FAA Office of Environment and Energy (AEE) Research Overview

Presented to: E&E REDAC Subcommittee

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Date: September 11, 2018

Outline

- **AEE Research**
  - AEE in context
  - Mission, vision and five pillar approach
  - Current research direction
- **CLEEN Update**
- **ASCENT COE Update**
- **NARP Update**
- **Budget Update**
- **Recent Successes**
- **Questions for Tomorrow**

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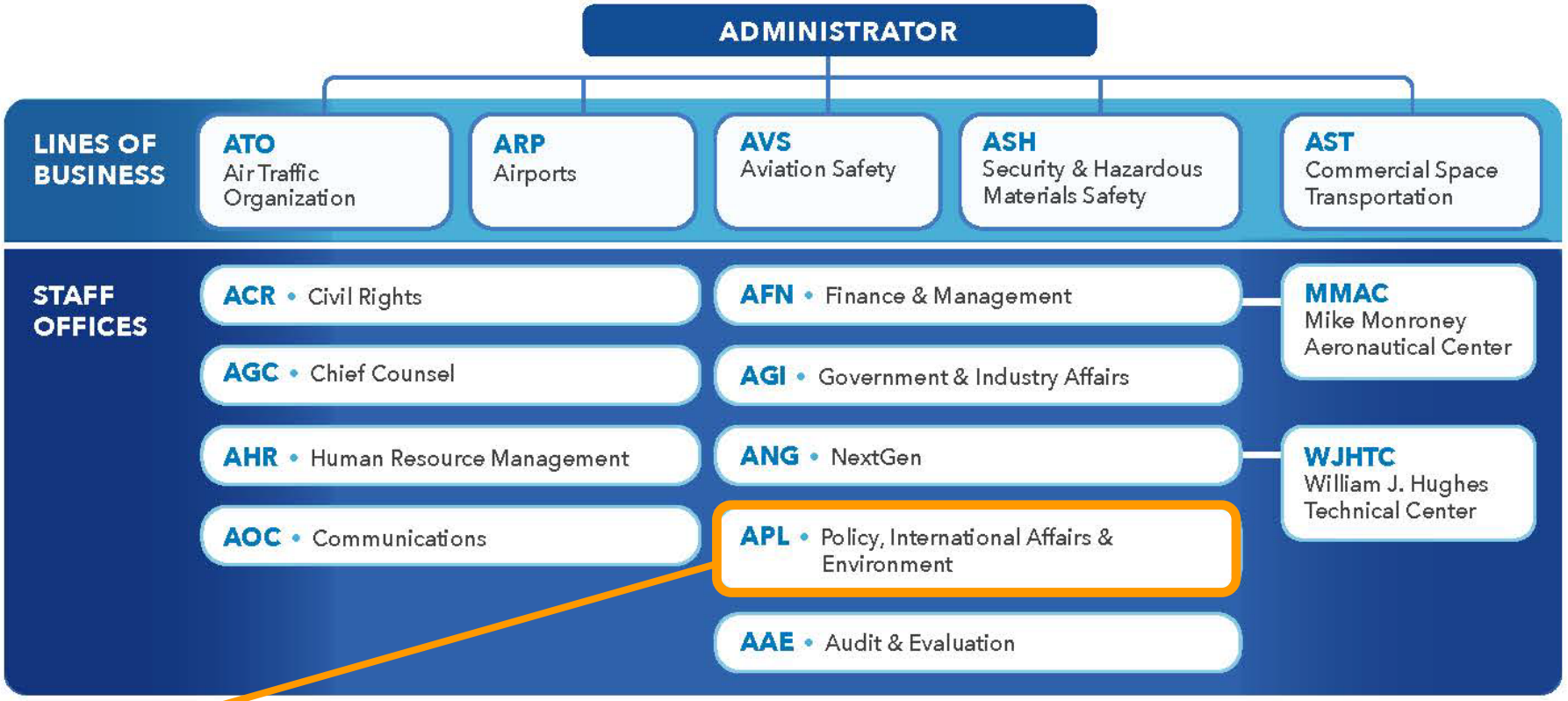
FAA Organizational Structure



Office of Environment and Energy (AEE)

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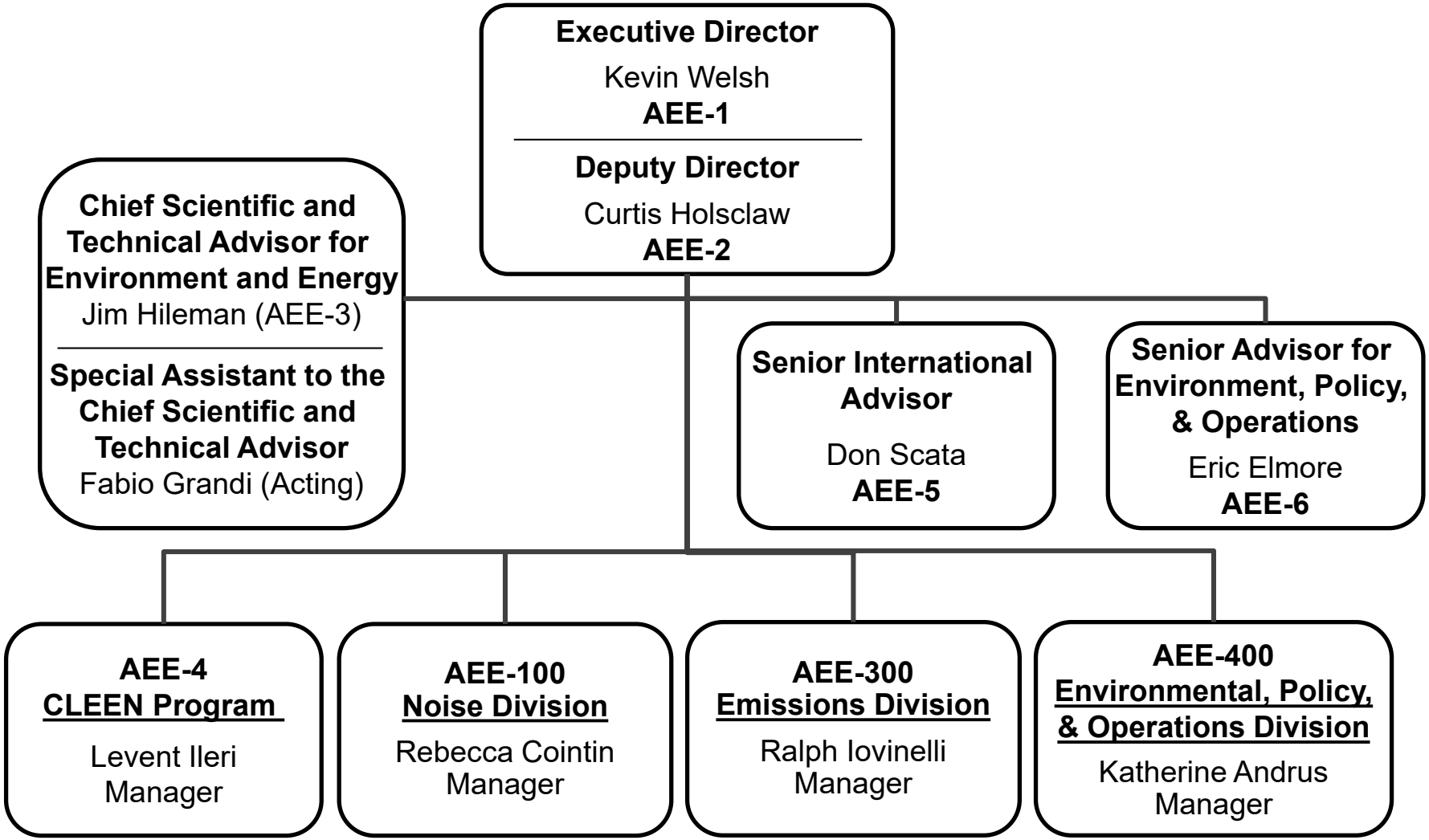

AEE Mission and Vision

Mission:

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

Vision:

Remove environmental constraints on aviation growth by achieving quiet, clean, and efficient air transportation

Economic Benefits of Aviation

5.1% of U.S. GDP

10.6 Million
U.S. jobs

$1.6 Trillion
in U.S. economic activity annually

$59.9 Billion
of U.S. Trade Balance (exports-imports)

SOURCE: FAA Air Traffic Organization

Aviation equipment (aircraft, spacecraft, and related equipment) is largest export sector in U.S. economy accounting for over 8% of total exports.

