FAA Office of Environment & Energy Overview and Update

Federal Aviation Administration

Prepared for: CLEEN Consortium Meeting

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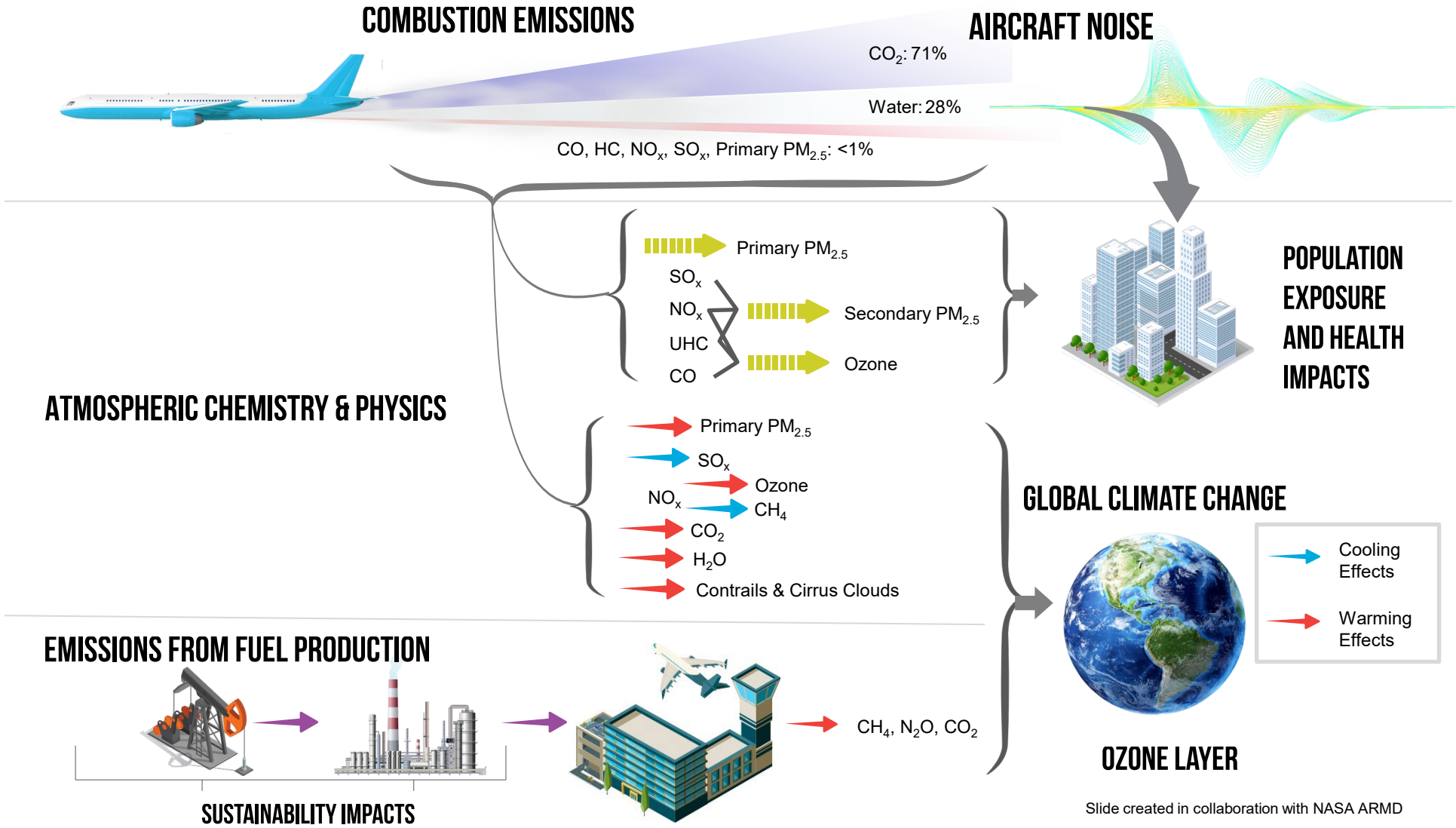
Presentation Outline

- **FAA Office of Environment & Energy**
- **Aircraft Technology Research & Development**
  - Continuous Lower Energy, Emissions and Noise (CLEEN)
  - Aviation Sustainability Center of Excellence (ASCENT)
  - Fueling Aviation's Sustainable Transition (FAST)
- **Funding Update**

