FAA Office of Environment & Energy Overview and Update

Federal Aviation Administration

Prepared for: CLEEN Consortium Meeting

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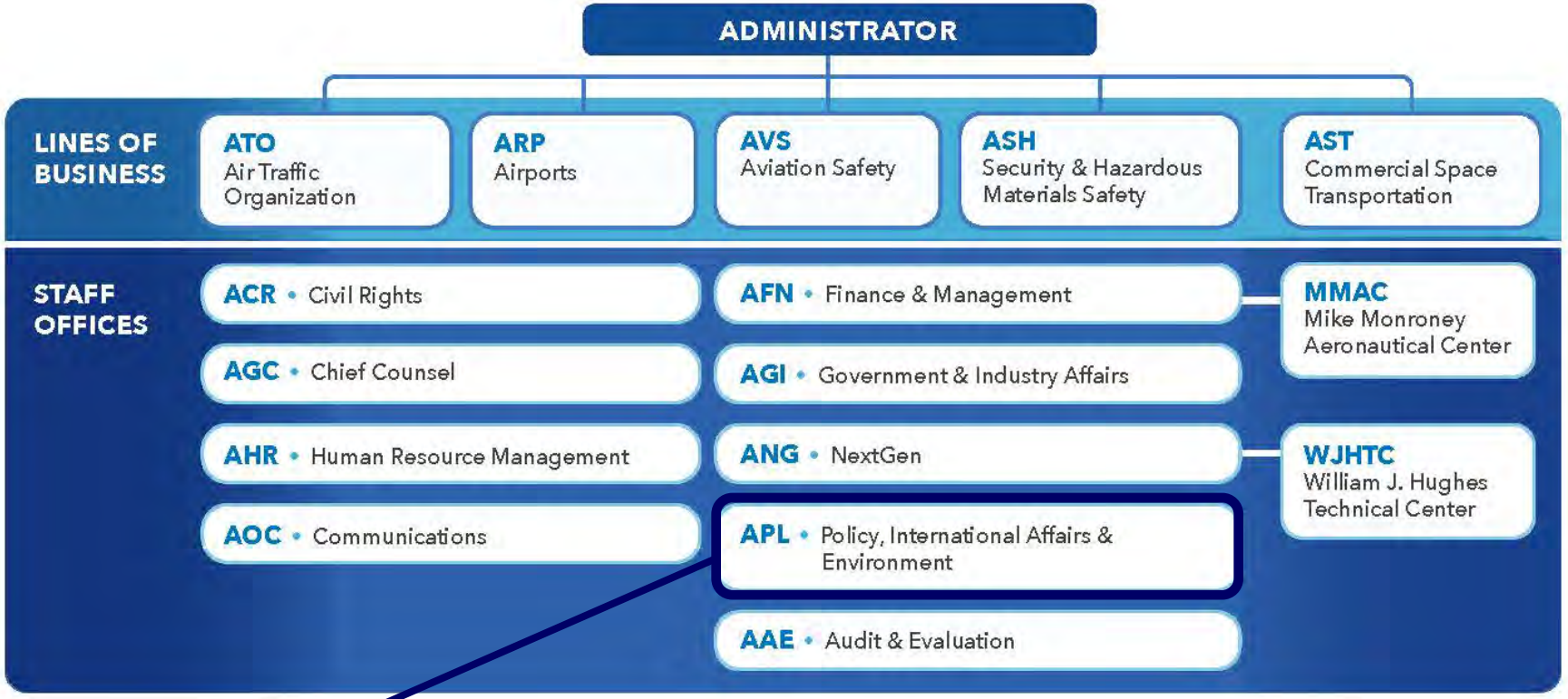
FAA Office of Environment and Energy

Date: May 8, 2024

Presentation Outline

- FAA Office of Environment & Energy
- Environment & Energy Strategy
- Aircraft Technology Research & Development
- Sustainable Aviation Fuel Efforts
- Funding Update

