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: September 15, 2021

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
  - Overview of Climate Change Efforts
  - Sustainable Flight National Partnership
  - SAF Grand Challenge
- **Budget Profile for E&E Portfolio**
- **Summary**
- **Backup** – FY2022 Budget Narrative Details

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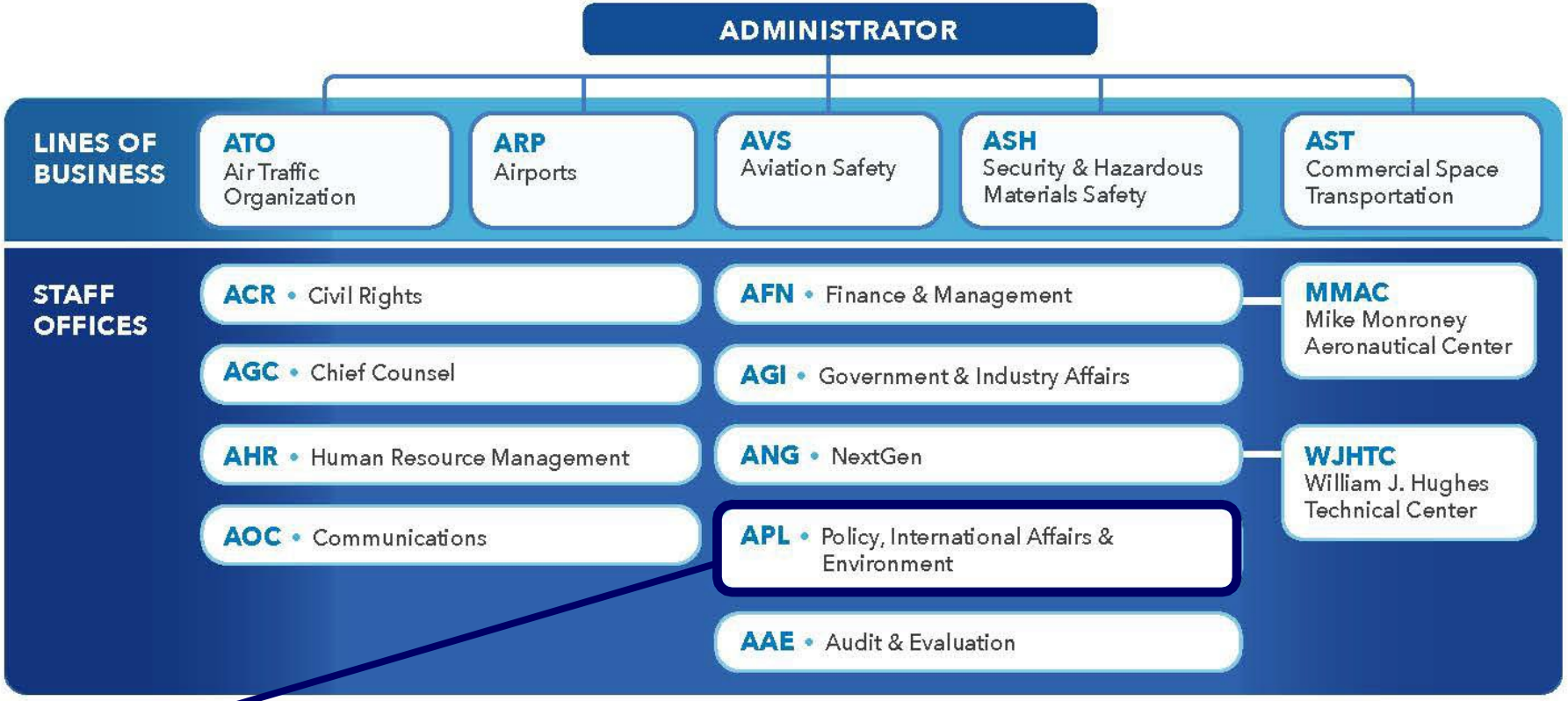
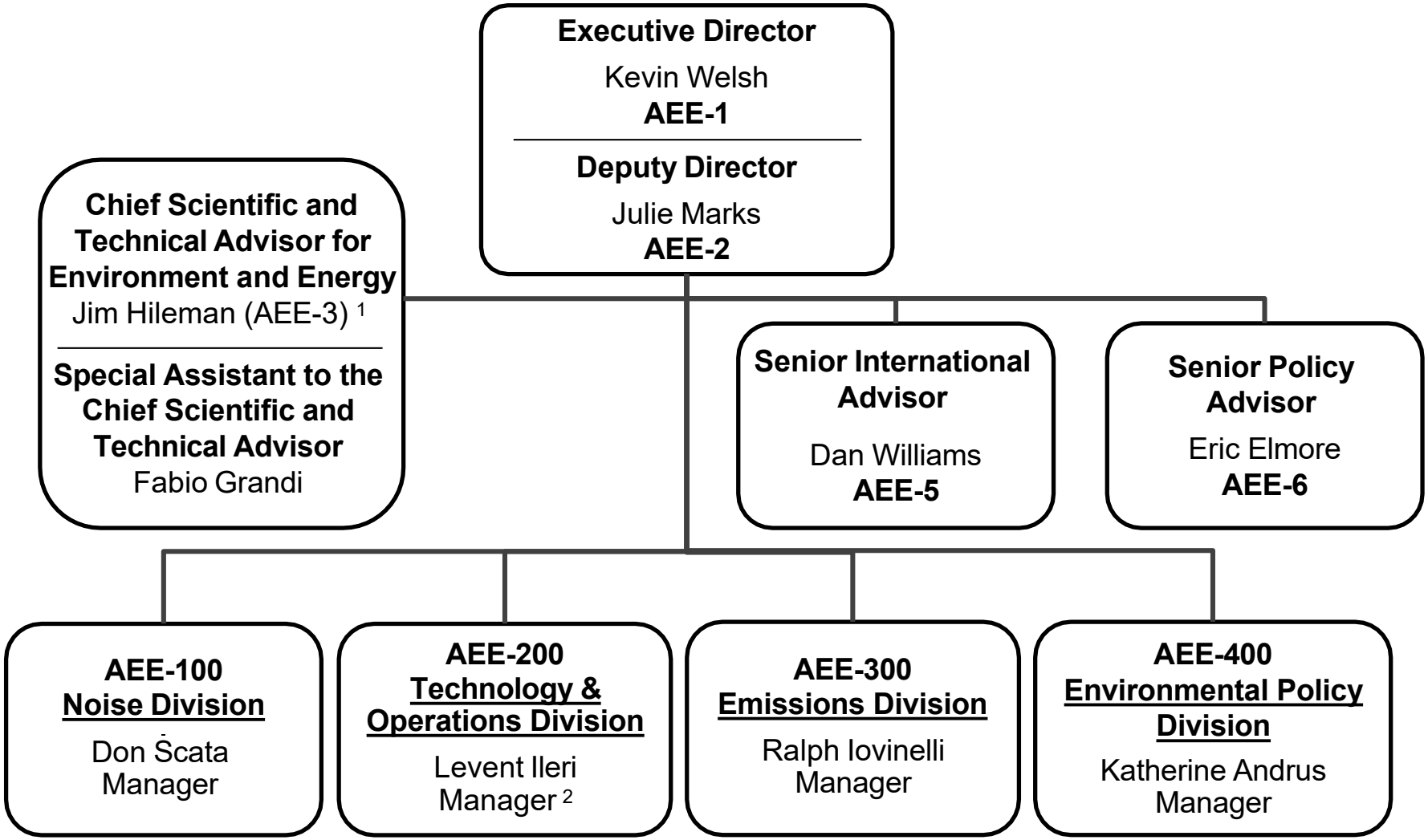
FAA Organizational Structure



Office of Environment and Energy (AEE)

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

AEE Organizational Structure



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

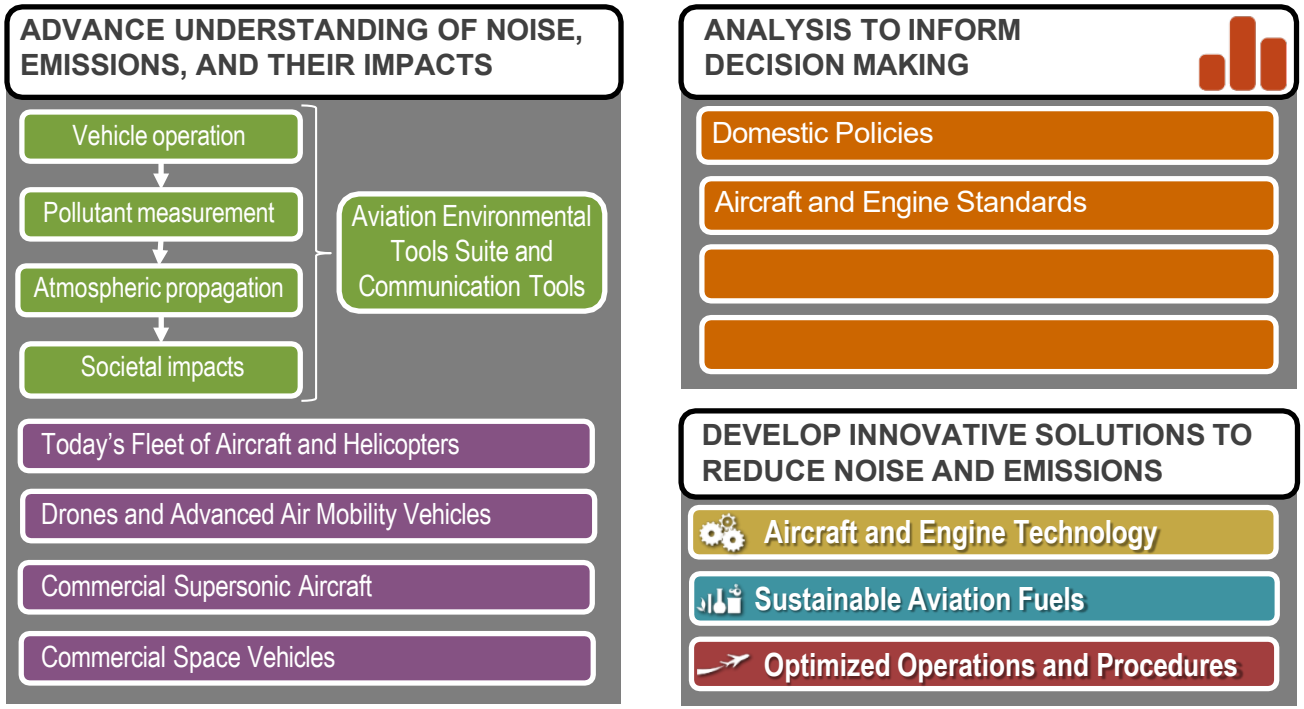
[2] CLEEN Program Manager, as a subset of his Division Manager duties