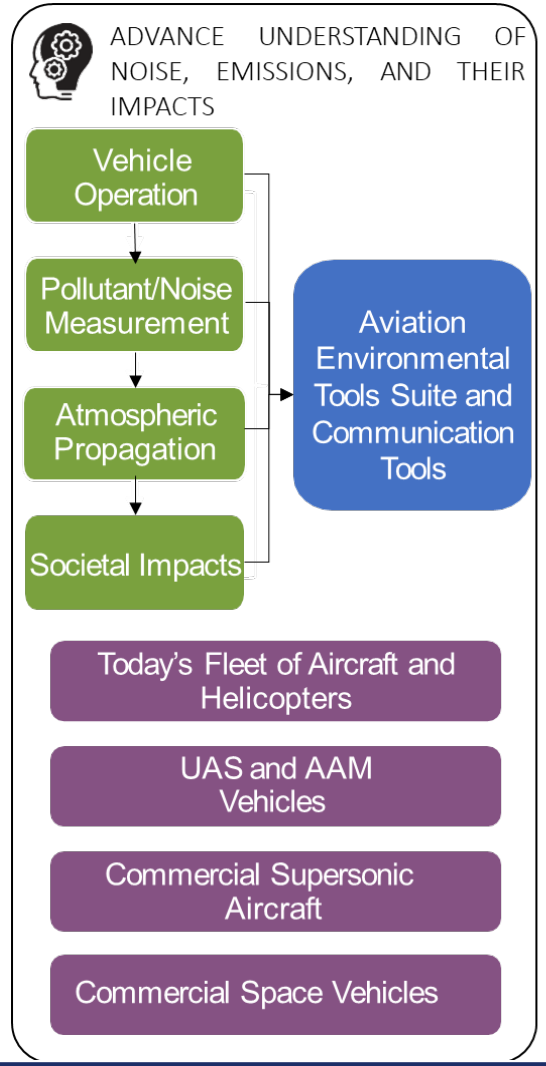
Environmental Impacts of Aviation

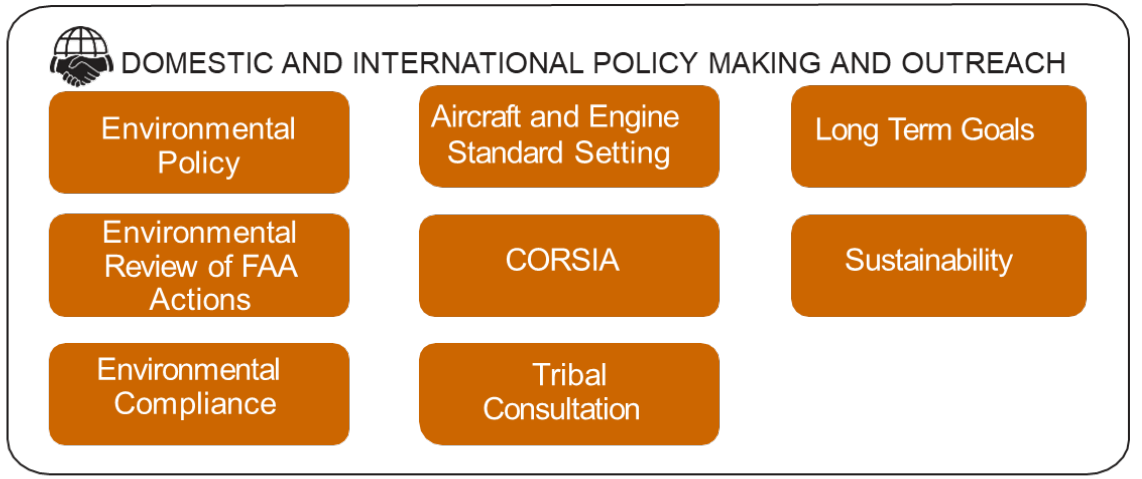


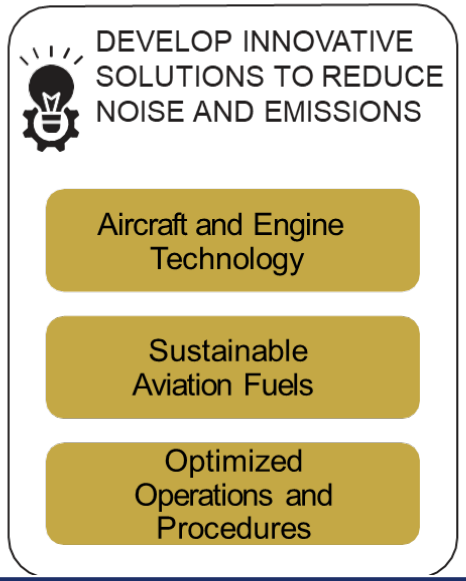
Slide created in collaboration with NASA ARMD