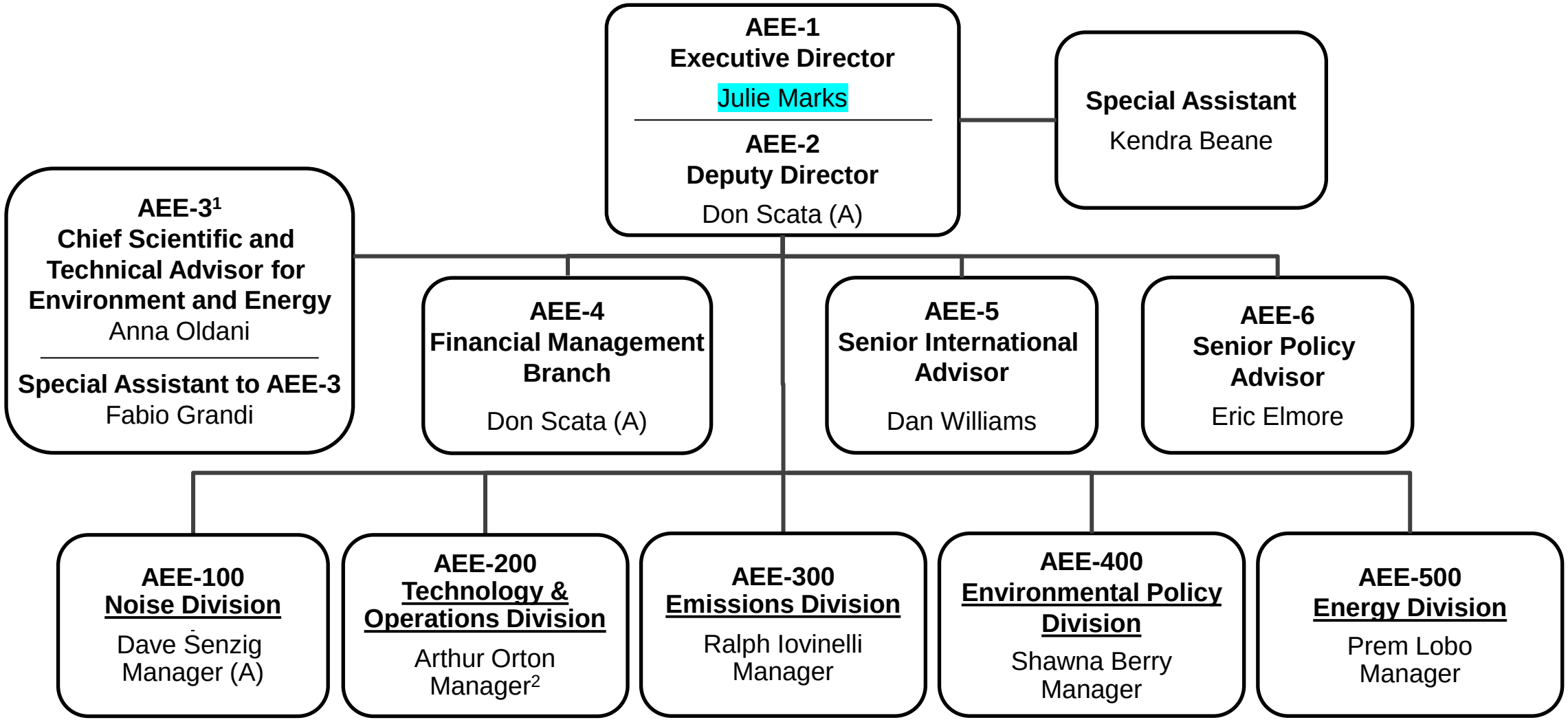
FAA Organizational Structure



Office of Environment and Energy (AEE)

- Office within APL, responsible for broad range of environmental policies
- Roughly 45 staff members
- Responsible for roughly 1/3 of FAA RE&D Budget
- Responsible for the FAA I.R.A. Grant Program