SOURCE: U.S. International Trade Commission

Benefits to Regional and Local Economies

- Aviation is a critical link for people, goods and services coming in and out of communities
- Access to aviation can be a vital reason that some companies use when choosing to locate offices, manufacturing and/or distribution facilities; and
- Passenger and cargo service can be crucial for community access and time-critical delivery services ranging from mail and packages to pharmaceuticals, biotech devices and computer components.

Environmental Protection that Allows Sustained Aviation Growth

ENVIRONMENT AND ENERGY GOALS

NOISE

Reduce the number of people exposed to significant noise around U.S. airports

AIR QUALITY

Reduce significant air quality impacts attributable to aviation

ENERGY

Achieve net fuel burn reduction by 2020 relative to a 2005 baseline and deploy sustainable aviation fuels.

The Five Pillar Approach

Science and Tools

PILLAR 1: Improved Scientific Knowledge and Integrated Modeling

- Decision-making based on solid scientific understanding
- Work with research community through the **Aviation Sustainability Center (ASCENT)**
- Understand public health and welfare impacts
- Incorporate this knowledge within the Aviation Environmental Tool Suite

Technology

PILLAR 2: New Aircraft Technologies

- Offer the greatest opportunity to reduce environmental impacts
- Partner with industry, research community, NASA, and Department of Defense
- Mature new engine and airframe technologies through the **Continuous Lower Energy, Emissions and Noise (CLEEN) Program**

Alternative Fuels

PILLAR 3: Sustainable Alternative Aviation Fuels

- Reduce environmental impacts, enhance energy security, and provide economic benefits
- Collaborate with stakeholders through the **Commercial Aviation Alternative Fuels Initiative (CAAFI)**
- Test alternative jet fuels to ensure they are safe for use through **ASCENT** and **CLEEN**
- Analyze their potential for reducing the environmental impacts of aviation

Operations

PILLAR 4: Air Traffic Management Modernization and Operational Improvements

- Increase efficiency of aircraft operations through the **Next Generation Air Transportation System (NextGen)**
- Engage with industry, research community, NASA, and Department of Defense
- Develop advanced operational procedures to optimize gate-to-gate operations
- Integrate infrastructure enhancements to the National Airspace System (NAS), improving environmental performance

Policy

PILLAR 5: Policies, Environmental Standards, and Market Based Measures

- Implement domestic policies, programs, and mechanisms to support technology and operational innovation
- Develop and implement aircraft emissions and noise standards
- Work within the International Civil Aviation Organization (ICAO) to pursue a basket of measures to address emissions that affect climate, including a global market based measure as a gap filler
- Seek international partners to further our environmental and energy strategy

NextGEN
http://www.faa.gov/nextgen

CAAFI
http://www.caafi.org

CLEEN
NextGEN
http://www.faa.gov/go/cleen

ASCENT
http://ascent.aero

Addressing Aircraft Noise

- **Understanding Impact of Noise**
  - Improving modeling capabilities
  - Examining relationship between noise and annoyance, sleep, cardiovascular health and children's learning.
  - Evaluating current aircraft, helicopters, commercial supersonic aircraft, unmanned aerial systems, and commercial space vehicles.
- **Outreach**
  - Enhanced community involvement (e.g., community roundtables)
  - Increase public understanding
- **Mitigation**
  - Noise Compatibility Planning (Part 150)
  - Noise-based access restrictions (Part 161)
  - Vehicle operations
  - Aircraft technologies and architecture
  - Noise standards

Briefings:

- ***UAS***
- ***Noise***
- ***Operational procedures***
- ***AEDT***
- ***Supersonic aircraft***

Addressing Aircraft Emissions

- **Understanding Impacts**
  - Particulate Matter (PM) measurements and modeling
  - Improving atmospheric impact modeling capabilities
  - Evaluating current aircraft, commercial supersonic aircraft, unmanned aerial systems, and commercial space vehicles
- **Mitigation**
  - Vehicle operations
  - Alternative fuel sources
  - Modifications to fuel composition
  - Aircraft technologies and architecture
  - Engine standard (CAEP PM standard)
  - Policy measures (CORSIA)

Briefings:

- ***UAS***
- ***Operational procedures***
- ***AEDT***
- ***Fuels***
- ***Emissions***
- ***Supersonic aircraft***

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

- Considerable emphasis on noise:
  - Research on noise impacts continues
  - Utilizing FAA-Massport MOU to explore low noise operational procedures in collaboration with ATO
  - Work on helicopter noise is making good progress
  - Examining UAS noise
- Growing efforts on supersonic aircraft
- Particulate Matter efforts in CAEP continue
- Executing long term vision for AEDT
- Alternative jet fuels: CAAFI, ASTM, and CAEP
- Technology maturation in CLEEN continues and we are setting stage for 3rd Phase of CLEEN
- Considering commercial space noise and emissions

Environment and Energy (E&E) Research Programs

Continuous Lower Energy, Emissions and Noise (CLEEN)

- Reduce aircraft fuel burn, emissions and noise through technology & advance alternative jet fuels
- Cost share partnership with industry

ASCENT Center of Excellence (COE)

- COE for Alternative Jet Fuel and Environment
- Cost share research with universities

Additional Efforts

- Commercial Aviation Alternative Fuels Initiative (CAAFI)
- Contract mechanisms (e.g., SEMRS, PEARS-II)
- Volpe Transportation Center

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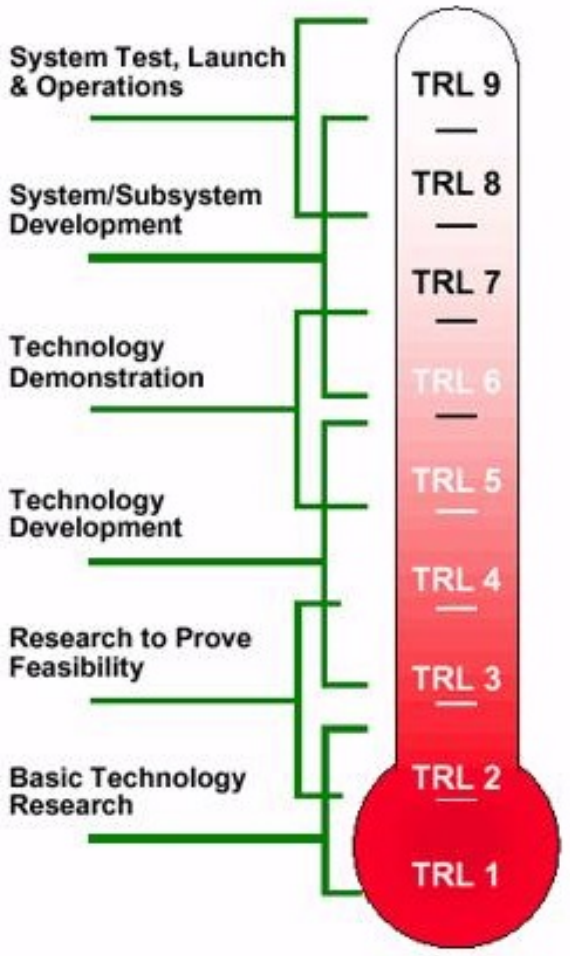
CLEEN Program Overview (1 of 2)

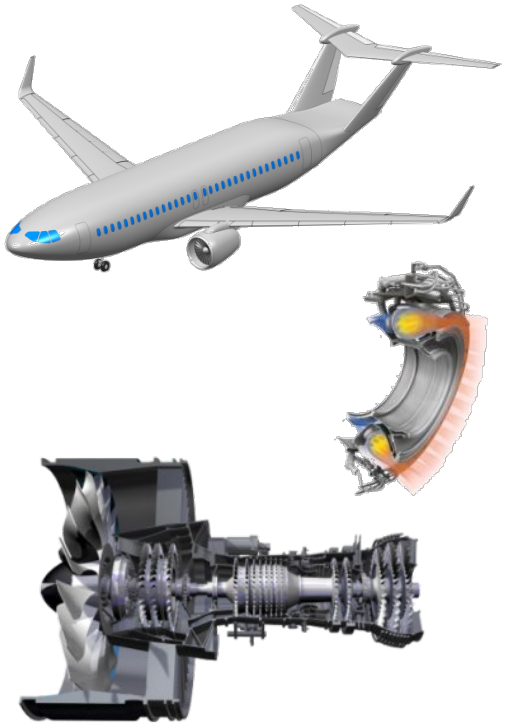
- FAA's principal environmental effort to accelerate development of new aircraft and engine technologies.
- Objective:
  - Mature previously conceived noise, emissions and fuel burn reduction technologies for civil subsonic airplanes from Technology Readiness Levels (TRL) of 3-5 to TRLs of 6-7 to enable industry to expedite introduction of these technologies into current and future aircraft and engines
  - Assess the benefits and advance the development and introduction of "drop-in" alternative jet fuels, including blends