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

NextGEN

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
- 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

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

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

Fuel
Emissions
Noise

Assessment of CLEEN Technologies' Benefits

Analytical Evaluation:

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

Fuel Burn Benefit:

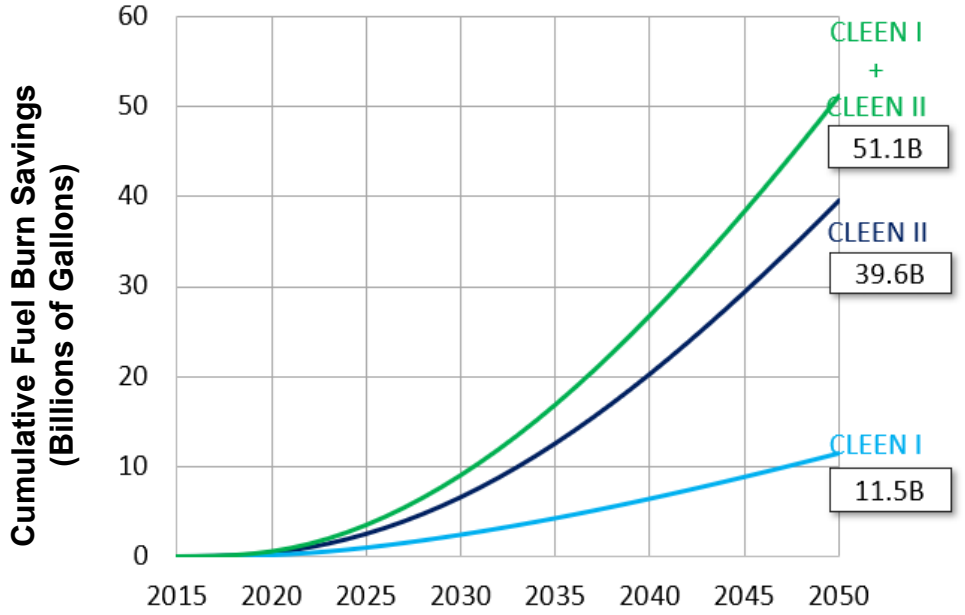
- 51.1 billion gallons of fuel saved cumulative by 2050 from CLEEN Phase I and II
- CO_2 emissions reduced by 500 million metric tons over this time period

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

Path Forward

- Plan to continue FAA's programmatic model of public-private partnership with 1:1 cost matching from industry to develop new environmentally beneficial aircraft technologies
- Solicitation planned in calendar year 2025, *pending internal approvals.*

	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

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

Program Overview

FAST Grants

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. (Legislative Authority: Section 40007 of the Inflation Reduction Act of 2022)

- Grants will carry out projects located in the United States that:
  - Produce, transport, blend or store sustainable aviation fuel (FAST-SAF) - $244,530,000
  - Develop, demonstrate, and apply low-emission aviation technologies (FAST-Tech) - $46,530,000