Environmental & Energy (E&E) Strategy

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

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

E&E R&D Portfolio Activities & Programs



ASCENT Aviation Sustainability Center
www.ascent.aero/

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

CAAFI®
www.caafi.org/

the VOLPE center

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

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

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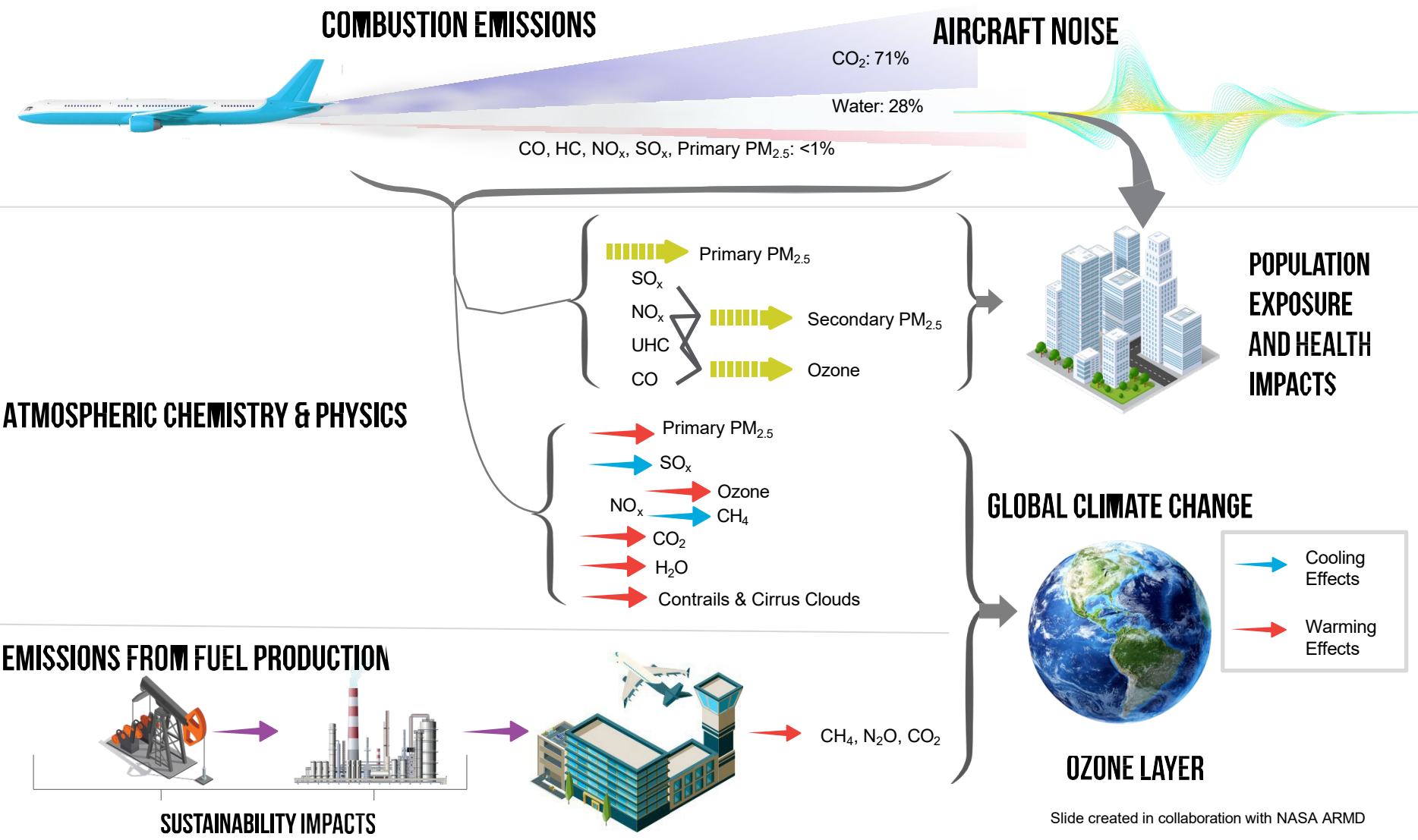
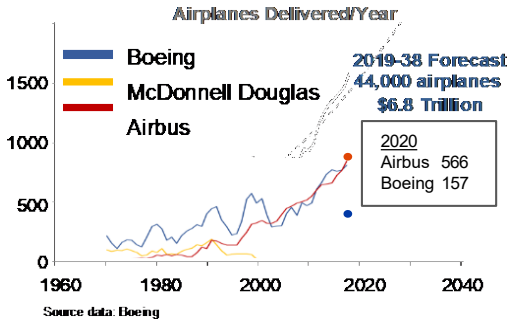
Environmental Impacts of Aviation



Slide created in collaboration with NASA ARMD

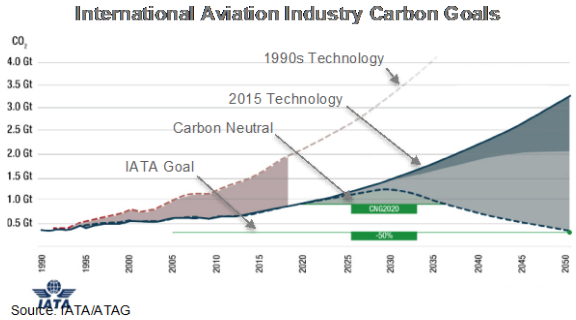
Global Competition and Environmental Pressures

Economic Perspective



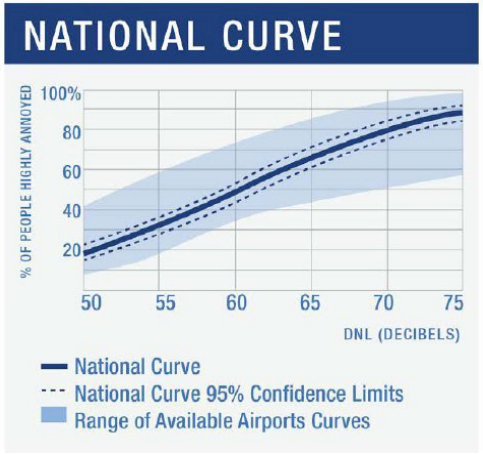
- Airline industry hard hit by COVID-19
- Global competition growing
- Limited industry funding for R&D investments

Environmental Context – CO_2



- Societal pressure growing on climate globally

Environmental Context – Noise



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

Noise R&D Update

Federal Register Notice

Provides comprehensive overview of FAA R&D efforts on noise

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

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

Received 4,162 comments

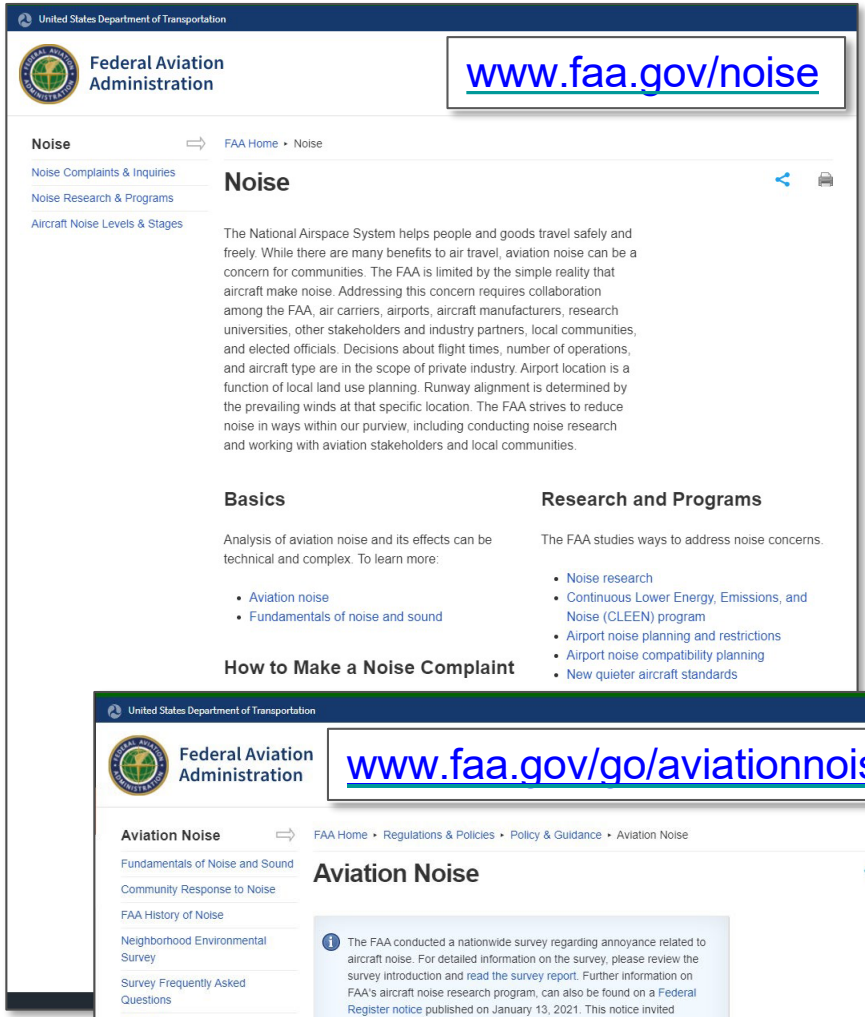
https://www.regulations.gov/docket/FAA-2021-0037

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

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

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

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



Helicopters, New Entrants and Commercial Space

Helicopters

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

Unmanned Aerial Systems

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

Advanced Air Mobility Vehicles

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

Supersonic Civil Aircraft

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

Hypersonic Civil Aircraft / Commercial Space

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

Efforts Relating to Aircraft Emissions

Understanding Emissions

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

Reducing Emissions at the Source

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

Mitigation

- Alternative fuel sources
- Policy measures (CORSIA)