AEE Organizational Structure

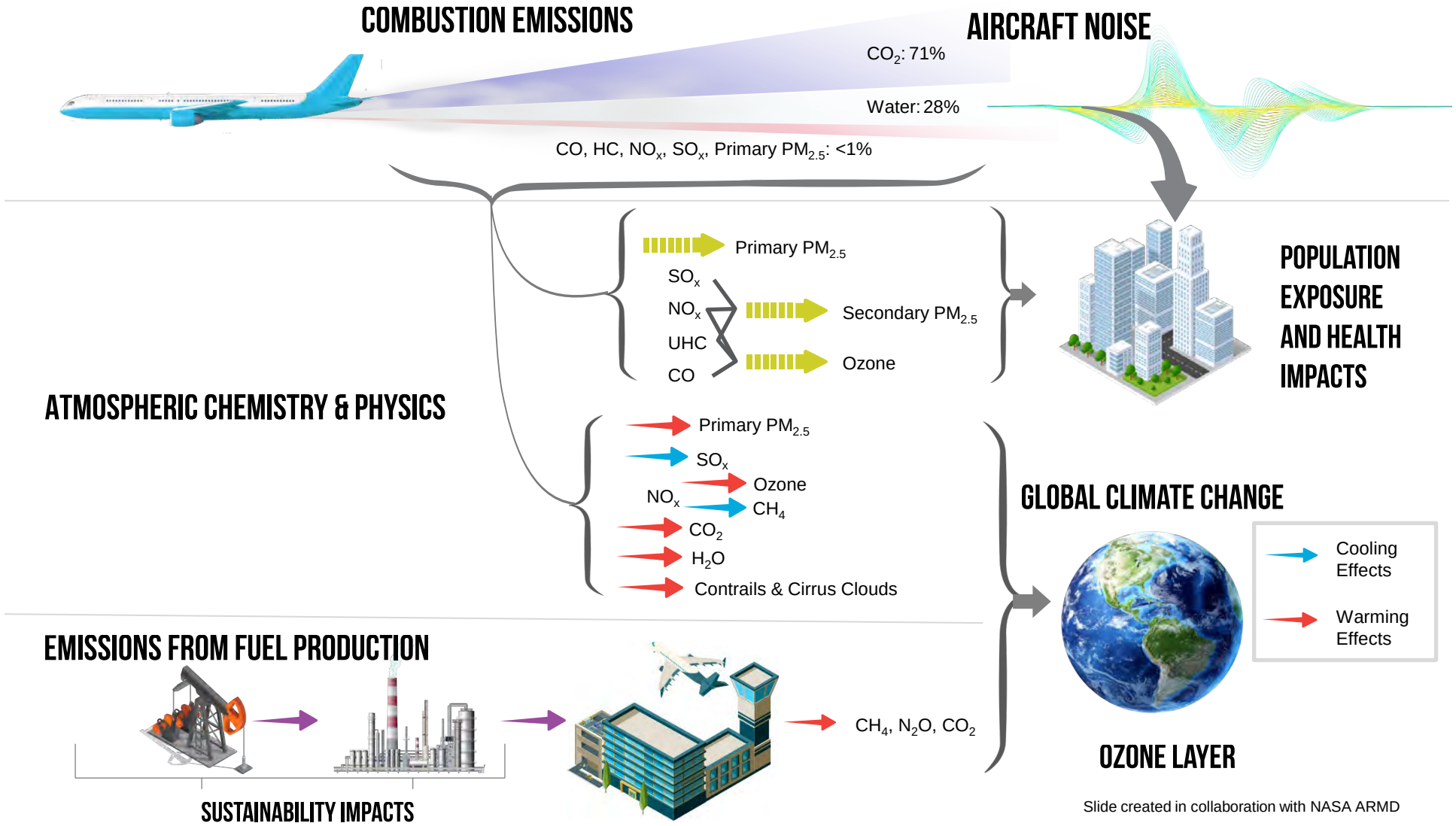


(A) = Acting

[1]ASCENT Program Manager, as a subset of CSTA duties

[2] CLEEN Program Manager, as a subset of AEE-200 Division Manager duties

Environmental Impacts of Aviation



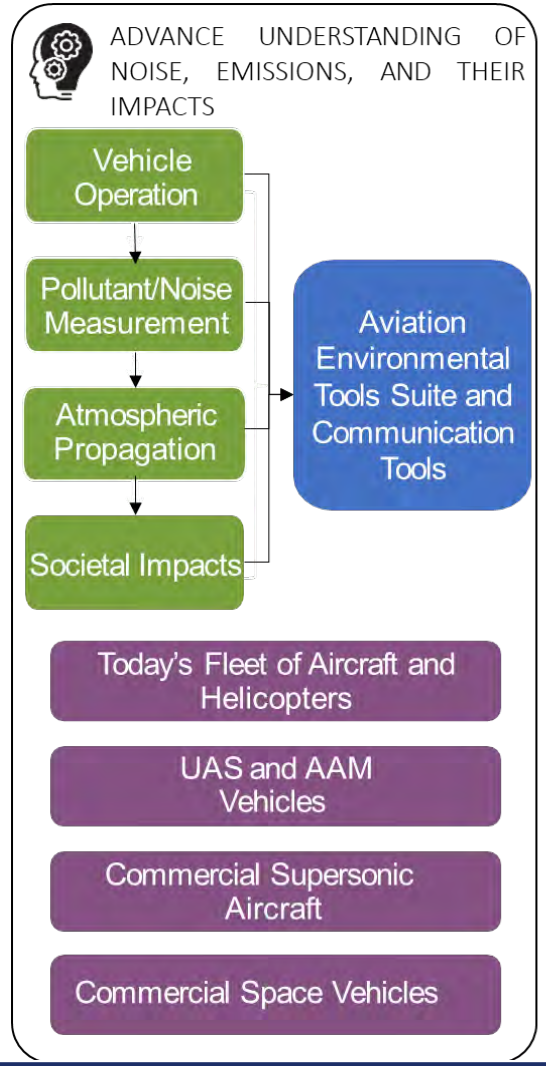
Slide created in collaboration with NASA ARMD