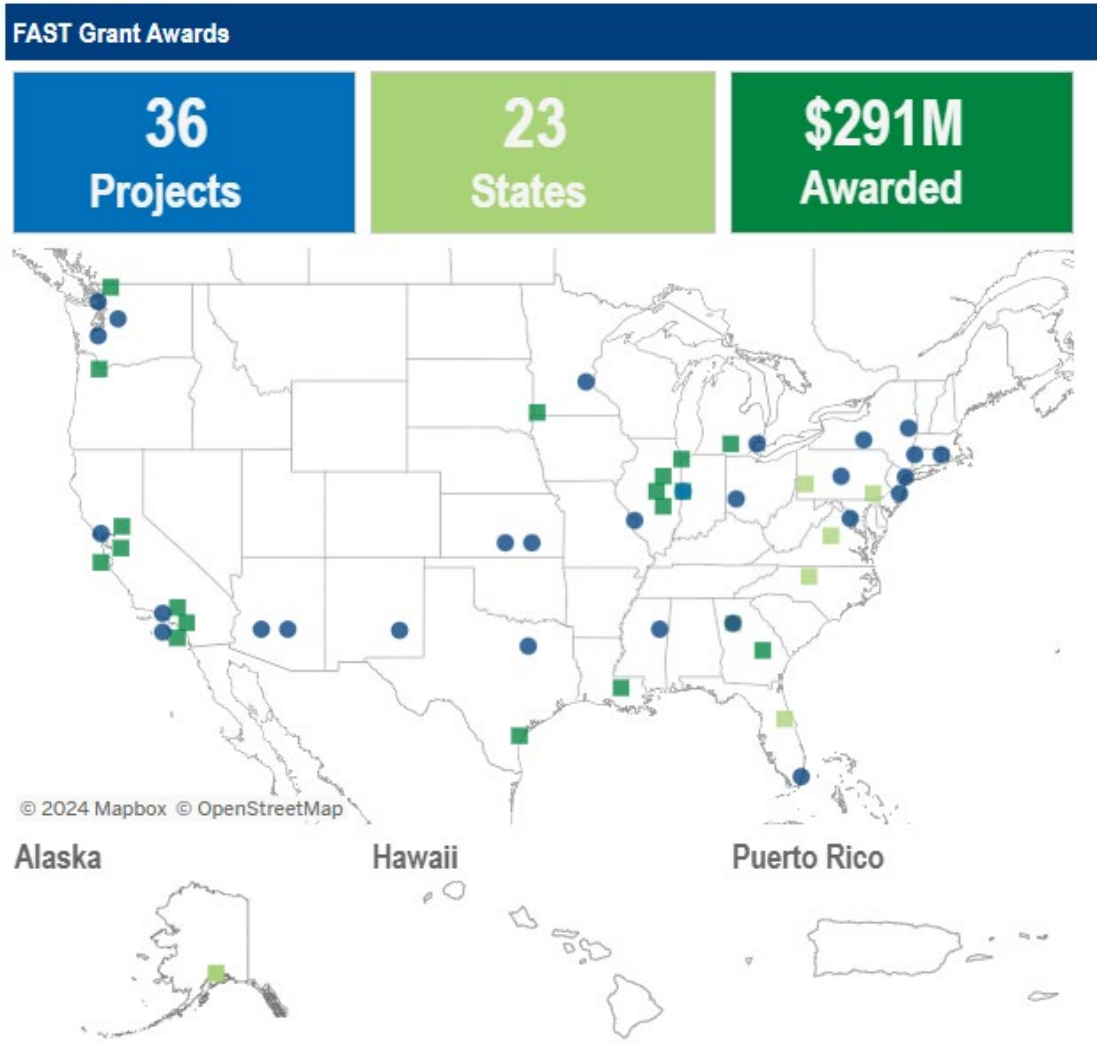
- Eligible entities include: state and local governments, airports, air carriers, academic and research institutions, other aviation industry, and nonprofits
- Federal cost-share is 75% of project cost (90% for small or non-hub airport awardees)

- Notice of Funding Opportunity (NOFO) released on Sept 25, 2023; closed on Dec 4, 2023
- **Awards announced August 16th:** https://www.faa.gov/newsroom/biden-harris-administration-announces-nearly-300-million-awards-sustainable-aviation-fuels

FAST Grant Awards

The FAA award selections:

- 7 SAF Tier 1 projects - supply chain studies to identify infrastructure needs
- 15 SAF Tier 2 projects - infrastructure for SAF production, transportation, blending, and storage
- 13 Low-Emission Technology Category 1 projects - developing low-emission aviation technologies
- 1 Low-Emission Technology Category 2 project - developing test capabilities to advance low-emission aviation technologies