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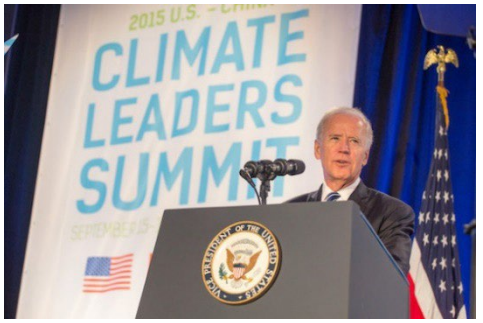
Biden Administration Commitment on Climate Change



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

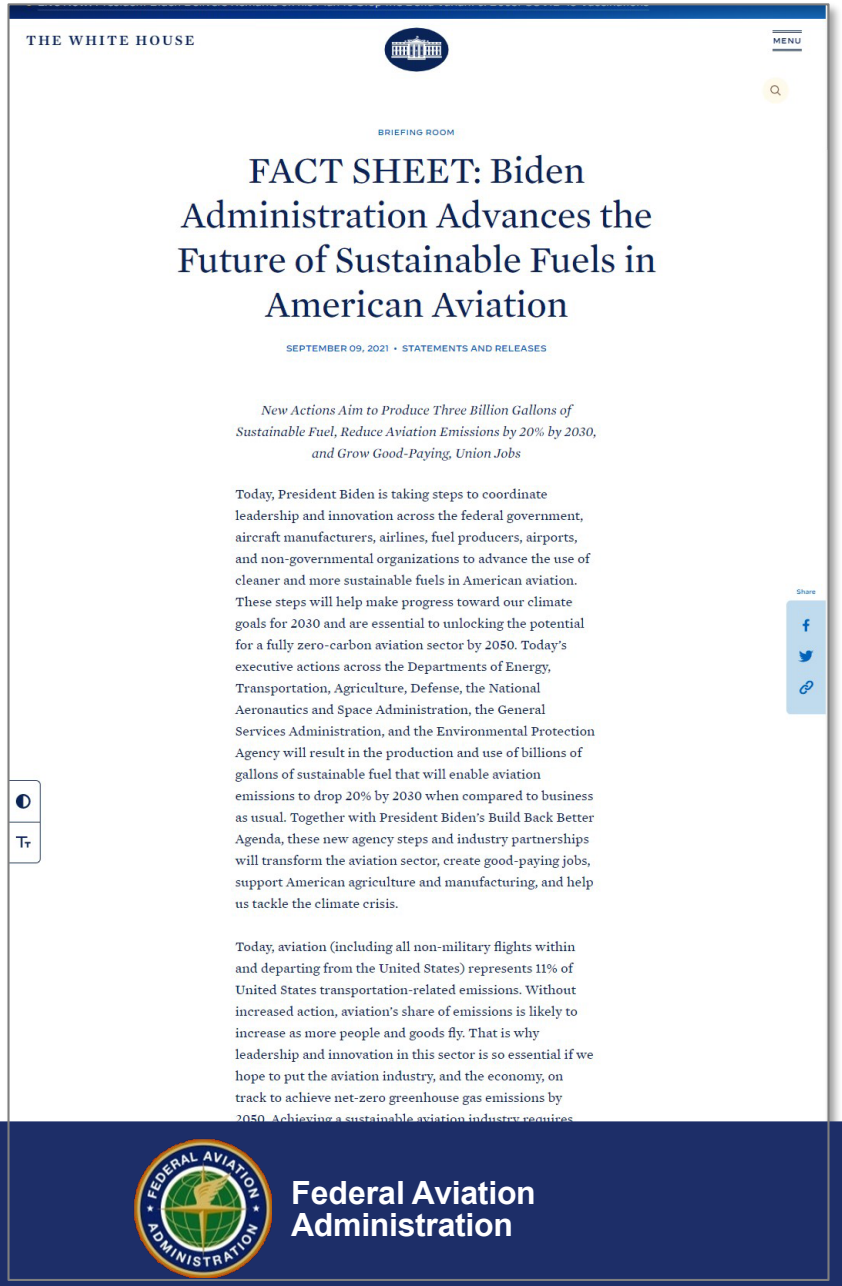
Fact sheet from President Biden's Leaders Summit on Climate: https://www.whitehouse.gov/briefing room/statements releases/2021/04/23/fact sheet president bidens leaders summit on climate/

White House Sustainable Aviation Event (1 of 2)

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

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

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



THE WHITE HOUSE

MENU

BRIEFING ROOM

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

SEPTEMBER 09, 2021 • STATEMENTS AND RELEASES

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

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

Today, aviation (including all non-military flights within and departing from the United States) represents 11% of United States transportation-related emissions. Without increased action, aviation's share of emissions is likely to increase as more people and goods fly. That is why leadership and innovation in this sector is so essential if we hope to put the aviation industry, and the economy, on track to achieve net-zero greenhouse gas emissions by 2050. Achieving a sustainable aviation industry requires

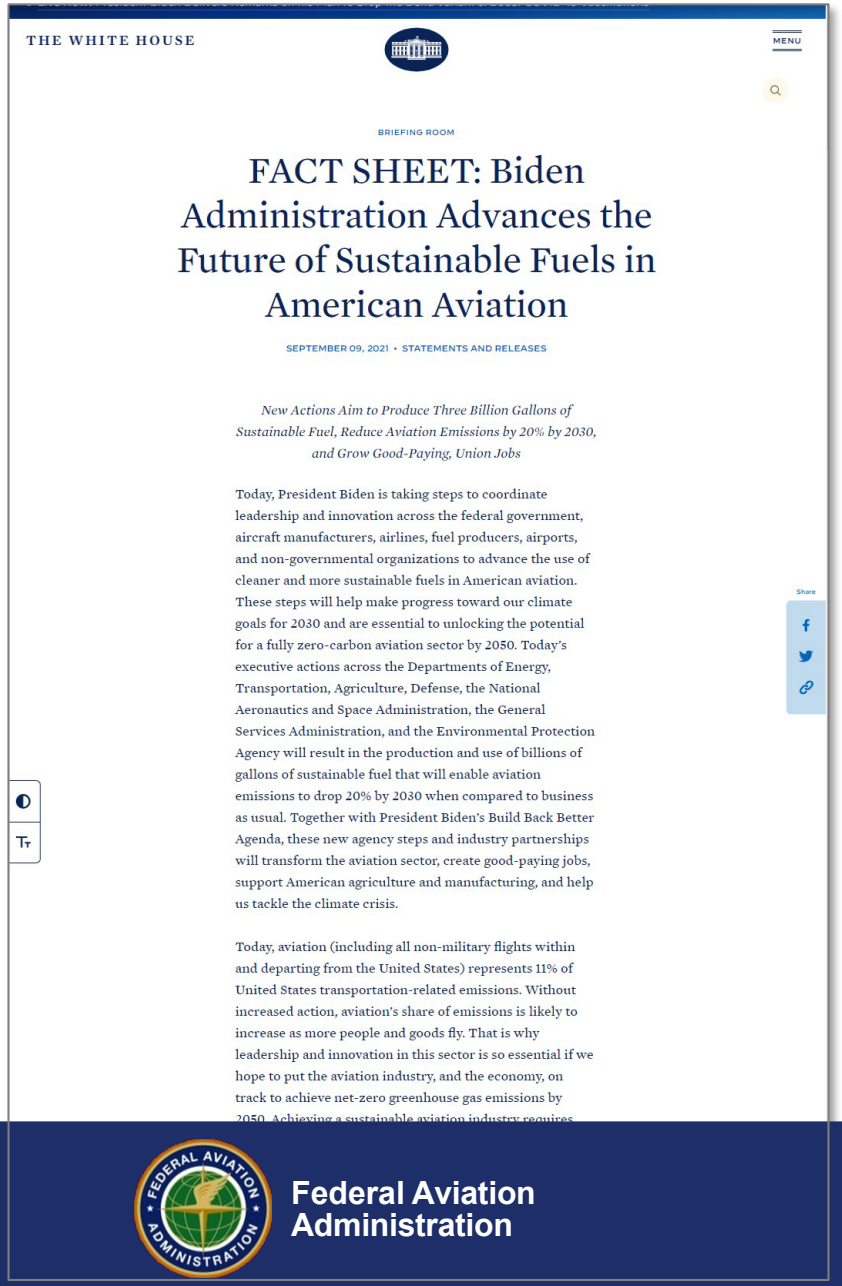
Share

White House Sustainable Aviation Event (2 of 2)

Key federal actions include:

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

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



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Federal Aviation Administration