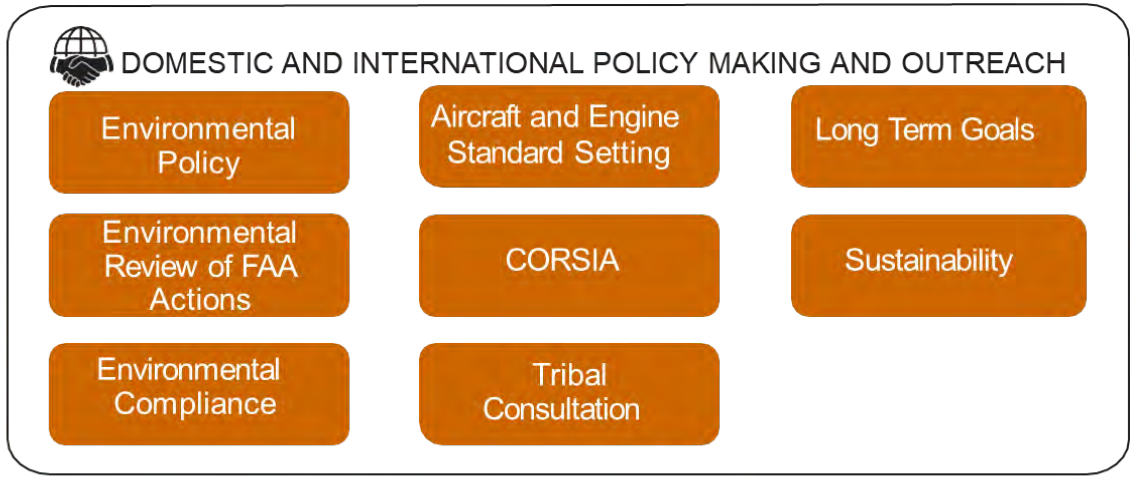
AEE uses research to support our mission

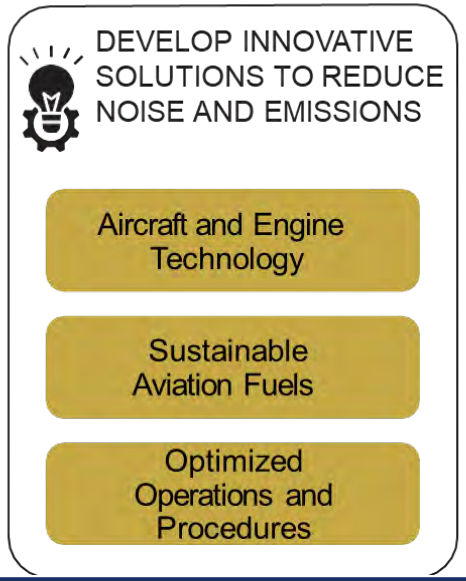
To understand, manage, and reduce the environmental impacts of global aviation

through research, technological innovation, policy, and outreach

to benefit the public







Continuous Lower Energy, Emissions & Noise (CLEEN) Program

- FAA led public-private partnership with 1:1 cost matching from industry
- Reducing fuel burn, emissions and noise via aircraft and engine technologies and alternative jet fuels
- Conducting ground and/or flight test demonstrations to accelerate maturation of certifiable aircraft and engine technologies

	Phase I	Phase II	Phase III
Time Frame	2010-2015	2016-2020	2021-2026
FAA Budget	~$125M	~$100M	~$125M
Noise Reduction Goal	25 dB cumulative noise reduction cumulative to Stage 5 and/or reduces community noise exposure (new goal for Phase III)		
Fuel Burn Goal	33% reduction	40% reduction	-20% re: CAEP/10 Std.
NO_X Emissions Reduction Goal	60% landing/take-off NO_X emissions (re: CAEP/6)	75% landing/take-off NO_X emissions (-70% re: CAEP/8)	
Particulate Matter Reduction Goal	-	-	Reduction relative to CAEP/11 Std.
Entry into Service	2018	2026	~2031

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

CLEEN Phase III Technologies

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

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

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

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

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

Fuel
Emissions
Noise

Assessment of CLEEN Technologies

Analytical Evaluation:

- Conducted by Georgia Tech through ASCENT COE Project 37
- Evaluating impact of technology applications through 2050

Fuel Burn Benefit:

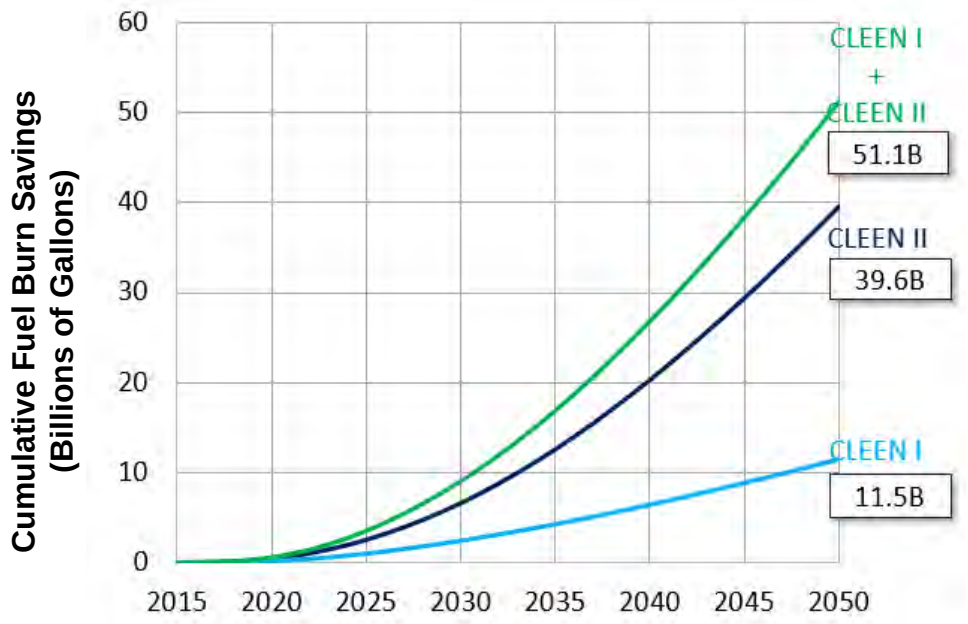
- 51.1 billion gallons of fuel saved cumulative by 2050 from CLEEN Phase I and II
- CO_2 emissions reduced by 500 million metric tons over this time period

