup Slides – FY22 Congressional Direction

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.