Climate Change - Direction of the R&D Portfolio

Background on Aviation and Climate Change

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

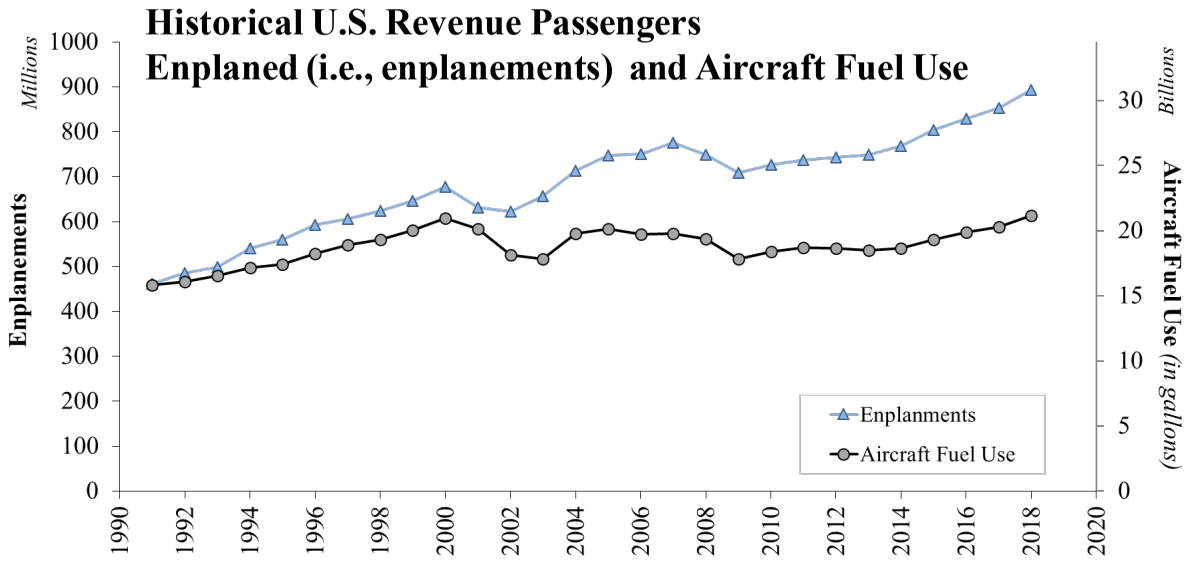
Climate Research Portfolio Direction

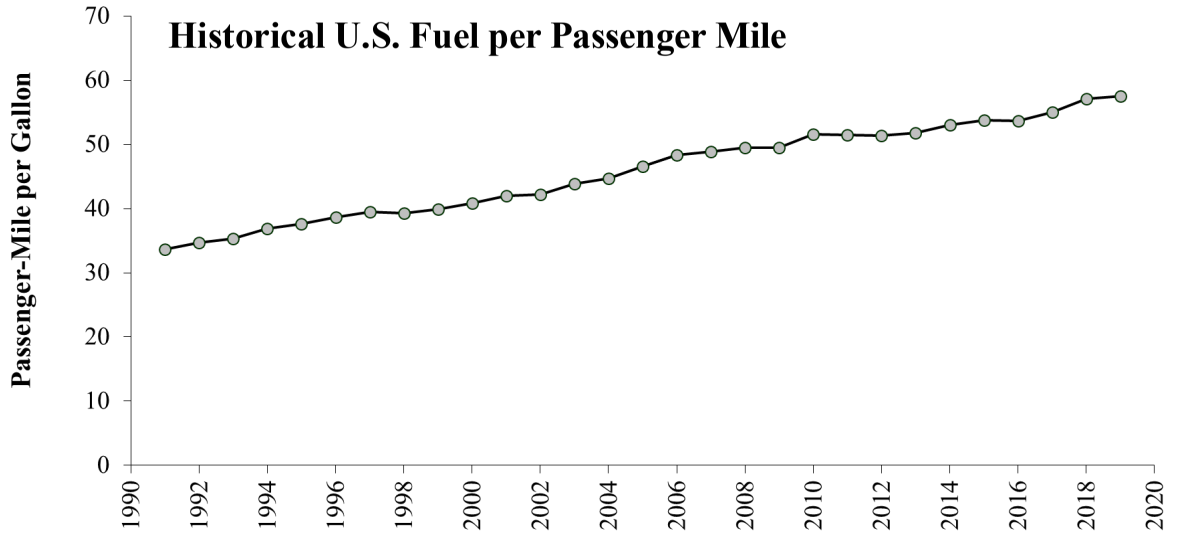
- Technology Development: required for to address climate crisis and noise challenge
- Sustainable Aviation Fuels: most promising near to medium-term means to reduce aviation CO_2 emissions, critical to decarbonization in the long term
- Operational Procedures: seeking opportunities to reduce fuel use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

U.S. Aviation 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, on par with a modern Toyota Prius hybrid, which has a fuel economy of 54 miles per gallon (MPG).



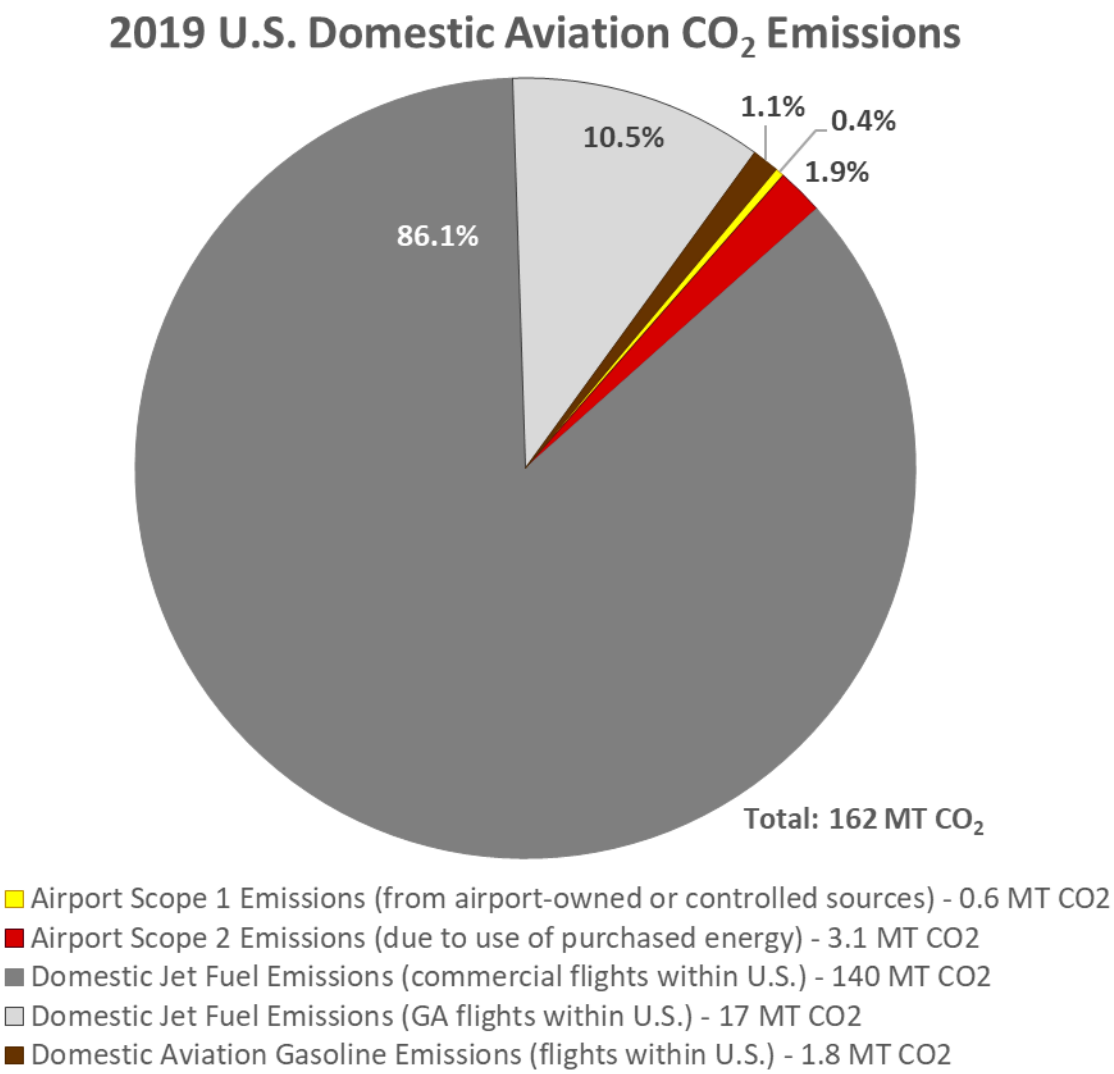


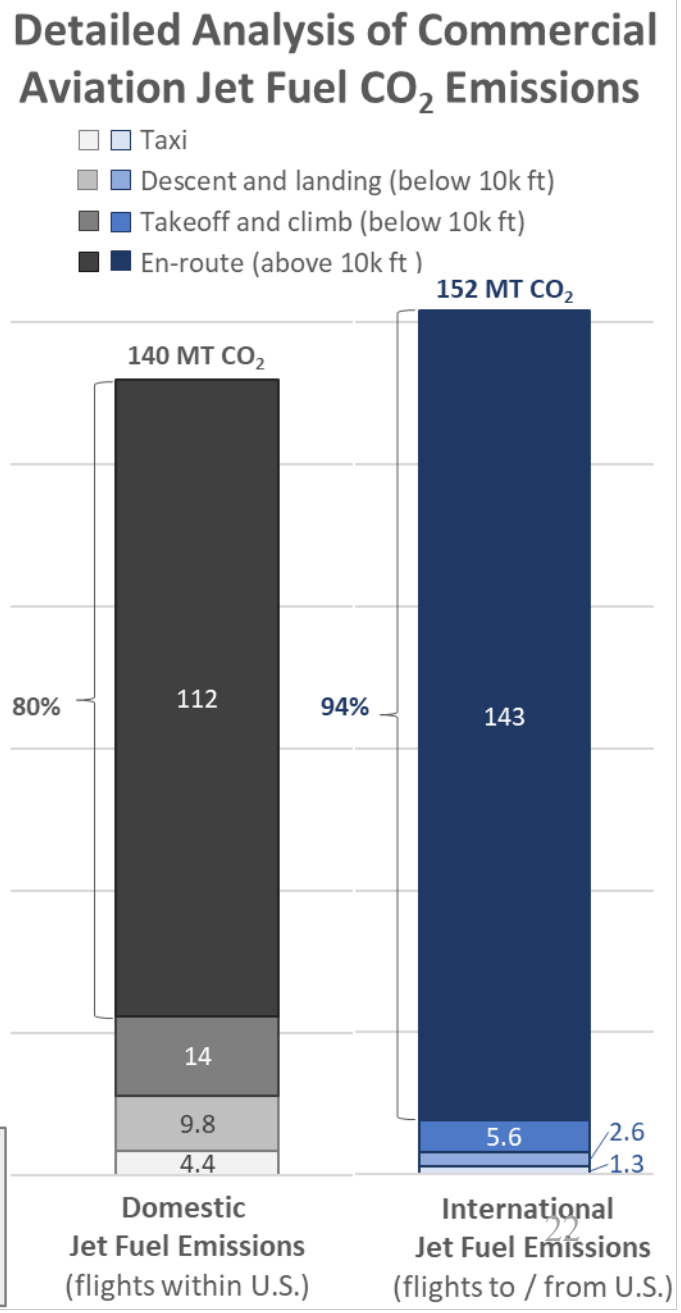
DATA SOURCES:

• U.S. Department of Transportation Bureau of Transportation Statistics, Air Carrier Summary Data, Form 41 and 298C Schedule T1: U.S. Air Carrier Traffic & Capacity Summary by Service Class for 1991 2019 (Aug. 2, 2019). Available at: http://www.transtats.bts.gov/.

•U.S. Department of Transportation Bureau of Transportation Statistics, Air Carrier Summary Data, Form 41 and 298C Schedule T2 for 1991 2019 (July 29, 2019). Available at: http://www.transtats.bts.gov/.