NOx Benefit:

- CLEEN Phase I and II technology cumulatively reduce LTO NOx emissions by 2.79 Megatons through 2050

Noise Benefit:

- The interim assessment indicates that the CLEEN Phase I and II technologies could yield a 10% reduction in 65 DNL noise contour area by 2050 compared to continued evolution of aircraft technologies absent CLEEN's research & development investments.



Updated 4/2024. Includes domestic operations and international departures of U.S. commercial and foreign flag carriers

Continuous Lower Energy, Emissions & Noise (CLEEN) Program

- FAA led public-private partnership with 1:1 cost matching from industry
- Reducing fuel burn, emissions and noise via aircraft and engine technologies and alternative jet fuels
- Conducting ground and/or flight test demonstrations to accelerate maturation of certifiable aircraft and engine technologies

	Phase I	Phase II	Phase III	Phase IV (DRAFT)
Time Frame	2010-2015	2016-2020	2021-2026	2025-2029
FAA Budget	~$125M	~$100M	~$125M	~$190M
Energy Efficiency / Fuel Burn Reduction Goal	33% reduction re: year 2000 baseline	40% reduction re: year 2000 baseline	-20% re: CAEP/10 Std.	-35% re: CAEP/10 Std., and/or reduces aviation's climate impacts
Noise Reduction Goal	25 dB cumulative noise reduction cumulative to Stage 5 and/or reduces community noise exposure (new goal for Phase III)			
NO_X Emissions Reduction Goal	60% landing/take-off NO_X emissions re: CAEP/6	-70% landing/take-off NO_X emissions re: CAEP/8 (-75% re: CAEP/6)		-70% landing/take-off NO_X emissions re: CAEP/8 and/or reduces absolute NOx over the aircraft's mission
Particulate Matter Reduction Goal	-	-	Reduction relative to CAEP/11 Std.	-50% landing/take-off nvPM number and mass re: CAEP/11
Entry into Service	2018	2026	~2031	~2035

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

ASCENT Technology Projects

- **Complementary venue for university-led research on aircraft technology research and development**
- **Advances the industry state-of-the-art and expands the technical knowledge base**
- **Cuts across development of individual technologies and models**
- **Technical Themes:**
  - Noise reduction technology modeling and development
  - System-level modeling and design considerations
  - Propulsion-airframe integration
  - Combustion
  - Turbomachinery
  - Supersonics
- **Overview of projects available on ASCENT website:**

  https://ascent.aero/topic/Aircraft-Technology/

ASCENT Aircraft Technology Innovation Portfolio

Noise reduction technology modeling and development

- 075 - Improved Engine Fan Broadband Noise Prediction Capabilities
- 076 - Improved Open Rotor Noise Prediction Capabilities
- 079 - Novel Noise Liner Development Enabled by Advanced Manufacturing

System-level modeling and design considerations

- 010 - Aircraft Technology Modeling and Assessment
- 037 - CLEEN II System Level Assessment
- 052 - Comparative Assessment of Electrification Strategies for Aviation
- 064 - Alternative Design Configurations to Meet Future Demand
- 095 – Assessment of Fuel Cells for Powering Modern Business Jets
- 096 – Future Transportation System Opportunities and Constraints
- 097 – FAST-Tech System Level Assessment

Propulsion-airframe integration

- 050 - Over-Wing Engine Placement Evaluation
- 063 - Parametric Noise Modeling For Boundary Layer Ingesting Propulsors

Supersonics

- 047 - Clean Sheet Supersonic Aircraft Engine Design and Performance
- 059 - Jet Noise Modeling to Support Low Noise Supersonic Aircraft Technology Development

Combustion

- 051 - Combustion concepts for next-generation aircraft engines to reduce fuel burn and emissions
- 055 - Noise Generation and Propagation from Advanced Combustors
- 066 - Evaluation of High Thermal Stability Fuels
- 067 - Impact of Fuel Heating on Combustion and Emissions
- 068 - Combustor Wall Cooling Concepts for Dirt Mitigation
- 070 - Reduction of nvPM emissions via innovation in aero-engine fuel injector design
- 071 - Predictive Simulation of Soot Emission in Aircraft combustors
- 074 - Low Emissions Pre-Mixed Combustion Technology for Supersonic Civil Transport
- 098 – Low Emissions Lean Pre-Mixed Pre-Vaporized Combustion Technology for Subsonic Civil Transport

Turbomachinery

- 056 - Turbine Cooling Through Additive Manufacturing
- 092 – Advanced Two-Stage Turbine Rig Development

Green = new projects just awarded

FAST Program Overview

The new **Fueling Aviation's Sustainable Transition (FAST)** discretionary grant program will make investments to accelerate production and use of **sustainable aviation fuels** and the development of **low-emission aviation technologies** to support the U.S. aviation climate goal to achieve net zero greenhouse gas emissions by 2050.