CLEEN Program Overview (2 of 2)

- FAA led public-private partnership with 50-50 cost share 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
Time Frame	2010-2015	2015-2020
FAA Budget	~$125M	~$100M
Noise Reduction Goal	25 dB cumulative noise reduction cumulative to Stage 5	
NO_X Emissions Reduction Goal	60% landing/take-off NO_X emissions	75% landing/take-off NO_X emissions
Fuel Burn Goal	33% reduction	40% reduction
Entry into Service	2018	2026



CLEEN Awardees and Technologies

Awardees:

- **Aurora Flight Sciences (Phase II only)**
- **Boeing**
- **Delta Tech Ops, America's Phenix, MDS Coating Technologies (Phase II only)**
- **General Electric (GE) Aviation**
- **Honeywell Aerospace**
- **Pratt & Whitney**
- **Rohr, Inc. / UTC Aerospace Systems (Phase II only)**
- **Rolls-Royce**

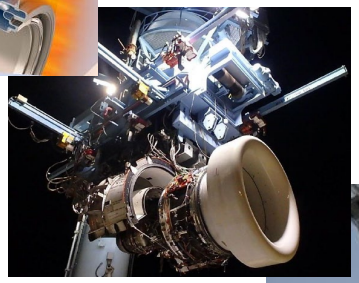
Phase I Technologies:

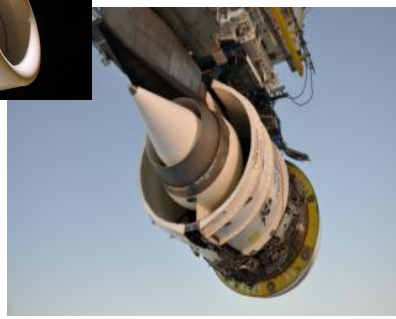
- **9 Technologies focused on**
  - Revolutionary Engine Design
  - Engine redesign
  - Wing technologies
  - Flight Management System Improvements
  - Improved Combustors

Phase II Technologies:

- **14 Technologies focused on**
  - Fuselage redesign
  - Engine redesign
  - Wing technology
  - Flight Management System improvements
  - Improved combustion

CLEEN Highlights





CLEEN Phase I

- GE TAPS II Combustor entered fleet in 2016 on LEAP engine
- Pratt & Whitney Gen 2 geared turbofan propulsor technology successfully engine tested
- Boeing ceramic matrix composite nozzle flight tested on a 787 aircraft

CLEEN Phase II

- GE TAPS III Combustor has achieved CLEEN goals on NOx reduction
- Aurora Flight Sciences tested key structural subcomponent that enables mass-efficient double bubble fuselage
- America's Phenix/Delta TechOps/MDS Coating Technologies currently conducting in-service flight evaluation of fan blade leading edge protective coating
- Boeing completed ground engine test of compact nacelle technology
- Rolls-Royce conducting full annular rig test for RQL low NOx combustion system
- Pratt & Whitney completed rig testing of advanced high pressure compressor technologies

CLEEN Outlook

- **Next CLEEN Consortium Meeting: Nov 6-8 in Washington, DC**
- **Notional CLEEN Phase III timeline**
- **Market Survey:** https://faaco.faa.gov/index.cfm/announcement/view/31002

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ASCENT Background

Timeline:

- In 2004, FAA established PARTNER Center of Excellence
- In 2013, FAA established Center of Excellence for Alternative Jet Fuels and Environment, a.k.a. Aviation Sustainability Center or ASCENT, that continues work of PARTNER with expanded efforts on alternative jet fuels R&D

COE fulfills requirements:

- P.L.112-95 Sec. 911 - conduct research to assist the development and qualification of jet fuel from alternative sources
- P.L.108-176 Title III Sec. 326 – conduct research to reduce community exposure to civilian aircraft noise and emissions

Budget Direction:

- FY2018 budget: FAA directed to use $15M in RE&D funds for ASCENT
- FY2016 budget: FAA directed to use $10.55M in RE&D funds for ASCENT

ASCENT Center of Excellence (COE)

Lead Universities:

Washington State University (WSU)*

Massachusetts Institute of Technology (MIT)

Core Universities:

Boston University (BU)

Georgia Institute of Technology (Ga Tech)

Missouri University of Science and Technology (MS&T)

Oregon State University (OSU)*

Pennsylvania State University (PSU)*

Purdue University (PU)*

Stanford University (SU)

University of Dayton (UD)

University of Hawaii (UH)*

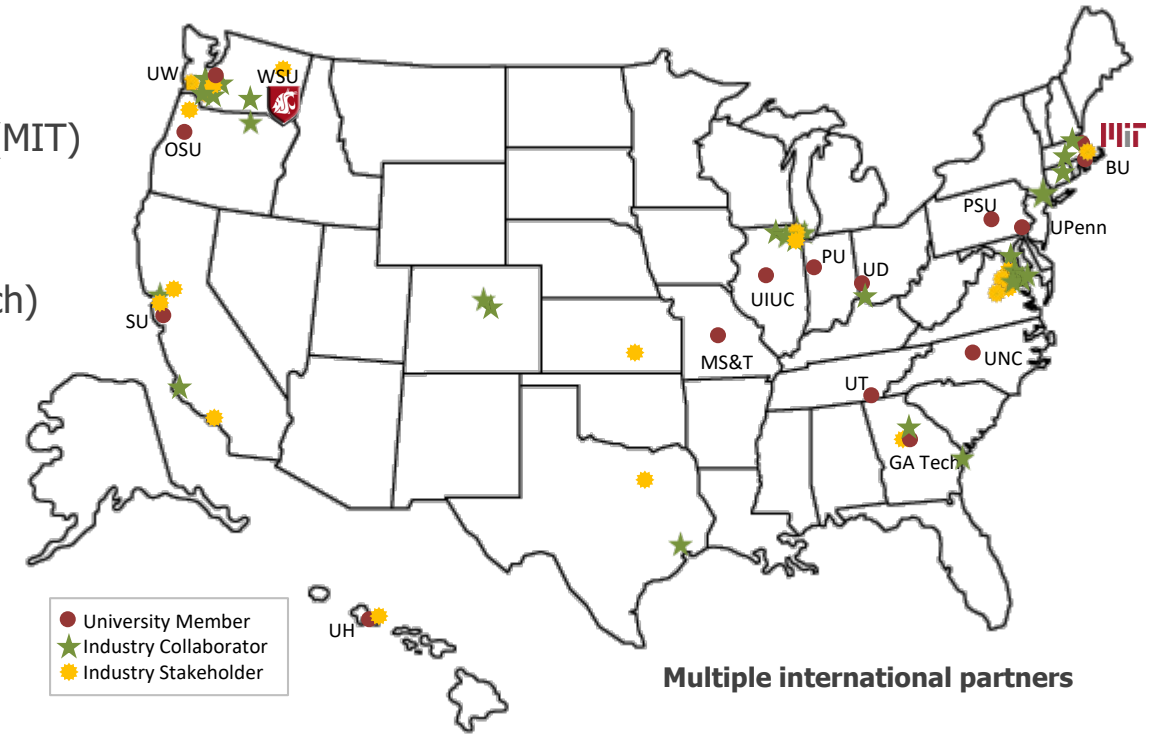
University of Illinois at Urbana-Champaign (UIUC)*

University of North Carolina at Chapel Hill (UNC)

University of Pennsylvania (UPenn)

University of Tennessee (UT)*

University of Washington (UW)*



Multiple international partners

Advisory Committee - 58 organizations:

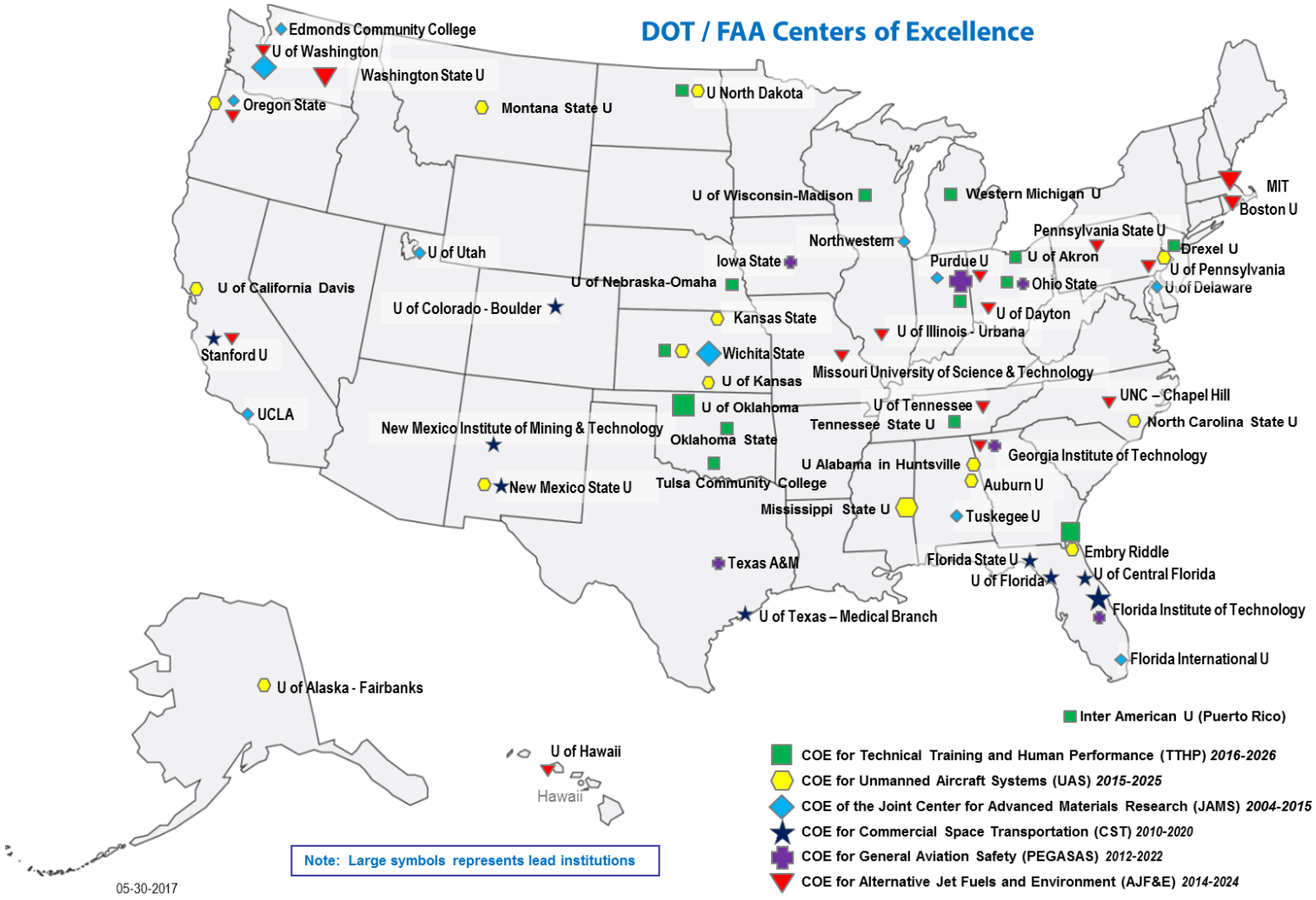
5 airports
4 airlines
7 NGO/advocacy
9 aviation manufacturers
11 feedstock/fuel manufacturers
22 R&D, service to aviation sector

*** Denotes USDA NIFA AFRI-CAP Leads and Participants & Sun Grant Schools**

For more information:
https://ascent.aero/

DOT/FAA Centers of Excellence

(ASCENT is one of 6 active COEs within FAA)



ASCENT COE - By the Numbers

- **Seeking Three New Research Projects (using FY2018 Funding)**
  Project 9: Noise Estimation Tool for New Entrants (GT)
  Project 44: Validation of Aircraft Noise Abatement Procedure Modeling (MIT)
  Project 47: Clean Sheet Supersonic Engine Design and Performance (MIT)
- **Annual Tech Report**
  - Available from https://ascent.aero/resources/

	Report 1	Report 2	Report 3
Time period	9/2013 – 9/2015	10/2015 – 9/2016	10/2016 – 9/2017
Research Projects	50	54	43
Publications, Reports, and Presentations	137	119	110
Students involved	131	112	105
Industry partners	63	70	72

ASCENT COE - Update

ASCENT Leadership

- Mike Wolcott of WSU - Director
- John Hansman of MIT - Co-Director
- Carol Sim of WSU - Assistant Director

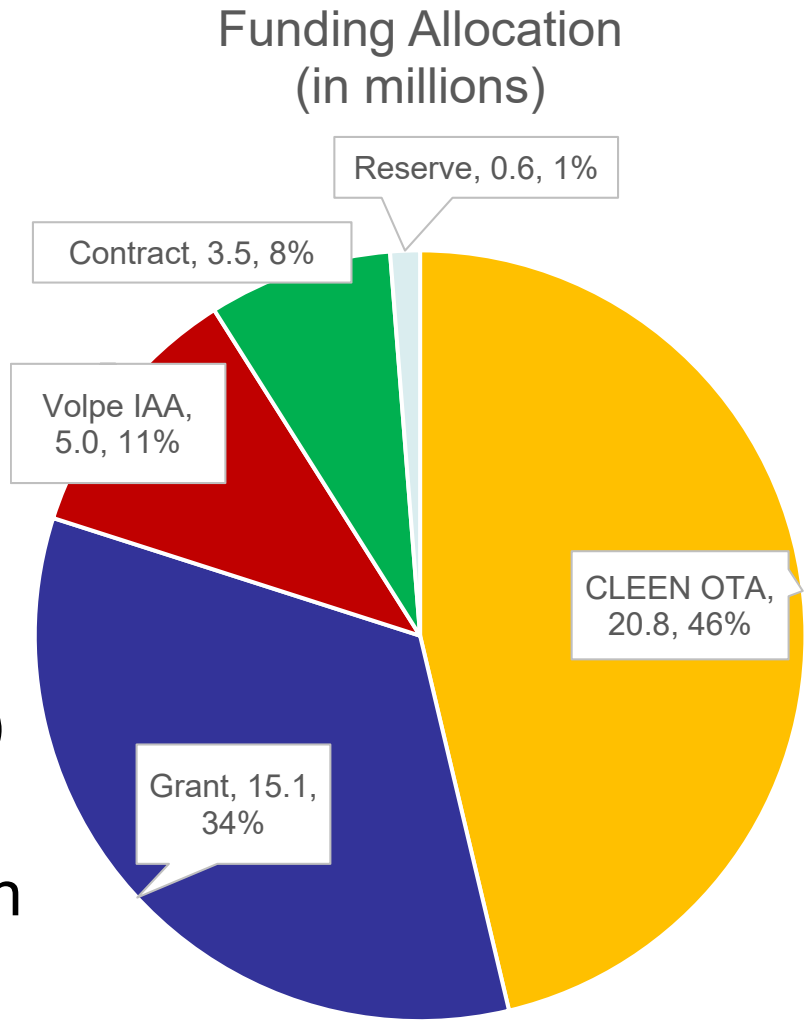
Working through new grant approval process – delayed in executing funds this year (have additional slides on this)

Meeting Update

- Autumn 2018 ASCENT Meeting – Oct 9-10, 2018 (Alexandria, VA)
  - Poster session will capture projects that are out of funds or will soon be out of funds
- 5 Year Symposium – have Briefings / Sessions at:
  - ACI-NA AAAE Noise Conference Oct, 2018 (Indianapolis, IN)
  - CAAFI Biennial General Meeting Dec 3-6, 2018 (Washington, DC)