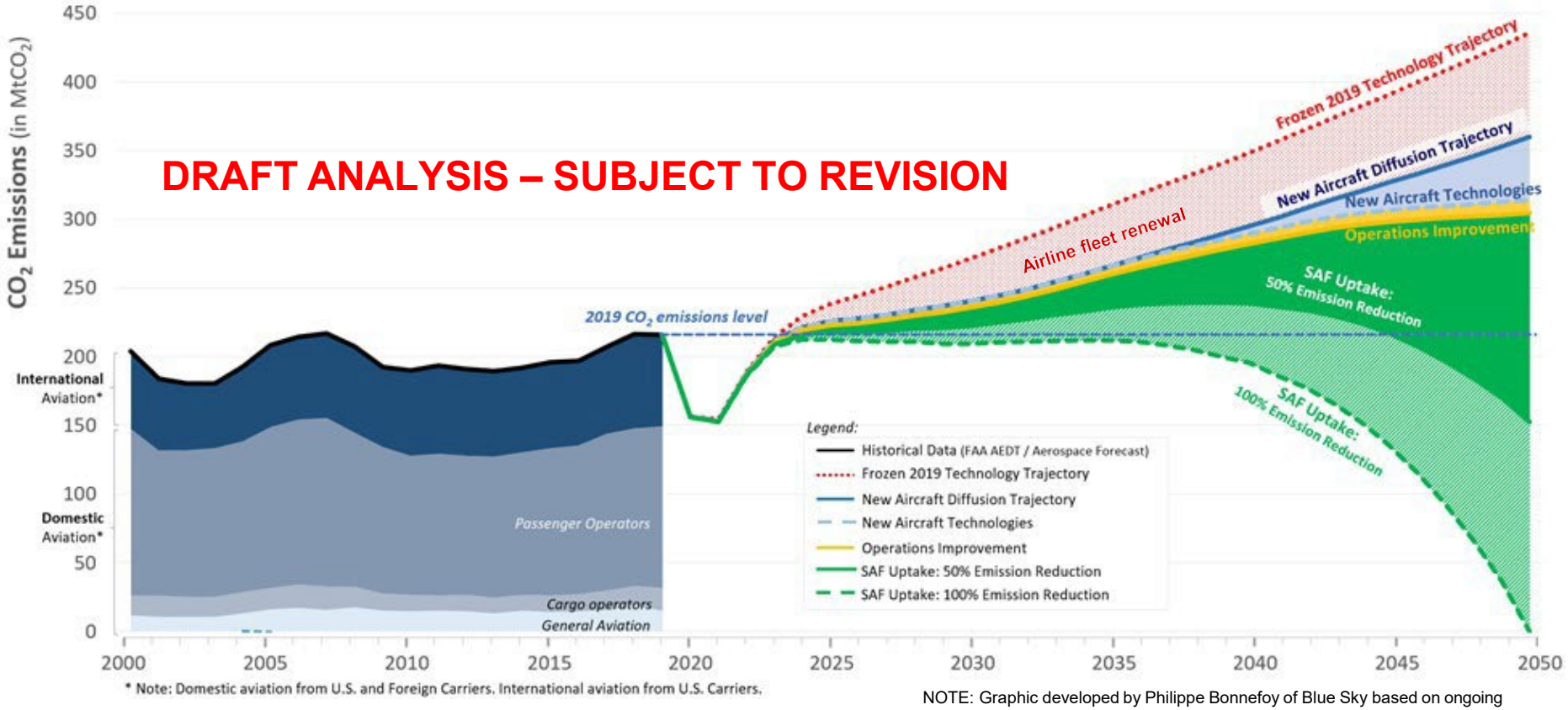
Domestic Aviation Emissions





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

Actions to Reduce U.S. Aviation CO_2 Emissions



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

Means to reduce aviation CO_2:

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

Working to accelerate industry action to lower CO_2 emissions trajectory

ICAO CAEP Long Term Aspirational Goal (LTAG) Support

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

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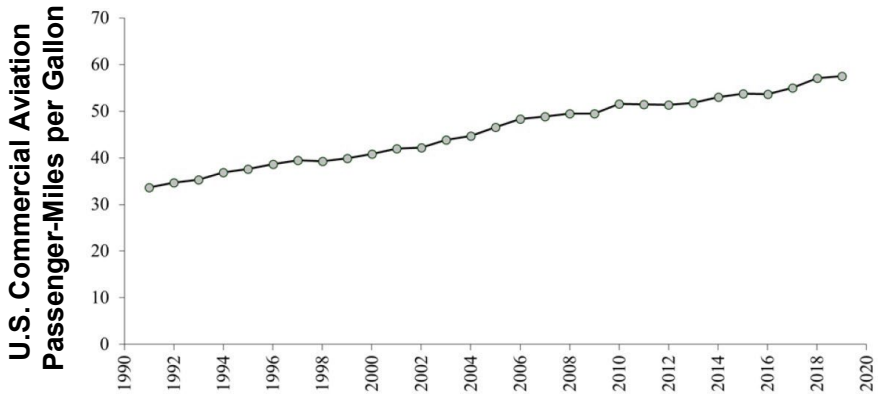
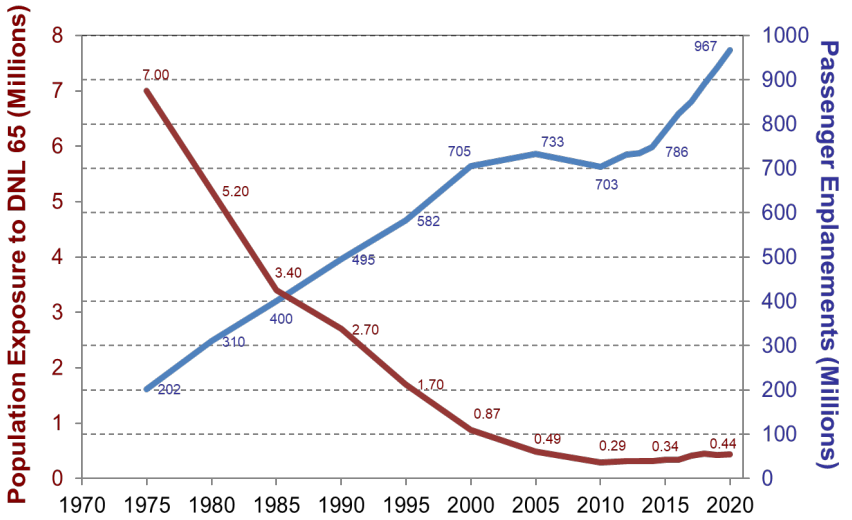
Rationale for Investing in Aircraft Technology

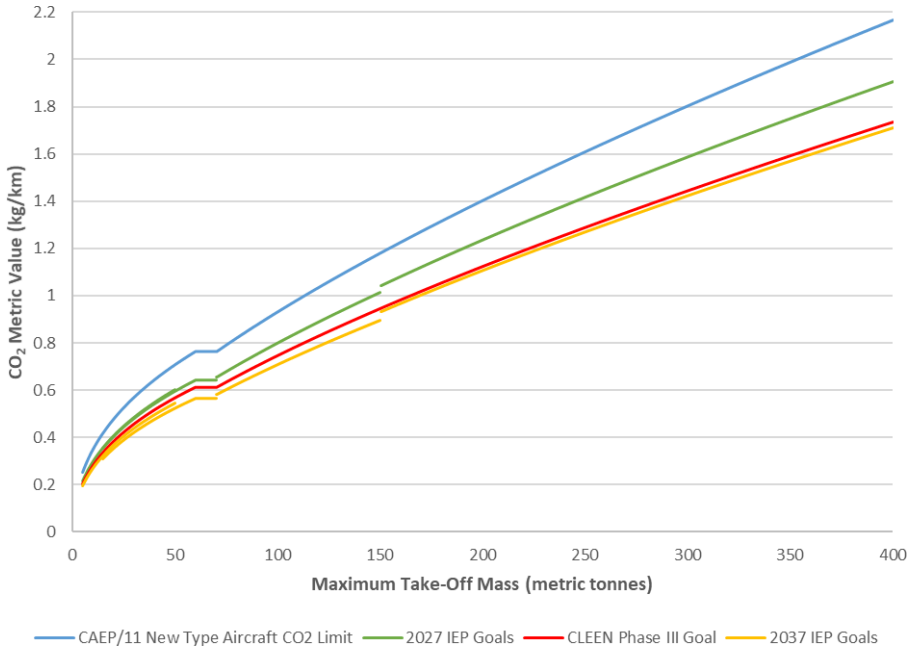
- Historically, advances in aircraft technology have been the main factor in reducing aviation's environmental impact
- Continued improvements come with large technological risk
- Manufacturers have limited financial incentive to develop technologies to reduce noise and emissions
- COVID-19 pandemic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

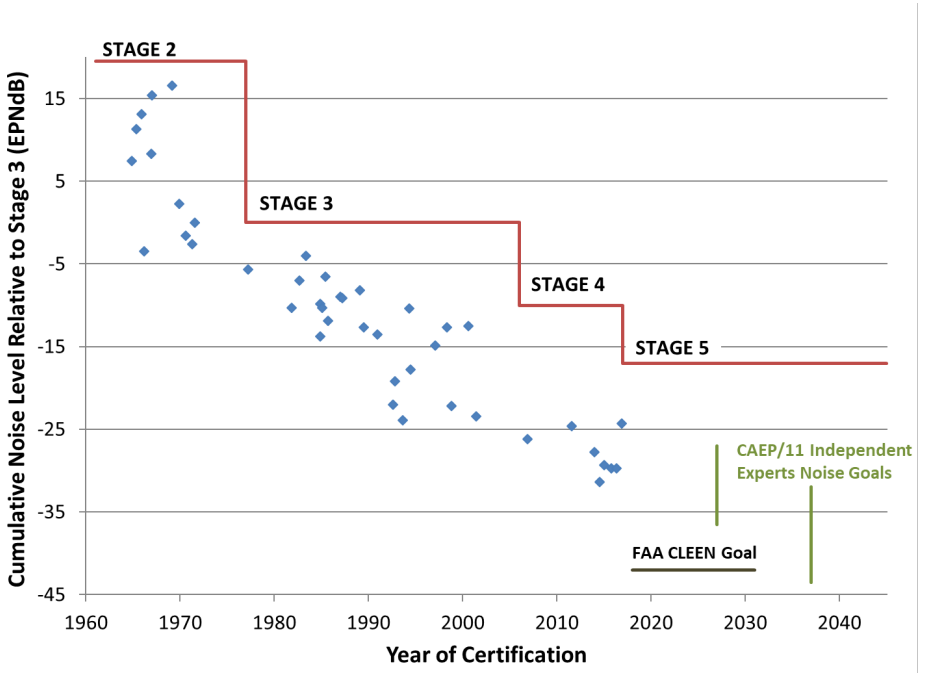




CO_2 and Noise Standards and Goals

Will need to go beyond current CO_2 standards to meet national / industry climate goals. Source noise also needs to decrease to address community concerns.