Grants will carry out projects located in the United States that:

- Produce, transport, blend or store sustainable aviation fuel - $244,530,000
- Develop, demonstrate, and apply low-emission aviation technologies - $46,530,000

Notice of Funding Opportunity closed December 4, 2023

Range of Potential Projects - Details

Two project categories being considered for the FAST Technology efforts:

1. Designing, prototyping, and testing of discrete low-emission aviation technologies
   - Relatively near-term impact on emissions from future engine and aircraft designs
   - Technologies might be limited vehicle types or specific company product lines
   - Similar to technology development efforts in CLEEN and ASCENT
2. Enhancing aircraft and engine technology testing and demonstration capabilities to accelerate development and demonstration of a broad range of low-emissions aviation technologies.
   - Longer-term impact on emissions from future engine and aircraft designs
   - Support development of tech over broad range of vehicle types
   - Impact of projects could endure for long time period and help entire industry
   - Improve understanding of technologies to enable future benefits
   - AEE currently standing up one project within ASCENT that fits in this category (ASCENT Project 92 at Penn State University to expand turbine facility)

Summarizing FAA Environmental Aircraft Technology Programs

- **CLEEN**
  - Industry partnership with 50/50 cost share via cooperative agreements
  - Focused on taking TRL 3-5 technologies through TRL 6-7 to reduce technical risk and put technologies on a path for entry into service ~5 years after conclusion of R&D
  - Focused technology development with additional benefits to enhancing analysis and design tools
- **Aviation Sustainability Center of Excellence (ASCENT)**
  - Academic partnership with 50/50 cost share via grants
  - Focused on applied R&D at any TRL
  - Advances state of the art of knowledge broadly in the industry
  - Covers: new discrete technologies, enhanced analysis and design tools, and improved physics modeling
- **Fueling Aviation's Sustainable Transition (FAST) via Technology**
  - Industry and/or academia partnership with 75% FAA cost share via grants
  - Explicitly focused on low-emissions technologies
  - *Focus areas:*
    - *Designing, prototyping, and testing of discrete low-emission aviation technologies, and*
    - *Enhancing aircraft and engine technology testing and demonstration capabilities to accelerate development and demonstration of a broad range of low-emission aircraft technologies.*

SAF Grand Challenge

Multi-agency roadmap for the next decade of work to enable SAF Grand Challenge Goals

Achieve 3 billion gallons of domestic SAF production in 2030 and put U.S. on trajectory to 35 billion gallons per year by 2050

At least a 50% reduction in life cycle greenhouse gas emissions, as compared to conventional jet fuel

Roadmap Addresses Six Key Action Areas

1. Feedstock Innovation
2. Conversion Technology Innovation
3. Building Supply Chains
4. Policy and Valuation Analysis
5. Enabling End Use
6. Communicating Progress and Building Support

Roadmap contains 2022-2030 & 2030-2050 timeframes

https://www.energy.gov/eere/bioenergy/articles/sustainable-aviation-fuel-grand-challenge-roadmap-flight-plan-sustainable

Building the Foundation – Consistent and Dedicated Resources Towards Scaling Up Sustainable Aviation Fuels

Testing
accelerate SAF development

- Test fuels
- Improve testing methods
- Conduct evaluation
- Streamline approval

Analysis
environmental and economic sustainability

- Lifecycle emissions
- Cost reduction
- Supply potential
- Supply chain opportunities