FY18 Funding Allocation – by Mechanism

- Primarily use three funding mechanisms to conduct R&D
- Contracts
  - CLEEN
  - PEARS-II
  - SEMRS
- Grants
  - ASCENT COE
- Inter Agency Agreement (IAA)
  - Volpe Center
- Have had challenges with both Grants and IAA this year



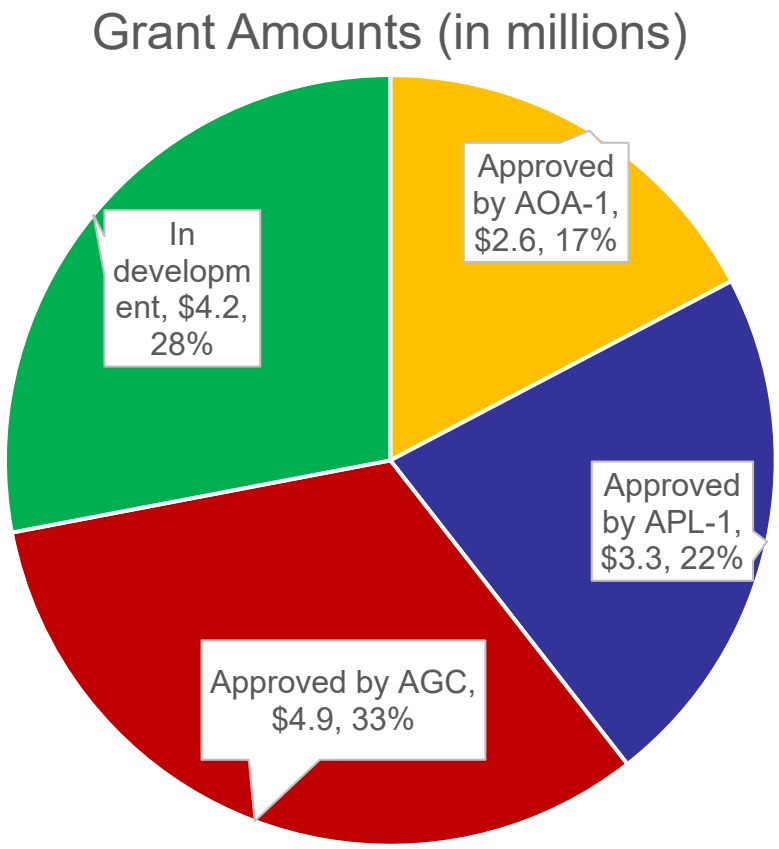
Grant Approval Process

- Grant approval process at FAA has undergone changes
- Putting new process in place, as well as additional steps, have resulted in a delay

- Grants currently working through new process:
  - 9 grants are being reviewed by OST
  - 14 additional grants are working through system to get to OST review
  - 15 additional grants have been approved by legal (AGC)
  - Will develop additional grants from FY18 funding

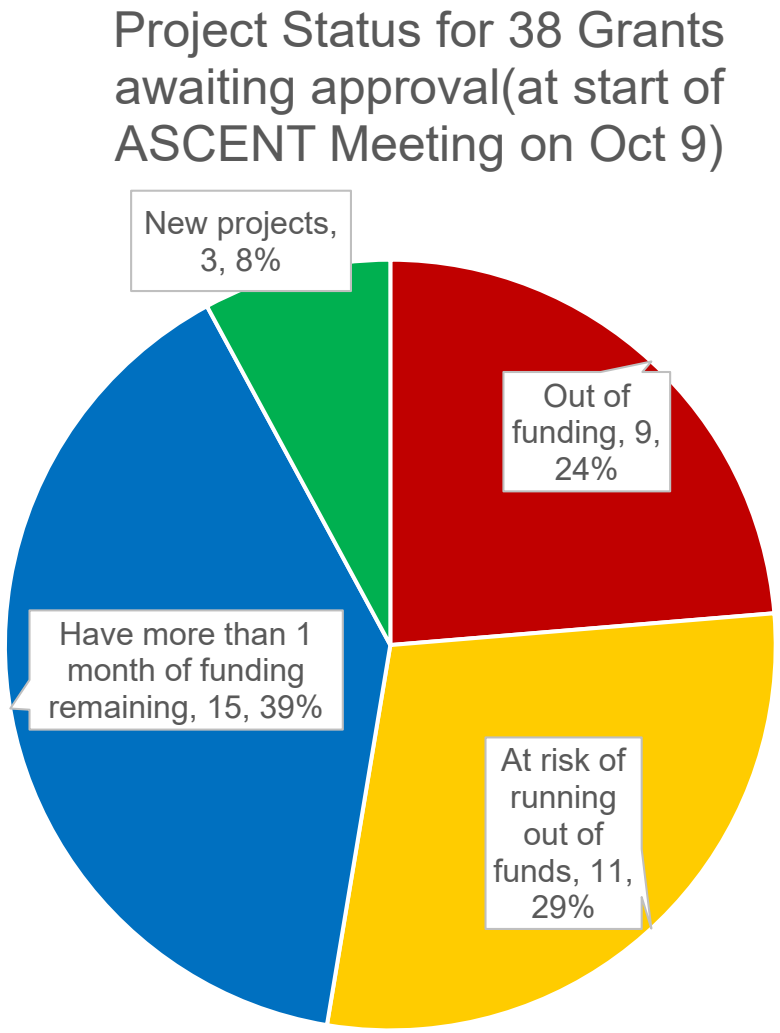
Grant Spending (from FY18 Appropriation)

- FY18 Appropriation has $15M requirement for spending in COE
- Normally have most (if not all) of the grant funds obligated in fiscal year funding is issued
- Due to delays from approval process, will not obligate all of the FY18 funds until midway through FY19



ASCENT Project Status

- Normally have most (if not all) of the grant funds obligated in fiscal year funding is issued
- Funding from one fiscal year is used to fund the next year's work (FY2018 funds pay for work during 2018-2019 academic yr)
- Approval delays resulting in ASCENT efforts being stopped



Additional Path for ASCENT Project Development

- Existing path for ASCENT Project Development
  - Project idea is developed by AEE
  - Idea is shared with ASCENT research community within a Notice of Funding Opportunity
  - Selected ASCENT researcher develops full proposal with AEE input
  - Seek approval of full proposal

- New path for ASCENT Project Development
  - Share an open solicitation with ASCENT research community for new project ideas that would result in innovative solutions to reduce noise, fuel burn, and emissions (short project statements)
  - Compile best ideas and review with senior leadership in FAA
  - Once approval is obtained, develop full proposals