GOAL: Mature aircraft and engine technologies to achieve a Step Change in Environmental Performance.

Finding Opportunity in These Challenging Times

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

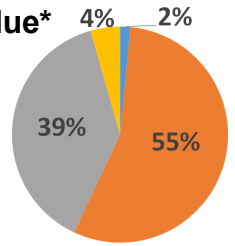
- R&D since FY10 (NASA, FAA); ~ $2,300M (NASA); $262M (FAA)
- Target 25 to 30% lower GHG re: Best in Class (e.g., A320neo / B737Max)
- Technologies need to be scalable from Single to Twin aisle aircraft
- GHG reductions need to be achieved WITH commensurate reductions in noise and emissions impacting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

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

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

Global Market Value*

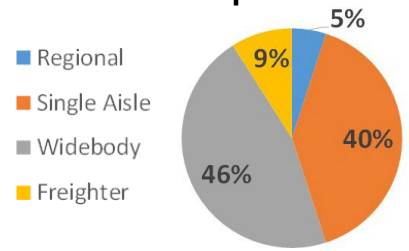
2020-2039 $6.8T



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

Estimated CO_2 Emissions from Global Commercial Operators**

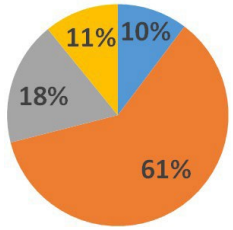
(2018)



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

Population Exposed to Significant Noise ***

65 DNL, U.S. CY 2019



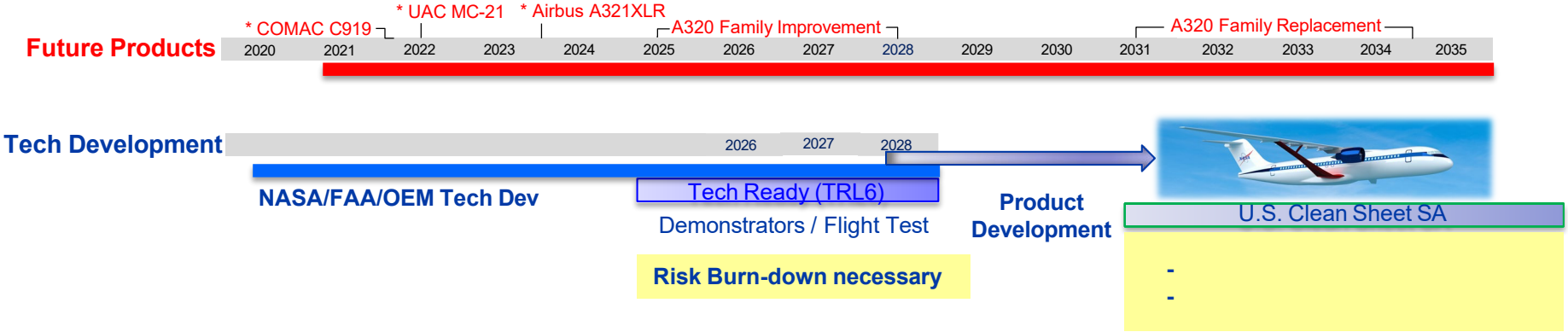
**** F. Grande, AEDT3c, CY 2019 U.S. inventory, 18March2021*

Opportunity: Clean Sheet Single Aisle in Early 2030's


COMAC C919


UAC MC-21


Airbus A321



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

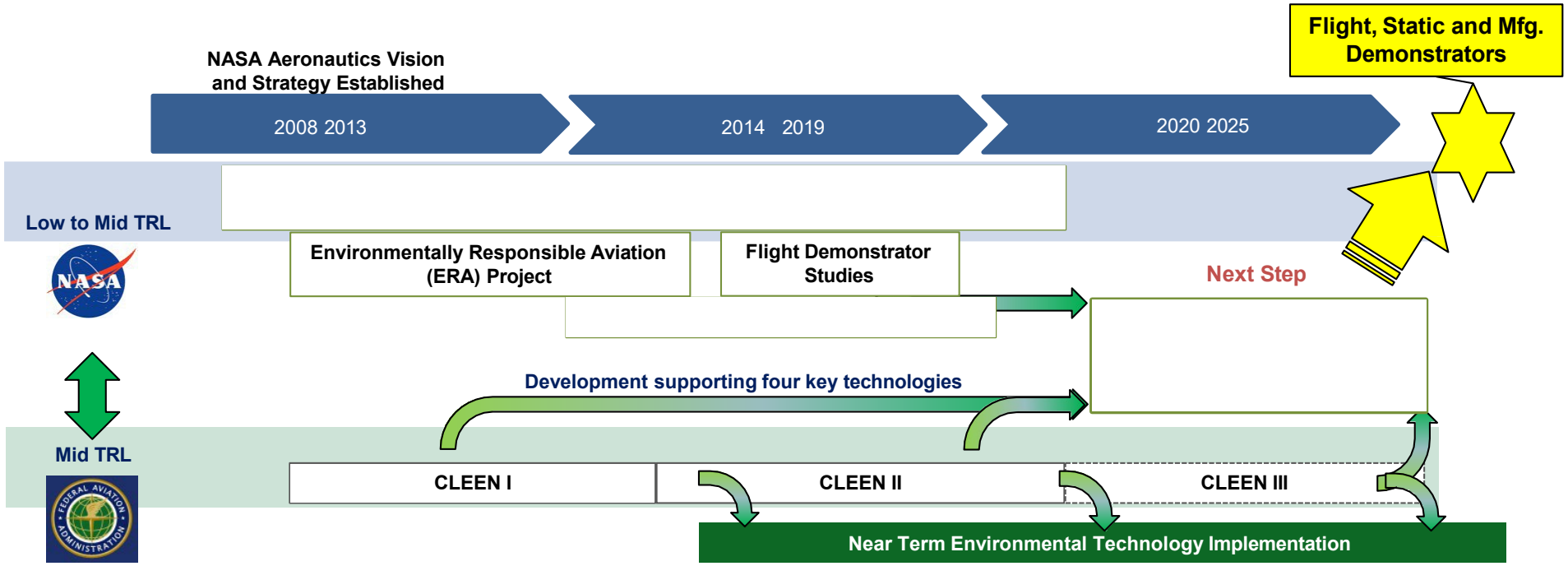
Success will reduce environmental impacts for decades to come

* Projected entry into service

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

Federal Aviation Administration

Complementary NASA & FAA Technology Maturation



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

FAA R&D Efforts Relating to Aircraft Technology

Continuous Lower Energy, Emissions & Noise (CLEEN) Program

- FAA partnership with industry - 100% industry cost share
- Focus on aircraft and engine technologies (CLEEN Phases I-III) and development of high performance fuels (CLEEN Phase III)
- Conducting ground and/or flight test demonstrations to accelerate maturation of certifiable aircraft and engine technologies
- Mature technologies from TRL 3-5 to TRL 5-7
- Individual companies use knowledge gained to improve their design methods

ASCENT COE Efforts on Innovation and Technology

- FAA partnership with academia - 100% in-kind cost share*
- Focus on broad range of innovation solutions (technology, fuels, ops, etc.)
- Conducting ground and/or flight test demonstrations to accelerate maturation of certifiable aircraft and engine technologies
- Advance technologies at any TRL, but with understanding that FAA has a focus on applied R&D
- Universities use knowledge gained to improve knowledge broadly, but there are opportunities to examine specific technologies under Non Disclosure Agreements (NDAs)

ASCENT
AVIATION SUSTAINABILITY CENTER

Continuous Lower Energy, Emissions & Noise
CLEEN
Federal Aviation Administration

NextGEN

For more information:

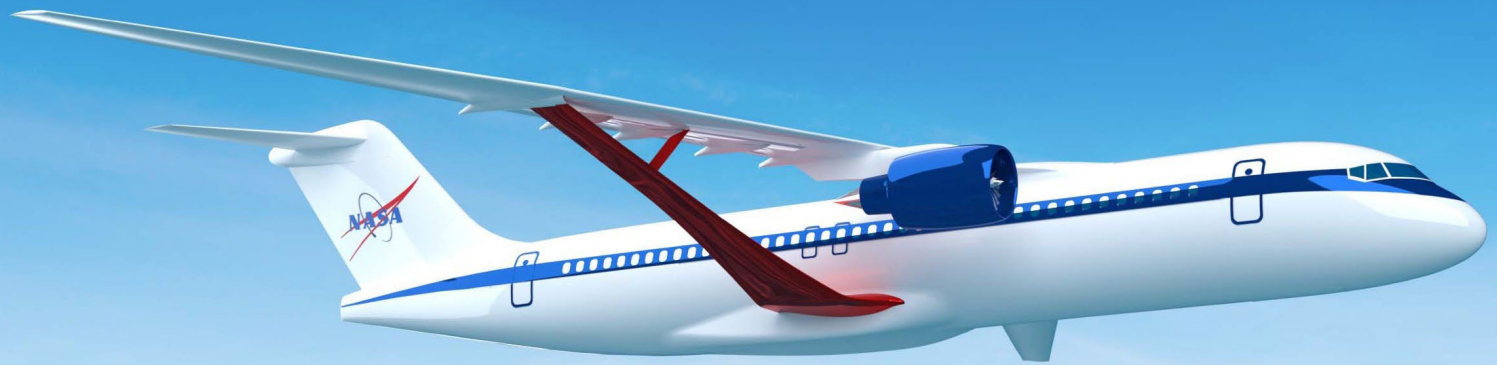
ASCENT: www.ascent.aero/ CLEEN: www.faa.gov/go/cleen/

* Universities can apply for a cost share reduction to a 25/75 split instead of 50/50

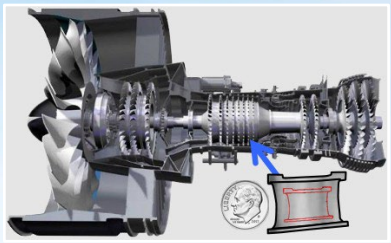
NASA/FAA Sustainable Flight National Partnership (SFNP)