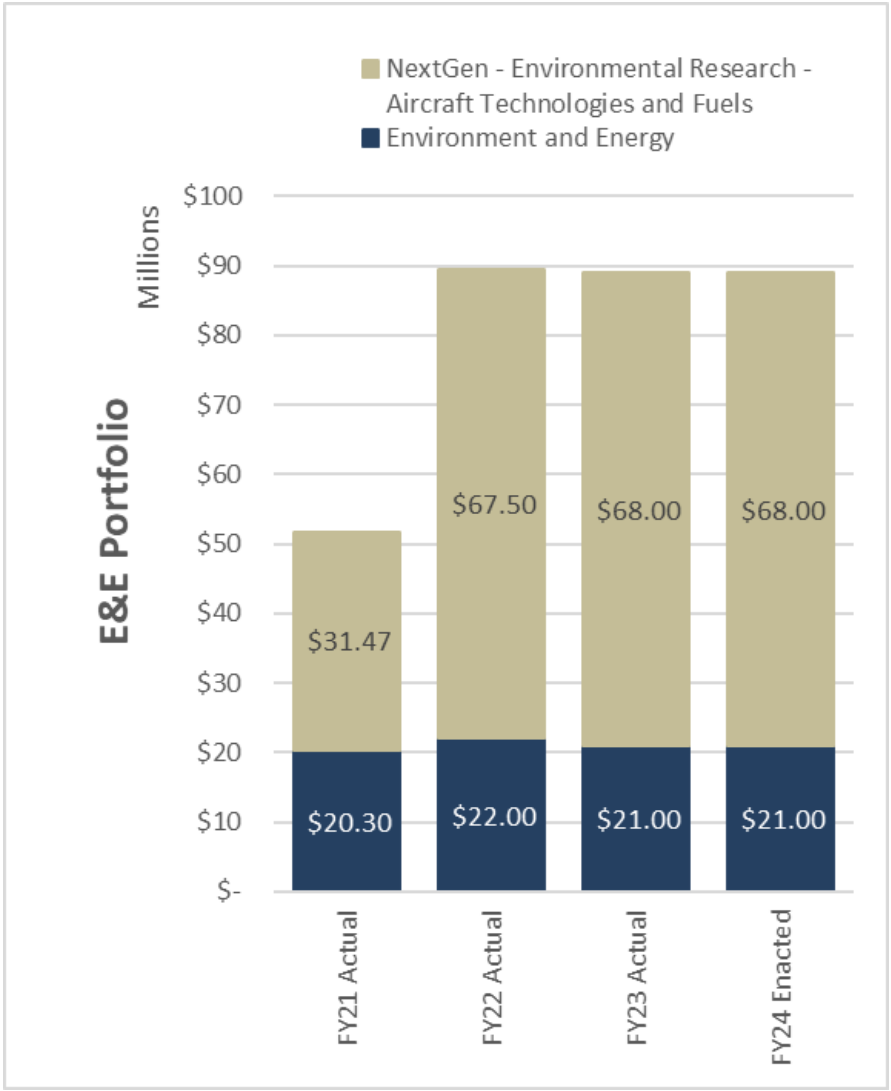
Coordination
support SAF integration

- Public-private partnership – *CAAFI*
- U.S. interagency cooperation – *SAF GC*
- International cooperation – *ICAO*

Deployment
enable SAF scale-up

- Build production, transportation, blending and storage infrastructure – *FAST*

E&E R&D Portfolio

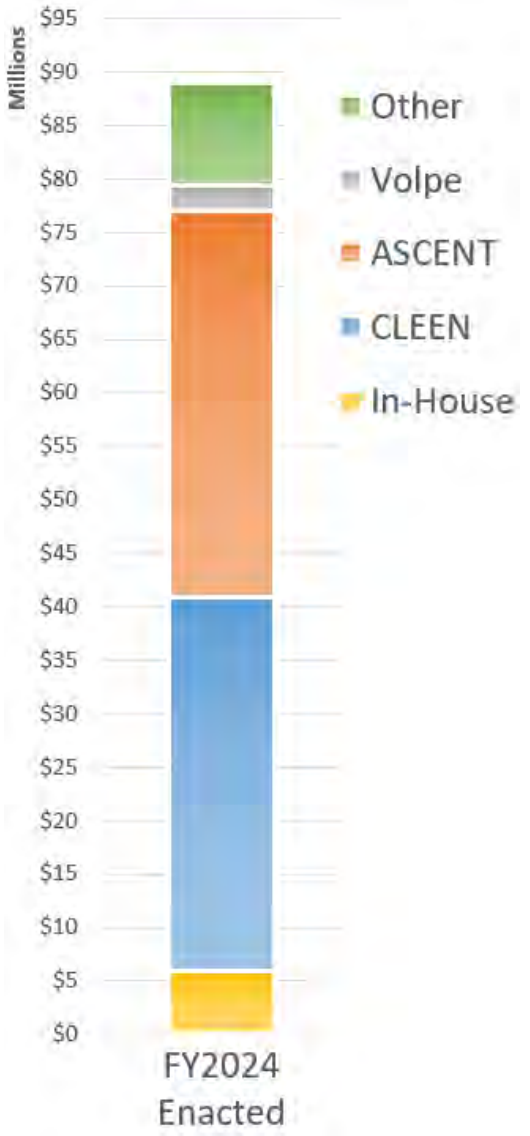


RE&D Environment & Energy (E&E) Budget Line Item

- 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
- Includes funding for CLEEN + ASCENT technology work



FAA Opportunities

- **National Air Grant Fellowship**
  - www.faa.gov/nagf

SAMYA ROSE STUMO NATIONAL AIR GRANT FELLOWSHIP PROGRAM

The Federal Aviation Administration (FAA) welcomes your interest in the Samya Rose Stumo National Air Grant Fellowship (NAGF) program. The program offers an opportunity for graduate students to gain experience in how aviation legislation and policy are developed in Congress.

ELIGIBILITY

Each Fellow will spend a year with a Congressional office that has jurisdiction over the FAA. A fellow may serve as an expert liaison and researcher for a Congressional committee and may participate in FAA program activities to further develop their knowledge and skills.