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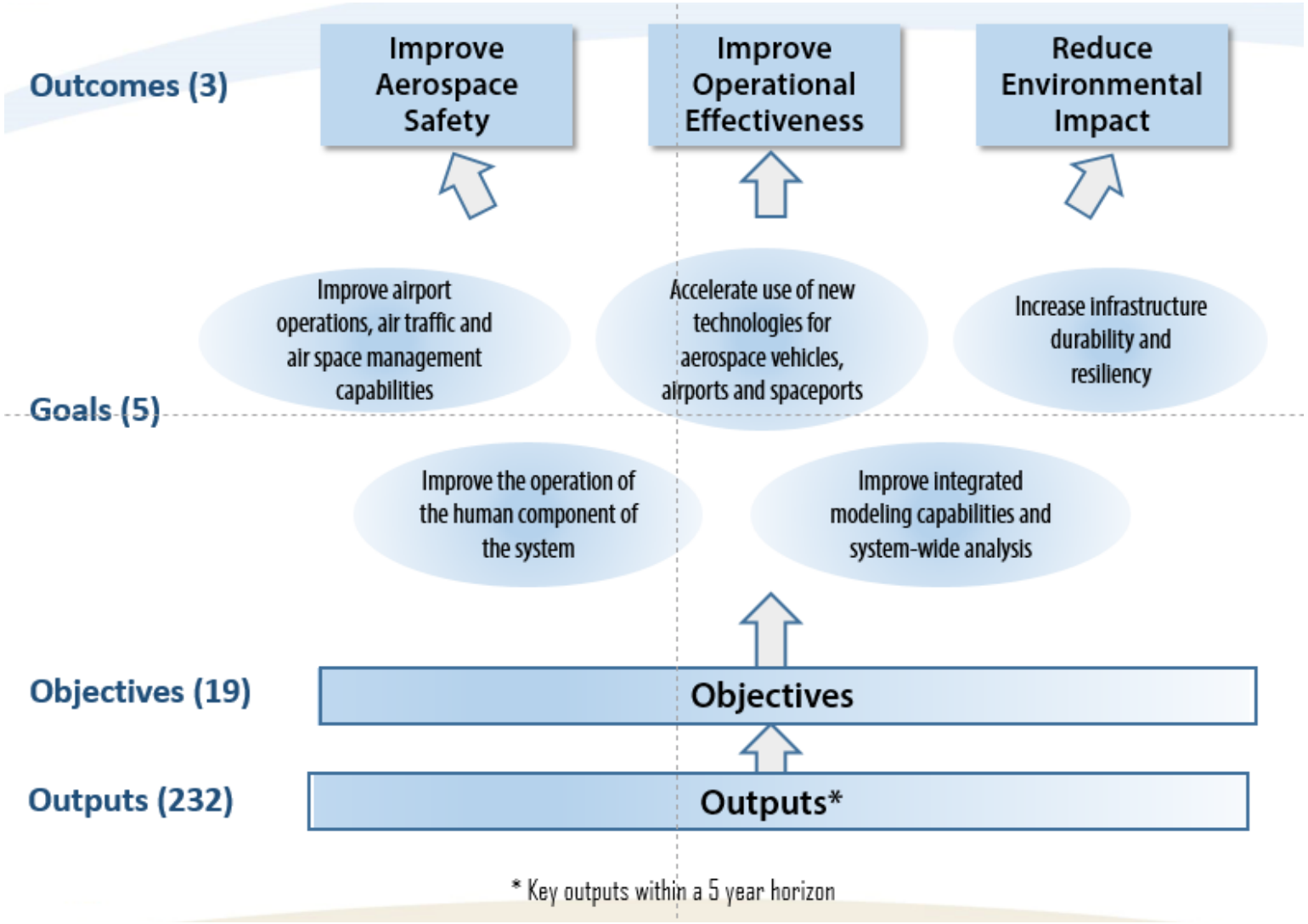
FAA National Aviation Research Plan (NARP)



Goal 1: Improve Airport Operations, Air Traffic, and Air Space Management Capabilities

Objective 1g: Noise and Emission

Identify and develop tools, methods, and procedures and/or requirements for the aerospace community to reduce the noise and emissions from aerospace vehicle operations.

Output	Collaborators	Long Term R&D	Fiscal Year						
			18	19	20	21	22	23	24
Report describing advanced operational procedural concepts that could reduce community noise exposure while maintaining safe flight operations and guidance for air space planners on how these concepts could be incorporated.	Industry, NASA, MITRE, ASCENT COE, Massport		X	X	X	X	X	X	X
Report on the operational feasibility of conducting steeper approaches in the NAS in order to reduce noise.	MITRE		X						
Develop updated correction factors for ASTM E966 (Standard Guide for Field Measurements of Airborne Sound Insulation of Building Facades and Facade Elements) that are more suitable for aircraft noise applications.			X						

For discussion purposes with REDAC E&E Subcommittee – subject to change

Goal 2: Accelerate use of new technologies for aerospace vehicles and airport/spaceports

Objective 2a: Applied Innovation

Identify and demonstrate new aerospace vehicle and airport/spaceport technologies that could be adopted by the aerospace community to improve safety, increase efficiency, and reduce environmental impacts.

Output	Collaborators	Long Term R&D	Fiscal Year						
			18	19	20	21	22	23	24
Report on Continuous Lower Energy, Emissions and Noise Phase II (CLEEN II) activities to demonstrate certifiable aircraft and engine technologies and to enable industry to expedite introduction of these technologies into current and future aircraft.	Industry, NASA, DOD		X	X	X				
Report on Continuous Lower Energy, Emissions and Noise Phase III (CLEEN III) activities to demonstrate certifiable aircraft and engine technologies to expedite introduction of these technologies into current and future aircraft.	Industry, NASA, DOD	YES			X	X	X	X	X
Assessment report on the environmental benefits of the Continuous Lower Energy Emissions and Noise Phase II airframe and engine technologies (CLEEN II).	Industry, NASA, DOD, ASCENT COE				X				

For discussion purposes with REDAC E&E Subcommittee – subject to change

Goal 2: Accelerate use of new technologies for aerospace vehicles and airport/spaceports

Objective 2c: Alternative Fuels

Identify and evaluate alternative fuels that provide equivalent safety and improved performance relative to conventional fuels.

Output	Collaborators	Long Term R&D	Fiscal Year						
			18	19	20	21	22	23	24
Research report with potential means to streamline the American Society for Testing and Materials (ASTM) international approval process for alternative jet fuels.	Industry, USG, int'l stakeholders, ASCENT COE		X						
Research report that examines whether changing the composition of conventional jet fuels is cost beneficial in regards to environmental impacts, health effects, capital costs, and operator costs.	Industry, NASA, DOD, int'l stakeholders, ASCENT COE		X						
Research report with lifecycle greenhouse gas emissions values for alternative jet fuels for use by the International Civil Aviation Organization (ICAO) Committee on Aviation Environmental Protection (CAEP).Technical analyses will be conducted on the use of alternative jet fuels from feedstock production, transportation, fuel production, and combustion in the engine.	Industry, USG, int'l stakeholders, ASCENT COE		X						
Data collection and research reports for the approval of at least one alternative jet fuel type per year by ASTM International.	Industry, USG, int'l stakeholders, ASCENT COE	YES	X						

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Goal 2: Accelerate use of new technologies for aerospace vehicles and airport/spaceports

Objective 2d: Data Analysis

Provide data and analyses to decision-makers to inform development of guidance, standards, and policy measures.

Output	Collaborators	Long Term R&D	Fiscal Year						
			18	19	20	21	22	23	24
Reports that summarize experimental data that was acquired, and analyses that were performed, to inform the development of an engine particulate matter (PM) emissions standard in the International Civil Aviation Organization (ICAO) Committee on Aviation Environmental Protection (CAEP).	Industry, USG, int'l stakeholders, ASCENT COE		X	X					
Reports that summarize analyses that were performed to inform the development of the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) within ICAO CAEP.	Industry, USG, int'l stakeholders		X	X					
Reports that summarize data and analyses that are used to inform the development of new noise and emissions standards in ICAO CAEP.	Industry, USG, int'l stakeholders				X	X	X	X	X

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Goal 5: Improve integrated modeling capabilities and system-wide analysis

Objective 5a: Aerospace System

Identify and develop a sufficient scientific understanding of aerospace systems to enable the aerospace community's development of solutions to enhance safety, improve efficiency, and reduce environmental impacts.

Output	Collaborators	Mid-Term R&D	Fiscal Year						
			18	19	20	21	22	23	24
Conduct a national sleep study to collect nationally representative data on the relationship between aircraft noise exposure and residential sleep disturbance	Univ. of Pennsylvania, HMMH	YES	X				X		
Report on the reassessment of current metrics relative to community exposure to aircraft noise using the most recent annoyance information collected at U.S. airports.	USG		X	X	X				
Reports summarizing research on technologies to reduce supersonic aircraft noise, the public reaction to advanced supersonic aircraft noise, and procedures needed to certify aircraft noise to create the body of knowledge to support the development of en-route noise standards for airplanes that exceed Mach 1.	Industry, USG, int'l stakeholders, ASCENT COE		X	X	X	X	X	X	X
Report on the analysis findings from the National Civil Airport Aircraft Noise Annoyance Survey telephone data.				X					

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Goal 5: Improve integrated modeling capabilities and system-wide analysis

Objective 5c: System Performance

Identify and develop tools, methods, studies, reports, and assessments for use by the aerospace community that evaluate, in an integrated manner, the system-wide performance, and impacts of new and existing aerospace vehicles, air traffic concepts, and airport/spaceport operations.