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

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

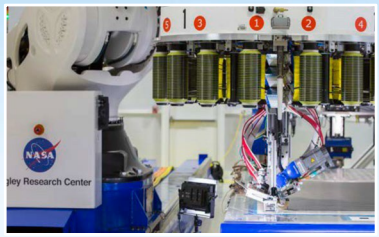


Transonic Truss-Braced Wing
5-10% fuel burn benefit



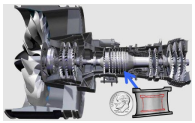
Small Core Gas Turbine
5-10% fuel burn benefit

Electrified Aircraft Propulsion
~5% fuel burn and maintenance benefit



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

Integrated Technology Development for the Next Generation of Transport Aircraft



FY20 | FY21 | FY22 | FY23 | FY24 | FY25 | FY26 | FY27 | FY28 | FY29

Technology Readiness Target

Model Based Systems Analysis & Engineering

Sustainable Flight Demonstrator (SFD)

Flight Test

Leverage the Asset

AATT - Transonic Truss Braced Wing

Hi-Rate Composite Aircraft Manufacturing (HiCAM)

Mfg Demo & Structural Test

Hybrid Thermally Efficient Core (HyTEC)

Core Demonstration & Test

Electrified Powertrain Flight Demonstration (EPFD)

Flight Test

AATT - Electrified Aircraft Propulsion

Achieve TRL 6 in time for Industry Product Decision Making

Planned

Notional

Technologies being concurrently worked

Sustainable Aviation Fuels, Low Emissions Combustion, Engine Propulsors, Operational Concepts and Enabling Aircraft Technologies

Sustainable Flight National Partnership (SFNP)
Flying test bed for future technologies demonstrations

Summary – Sustainable Flight National Partnership

Aviation industry is challenged on multiple fronts

- **Climate, Noise, Air quality and Economic impact (COVID-19)**
- **Challenges can serve as opportunity for step change improvement !**

Need sustainable & economic solution for Climate, Noise and Air quality

NASA / FAA's SFNP aims to mature innovative solutions / approaches

- **High risk / High payoff technologies**
- **Target: Up to 30% lower GHG and 15 dB quieter re: Best in class**
- **Applicable to Single Aisle and Wide-body aircraft (~95% of market value)**
- **Tech / Financial Risk reduction thru public – private partnership (e.g., CLEEN Model)**
- **Never compromising on safety**

Build on effective and open communication with public and stakeholders

Presentation Outline

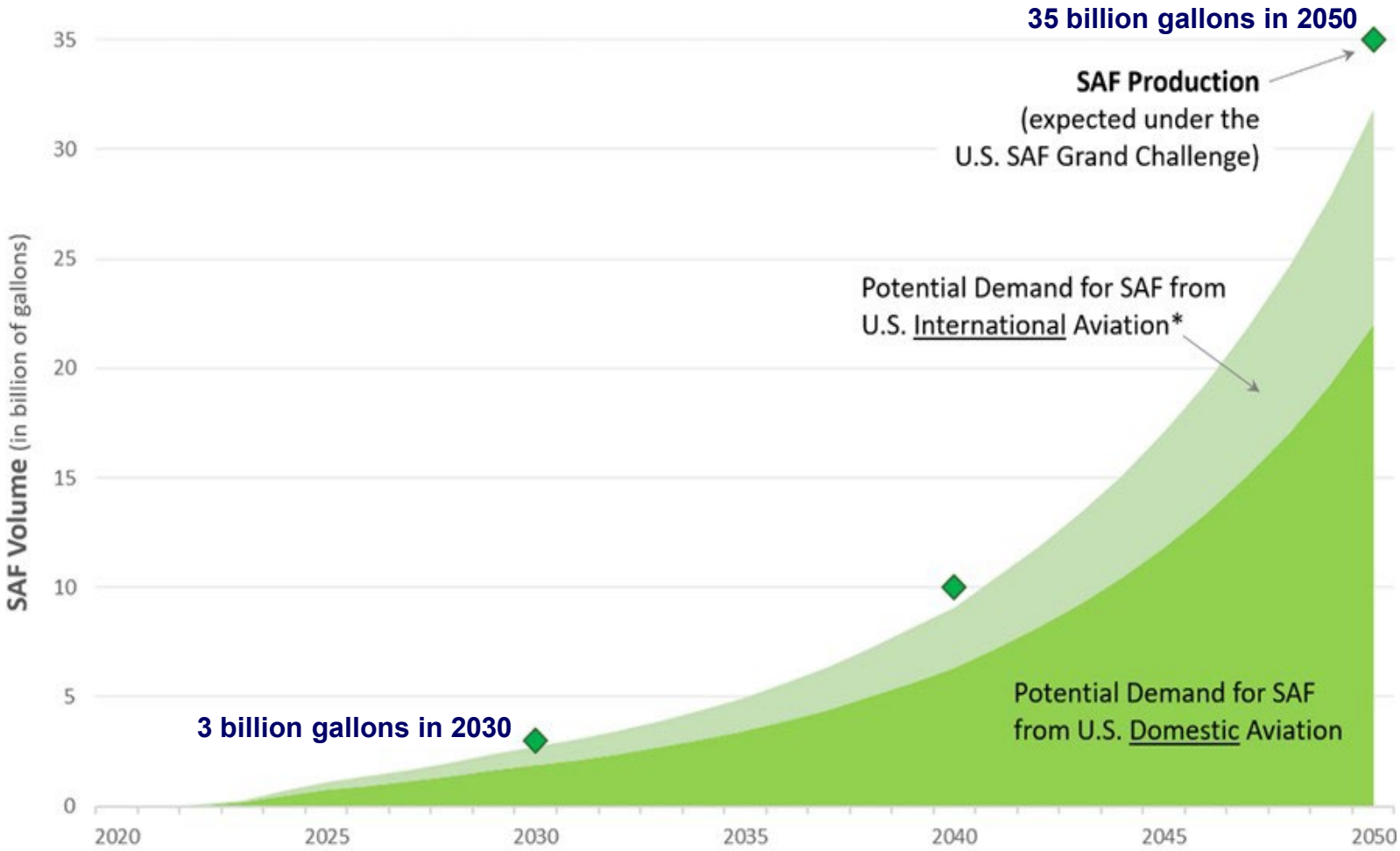
- Office of Environment and Energy – Background & E&E Strategy Overview
- Highlights of R&D Program
- **Direction of the E&E Portfolio**
  - Noise and Emissions
  - Overview of Climate Change Efforts
  - Sustainable Flight National Partnership
  - **SAF Grand Challenge (Nate Brown)**
- Budget Profile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

The SAF Grand Challenge

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

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

SAF Grand Challenge Goals relative to Consumption



** Note: U.S. International Aviation defined as all flights from U.S. carriers. Difference between total SAF needs and SAF Production (expected under the U.S. SAF Grand Challenge) could serve potential demand from flights performed by Foreign operators departing the United States.*

SAF Grand Challenge Roles (in MOU)

DOE

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

DOT/FAA

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

USDA

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

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

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Environmental & Energy R&D Portfolio

RE&D Environment & Energy Budget Line Item*

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

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

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

RE&D Aviation Climate Research Budget Line Item***

- New budget line item
- Enhances efforts on SAF, technology development, and efforts related to unleaded aviation gasoline (AVS/ANG)
- Details on next slide

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

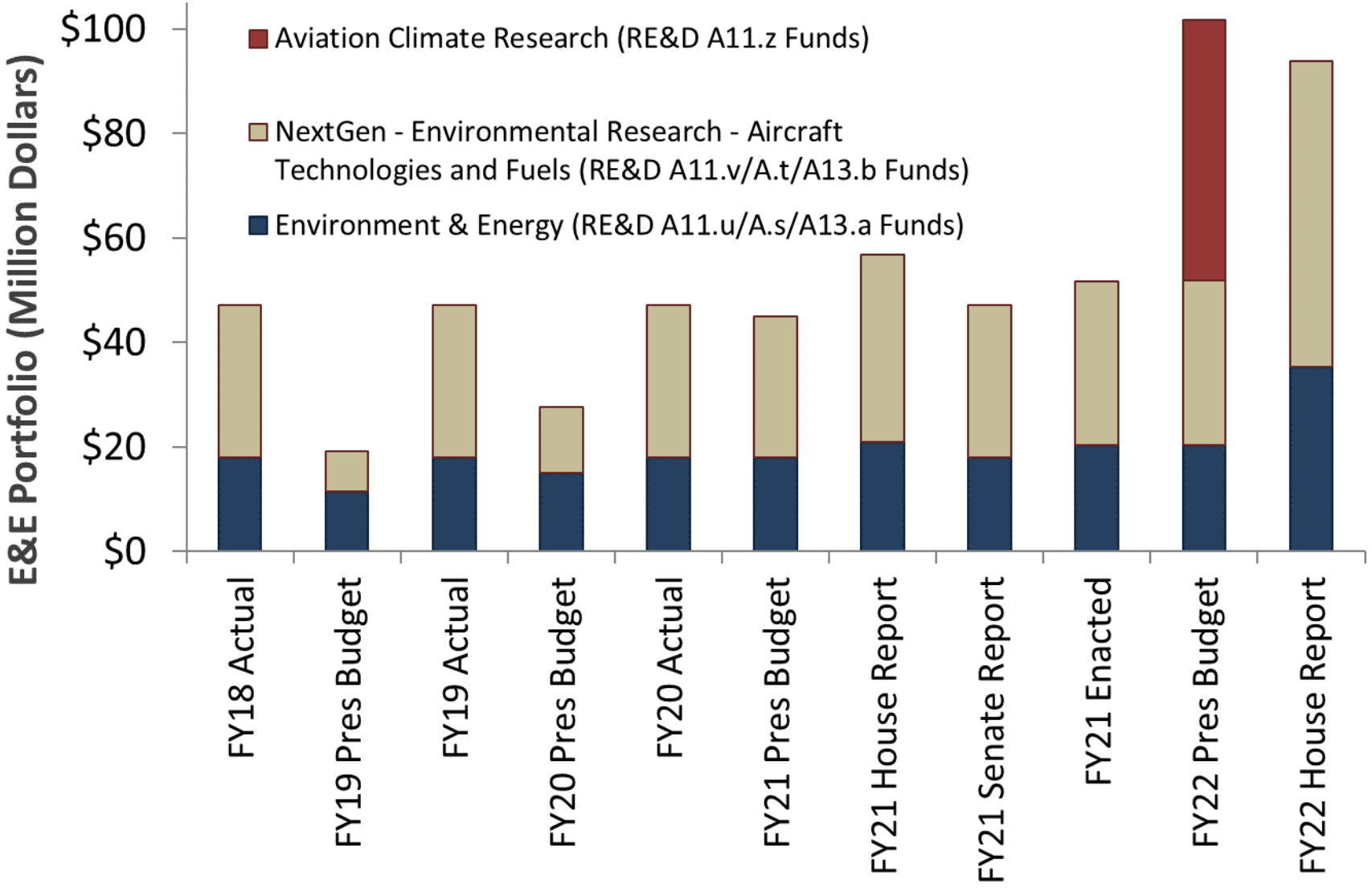
** Budget Line Items: A13.b (FY18 & FY19), A12.b (FY20), A.U (FY21), A11.v (FY22)