The program is designed to offer graduate students a hands-on experience at navigating public policy issues related to their field of expertise. FAA seeks participants in fields related to aerospace, including but not limited to, the following:

- Aerospace engineering
- Aerospace physiology
- Aeronautical engineering
- Airworthiness engineering
- Electrical engineering
- Human factors
- Software engineering
- Systems engineering

To apply, you must be a U.S. citizen, have an undergraduate degree and be pursuing an M.A. or PhD degree in a related field as listed or be within a year of completion of the post-graduate degree. You must also meet position-specific qualifications.

The annual application schedule takes place every spring. For eligibility and application instructions, visit the NAGF website at www.faa.gov/nagf

FELLOWSHIP AWARD INFORMATION

The Samya Rose Stumo National Air Grant Fellowship program anticipates supporting multiple fellowships each calendar year.

- The application period for the 2025 cohort is December 1, 2024 through January 31, 2025.
- Length: 12-month, non-renewable fellowship assignment
- Start date: Late June/July of 2025

Looking Ahead: University and Industry Discussion Panel

- **Panel this afternoon (14:55-16:25) focused on the state of sustainable aviation technology**

- **Please submit any questions for this afternoon's panel to cleen@faa.gov**

Arthur Orton

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Federal Aviation Administration
Office of Environment and Energy

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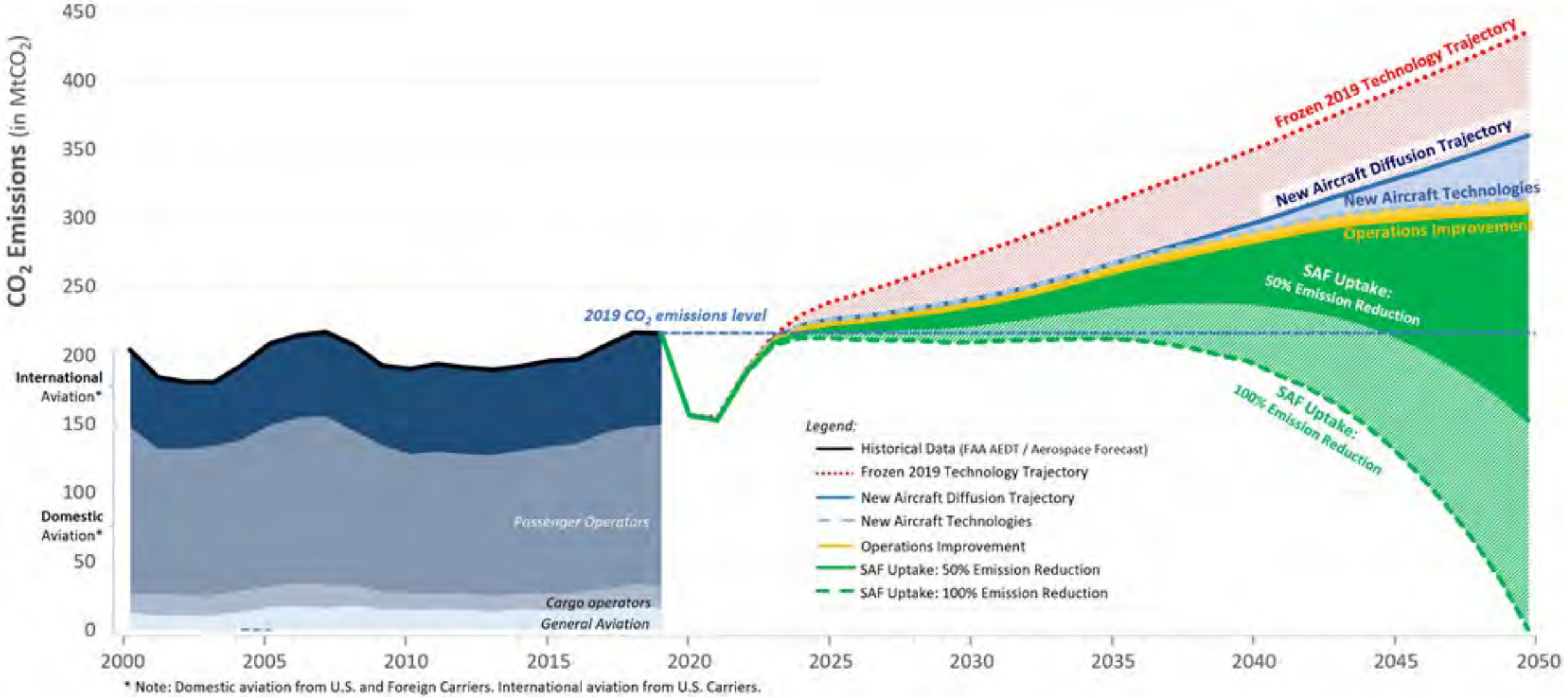
Backup

Domestic and International Aviation CO_2 Emissions



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