Output	Collaborators	Long Term (>10 yrs)	Fiscal Year						
			18	19	20	21	22	23	24
Aviation Environmental Design Tool (AEDT) Version 3 with improved aircraft performance modeling capabilities including noise, emissions, and fuel burn estimation methodologies.	Industry, USG, int'l stakeholders, ASCENT COE		X						
Advanced emissions modeling capabilities that leverage the latest national and international research.	ASCENT COE		X						
Improved analytical capabilities of aviation environmental analysis tools by expanding the computational models for aircraft performance, noise and emissions source generation processes, and noise and emissions propagation processes.	Industry, USG, int'l stakeholders, ASCENT COE				X	X	X	X	X
Quantitative analyses through modeling of the change in fuel use and emissions that could result from changes in aircraft technology, operational procedures and alternative fuel use.	Industry, USG, ASCENT COE		X			X			X

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Environment & Energy Portfolio
(Work items within Enacted FY17 and FY18 Budget)

Core RE&D (A13.a) Environment & Energy

- Improve scientific understanding of environment & energy constraints
- Incorporate scientific knowledge into an integrated analytical tool suite
- Analyze mitigation options for reducing environmental impacts including policy measures and environmental standards

NextGen RE&D (A13.b) Environmental Research

- Accelerate maturation of airframe and engine technologies
- Advance sustainable alternative jet fuels (zeroed out in FY19 President's budget)

Airport Technology Research (ATR)

ATR Overview:

- Three Research Programs Areas (RPA): Airport Safety, Pavement and Airport Environment
- All three RPAs presented to Airports Subcommittee

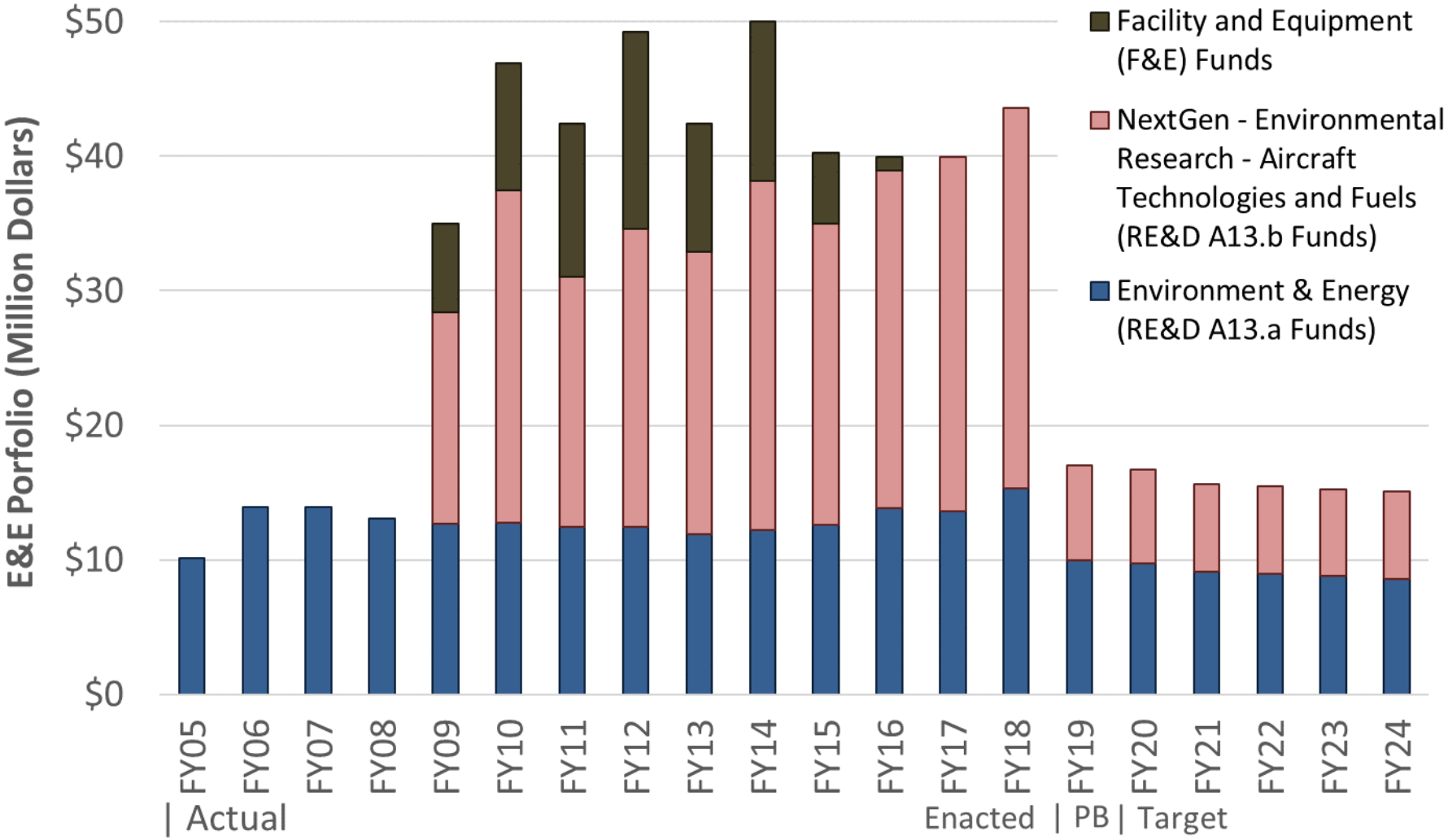
Environmental Efforts within ATR:

- Airport noise research started in FY12
- Expanded to cover broader environmental research in FY16

Collaborative effort among Tech Center, Office of Airports, and Office of Environment and Energy

Select projects are covered in noise and operations briefings

Twenty Year Funding Profile
E&E Portfolio (Contract Funding)



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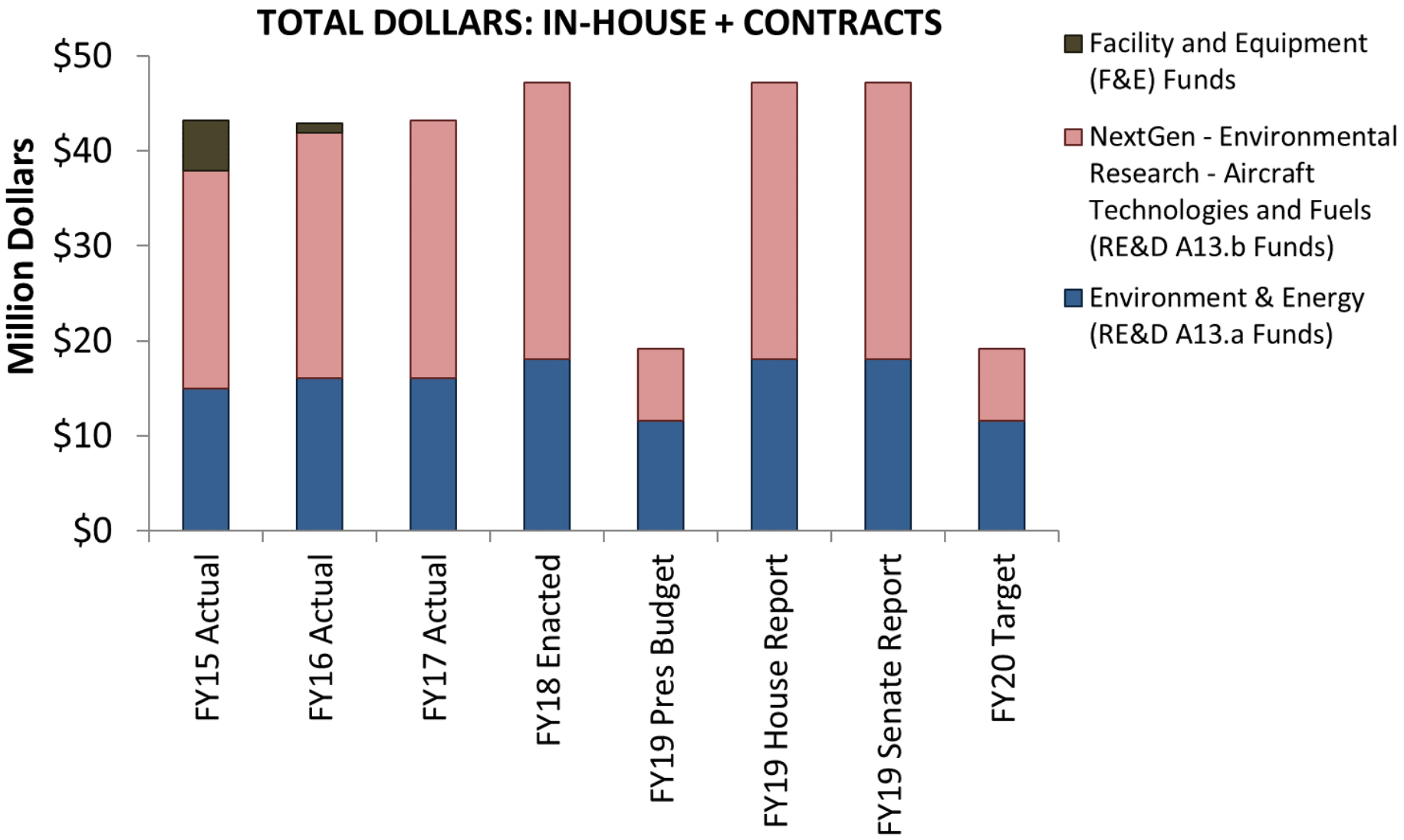
Airport Technology Research has ~$1.5M/year for noise/environment projects
Airports Cooperative Research Program (ACRP) provides ~$5M/year for environment projects