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

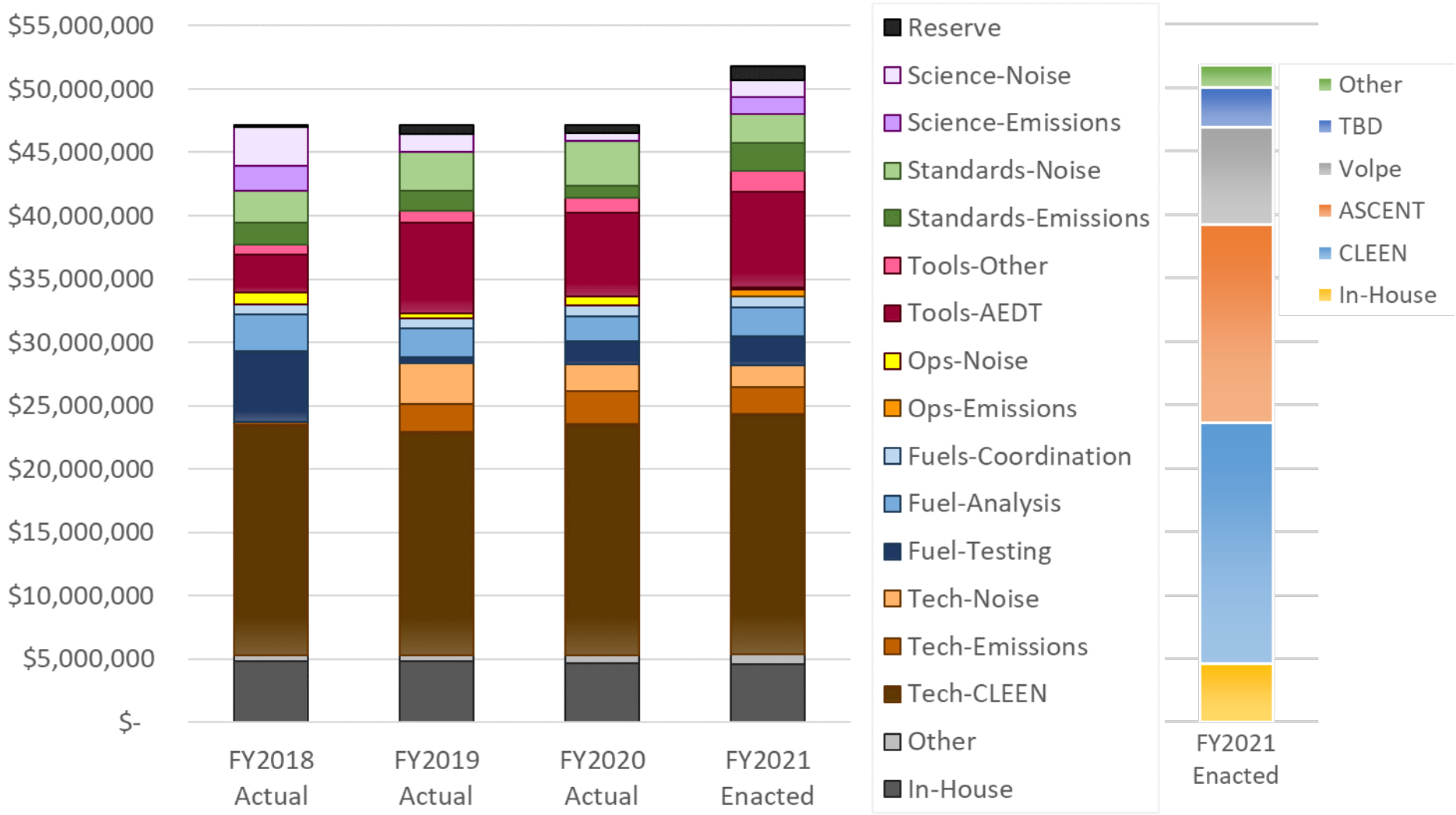
New Budget Line Item: Aviation Climate Research

- Invest in high-risk, accelerated research that has transformative impact potential to reduce GHG emissions
- Execute in coordination with DOE and USDA
- Enhance and accelerate existing research
- Specific research areas:
  - Develop SAF that could be used in jet engines without blending with conventional petroleum-based jet fuel
  - Evaluate aviation fuel supply chains to reduce the cost to produce sustainable aviation fuels and maximize their environmental benefits
  - Support the accelerated development of fuel efficient, low-emissions aircraft technologies, including electric propulsion
  - Accelerate the identification of safe alternatives to leaded aviation fuel
  - Support collaborative research in the areas of climate adaptation and resilience
- Work will enhance essential laboratory capabilities and build on ASCENT, CAAFI, CLEEN, and the Piston Aviation Fuels Initiative (PAFI),

Recent Trends in E&E R&D Portfolio Budget



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



Overarching Direction for FY22

- **Operating under budget uncertainty (but it's much more pleasant this time around)**
- **Expect to use any funding increases to:**
  - Expand efforts on aircraft technology maturation in CLEEN and ASCENT
  - Develop SAF that could be used in jet engines without blending with conventional petroleum-based jet fuel
  - Evaluate aviation fuel supply chains to reduce the cost to produce SAF and maximize environmental benefits
  - Obtain the data and develop the analytical tools to support evaluation and certification of new vehicle types

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

Supporting the Development of Sustainable Aviation Fuels (SAF)

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

Accelerating Technological Innovation and the Development of Improved Operational Procedures

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

Advancing Our Understanding of Noise, Emissions, and their Impacts

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

FAA Portion of the Remaining Agenda

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

Questions for Tomorrow:

- Are there R&D areas within the E&E Portfolio that should be lower / higher priority?

- Are there R&D areas that AEE is not examining that should be added to the E&E Portfolio?

- What do you see coming on the horizon regarding E&E that may require future R&D efforts?

Dr. Jim Hileman

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Federal Aviation Administration
Office of Environment and Energy

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Backup Slides

- **FY2022 Budget Narrative Details**

RE&D A.11u: Environment & Energy

Major Activities and Accomplishments Planned in FY 2022 Include:

- Provide the data and analysis necessary to support the development of international standards for subsonic and supersonic aircraft
- Provide data and analysis necessary to support the development of noise certification standards and processes for UAS and AAM vehicles
- Develop more efficient noise and emissions certification processes for subsonic aircraft and engines
- Continue the development of analytical tools for noise and emissions modeling, noise screening for environmental compliance, and fleet and operations scenarios forecasting
- Develop advanced operational procedural concepts that could reduce community noise exposure while maintaining safe flight operations and providing guidance for air space planners on how these concepts could be incorporated
- Develop a decision support tool to enable industry to mitigate the climate impacts of contrails and aviation induced cloudiness
- Develop the methodologies and data necessary to enable industry to design aircraft technologies with reduced noise and emissions
- Expand the scientific understanding of the impacts of aircraft noise on communities and aviation emissions on air quality and climate change

RE&D A.11u: Environment & Energy

Goals for FY 2022 Funding:

- Conduct analyses to support the development of new international standards for subsonic and supersonic transport aircraft and engines in ICAO CAEP
- Conduct measurements and complete analyses to inform the development of noise standards for UAS and AAM vehicles
- Release AEDT Version 3e and the noise screening method
- Support the development of a more efficient and accurate environmental review process
- Support the development of more efficient certification processes
- Conduct analyses to support the development of operational procedure concepts to mitigate the environmental impacts of the current fleet of airplanes and helicopters

* Revised date. Listed as 2022 in the FY2021 President's Budget.

RE&D A.11v: NextGen – Environmental Research – Aircraft Technology and Fuels

Major Activities and Accomplishments Planned in FY 2022 Include:

- Develop aircraft and engine technologies, as well as sustainable aviation fuels for subsonic and supersonic aircraft through the CLEEN program that reduce noise and emissions while increasing fuel efficiency
- Evaluate innovative technological solutions to reduce noise, emissions, and fuel burn from subsonic and supersonic aircraft through ASCENT
- 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
- Support efforts to evaluate sustainable aviation fuels that can be used safely at greater than a 50% blend level, the current maximum allowable volume, with the goal of developing sustainable aviation fuels that can be used without any blending with conventional jet fuel
- 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
- Through ASCENT and CAAFI, identify barriers to the use of sustainable aviation fuels by the aviation industry and work across the U.S. government and with industry to overcome these barriers

RE&D A.11v: NextGen – Environmental Research – Aircraft Technology and Fuels

Goals for FY 2022 Funding:

- Continue activities within the third phase of the CLEEN program to demonstrate technologies that can reduce energy use, emissions, and noise for subsonic and supersonic aircraft
- Conduct testing to support the approval of at least one alternative jet fuel type per year and streamline the ASTM certification process to reduce the time and cost of certification
- Identify sustainable aviation fuels that could be used at greater than a 50% blending level and develop ASTM certification processes to enable their use at these higher blending percentages
- Identify innovative solutions to reduce noise, emissions, and fuel burn through ASCENT
- Develop lifecycle greenhouse gas emissions values for alternative fuel pathways and sustainability criteria for use in CORSIA

RE&D A.11z: NextGen – Aviation Climate Research

Major Activities and Accomplishments Planned in FY 2022 Include:

- Develop ACR Program Management Plan to include how the program will build on other FAA environment and energy programs and federal interagency partner efforts
- Initiate program coordination outreach and review/select research initiatives for ACR funding
- Execute ACR-funded research initiatives

RE&D A.11z: NextGen – Aviation Climate Research

Goals for FY 2022 Funding:

- Establish a programmatic framework for increased investment in targeted high-risk, accelerated research to reduce greenhouse gas emissions from aviation.
- Establish interagency coordination and alignment
- Execute ACR-funded research initiatives