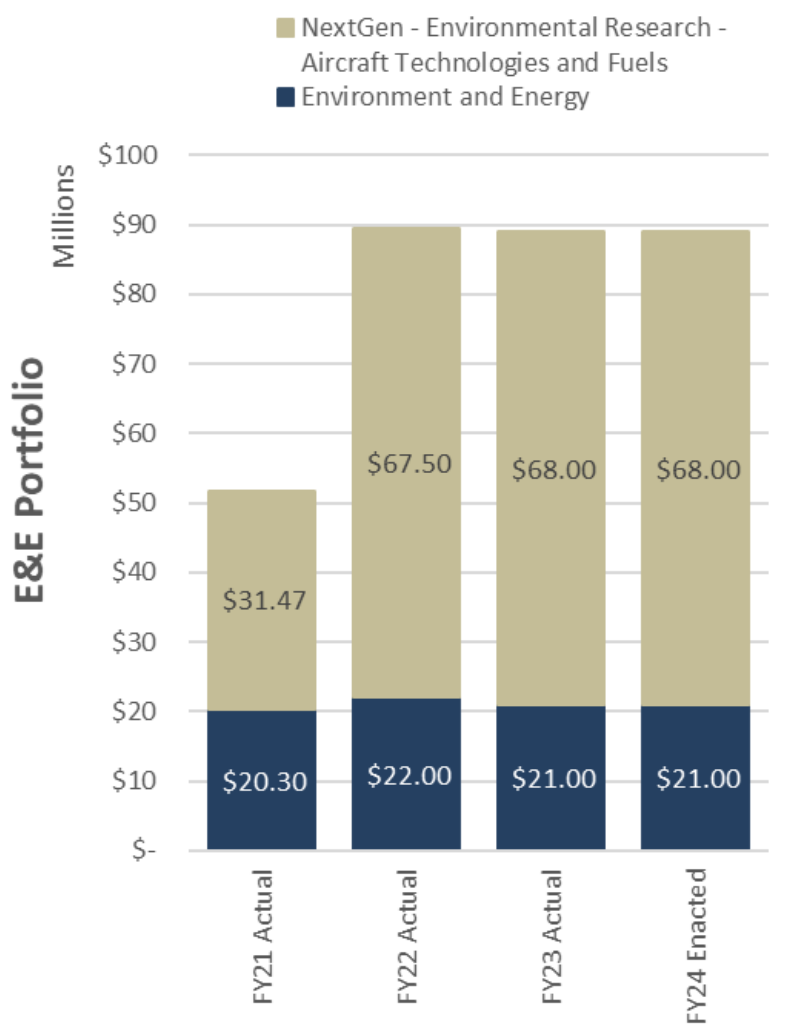


Full list of awards available at: https://www.faa.gov/general/fueling-aviations-sustainable-transition-fast-grants

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.*

E&E R&D Portfolio

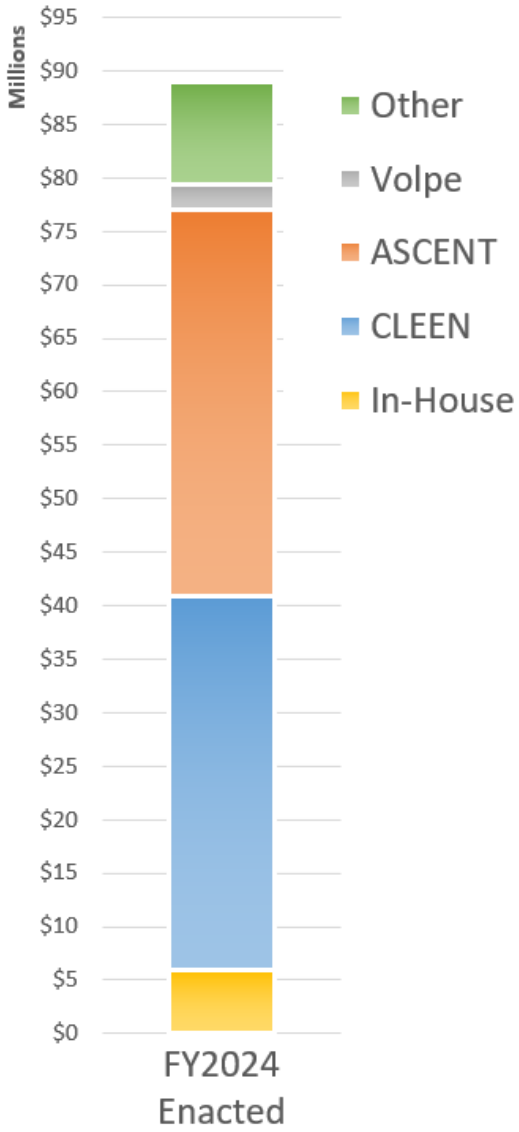


RE&D Environment & Energy (E&E) Budget Line Item

- 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



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