FY15-20 Funding Profile for E&E Portfolio



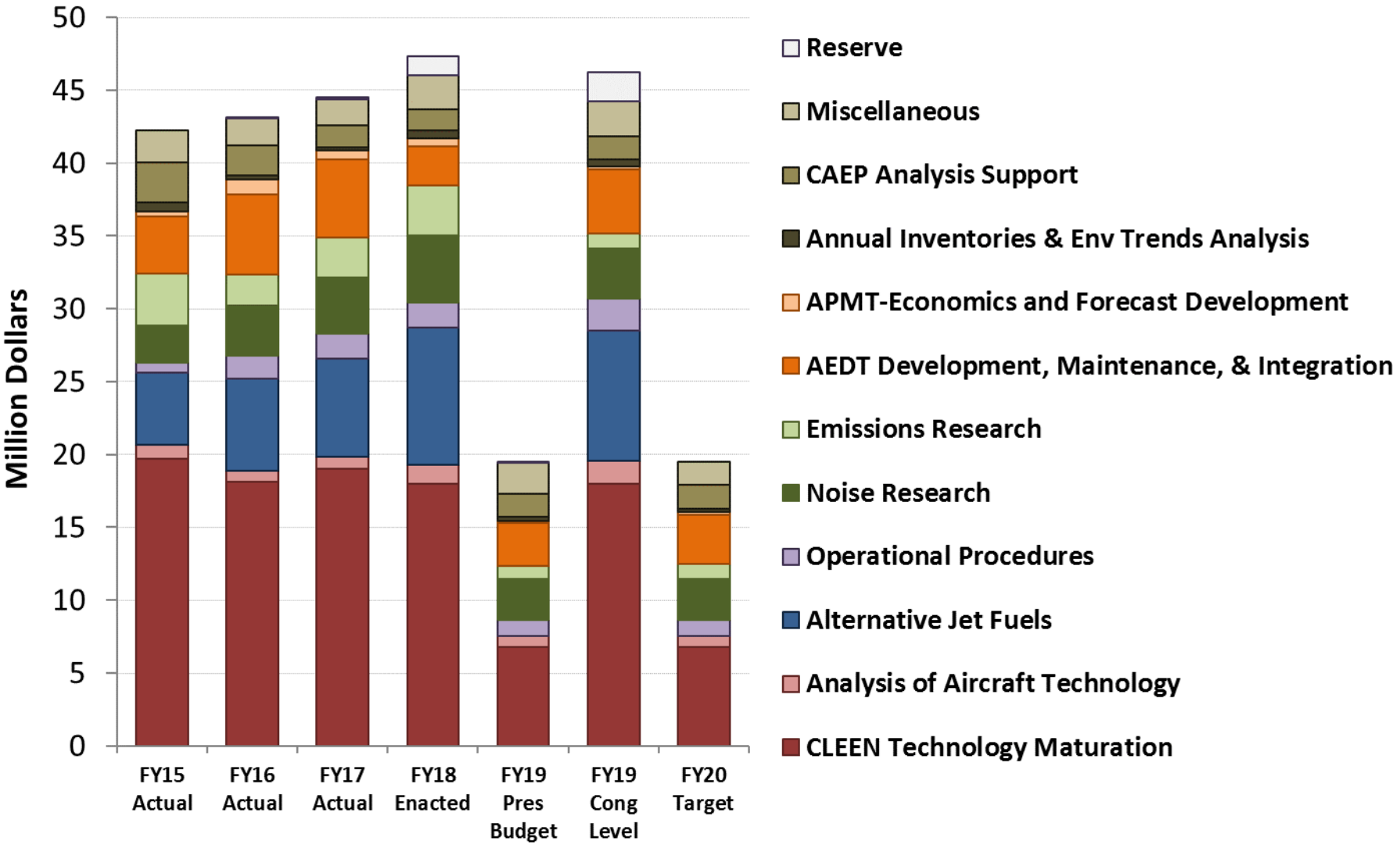
Not shown on graph:

Airport Technology Research has ~$1.5M/year for noise/environment projects

Airports Cooperative Research Program (ACRP) provides ~$5M/year for environment projects

Environment and Energy Funding

Includes: RE&D, F&E, ATR, Operations, and non-FAA funds (e.g., other US Government and Transport Canada)



E&E Program: FY19 and Beyond (relative to FY18)

Planning is a challenge

With FY19 Pres Budget, Work would be Slowed on the Following

- Funding for Phase 3 of CLEEN Program (2020-2025) will be one-fourth that of Phase 1 of CLEEN Program (2010-2015)
- Noise enhancements for analytical tools to support design of reduced noise operational procedure concepts
- Screening tool development to streamline environmental approval process
- Environmental analysis to support new entrants (e.g., supersonic aircraft, unmanned aerial systems, and commercial space vehicles)
- Quantifying aviation contributions to ambient PM emissions in communities

With FY19 Pres Budget, Work will be Stopped on the Following

- All work will be stopped on Alternative Jet Fuel Development
- Development of analytical tools for evaluating impacts of emissions on air quality and climate change
- Operational procedure development for lower noise helicopter operations

Outline

- AEE Research
  - AEE in context
  - Mission, vision and five pillar approach
  - Current research direction
- CLEEN Update
- ASCENT COE Update
- NARP Update
- Budget Update
- **Recent Successes**
- **Questions for Tomorrow**

Recent Successes

capabilities and solutions that are helping today

- Noise impacts work is starting to deliver results. Community noise survey nearing completion. Published report on pilot phase of aircraft noise sleep impacts study. Starting work on national sleep study.
- Provided critical analytical support to development of Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA).
- Alternative fuels scenarios adopted by ICAO CAEP for future trends assessment and research efforts instrumental for alternative fuel inclusion within CORSIA.
- Measurement technique and data providing foundation for ICAO CAEP PM standard.
- Integrated tool suite and analyses provided the scientific data used to support the decision making for the ICAO CAEP CO_2 standard.
- CLEEN aircraft and engine technologies appearing in next generation of aircraft with FMS technologies retrofitted into today's fleet - reduces noise, emissions and fuel use for many years to come.
- Certification of five alternative jet fuel pathways – certification enabled multiple airlines to buy and use biofuels in LAX and elsewhere.
- Aviation Environmental Design Tool (AEDT) being used extensively.
- Analytical framework was used to develop operational procedure concepts for Boston Logan that could provide noise reduction. Work is continuing to develop additional concepts and evaluate potential for broader use.

Outreach Materials

- Environment and Energy Tri-Fold
- FAA Environment and Energy Website (faa.gov/go/environment)
- Noise Website (faa.gov/go/aviationnoise)
- CLEEN Website (faa.gov/go/cleen)
- ASCENT Website (ascent.aero)
- CAAFI Website (caafi.org)

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?

Backup Slides

Online Materials

FAA Environment and Energy

- http://www.faa.gov/go/environment

Center of Excellence (COE) Program

- University research on alt jet fuels and environment
- http://ascent.aero and http://partner.aero

Continuous Lower Energy, Emissions and Noise (CLEEN)

- Reduce aircraft fuel burn, emissions and noise through technology & advance alternative jet fuels
- http://www.faa.gov/go/cleen

Commercial Aviation Alternative Fuels Initiative (CAAFI)

- Coalition that focuses the efforts of commercial aviation to engage the emerging alternative fuels industry
- http://caafi.org

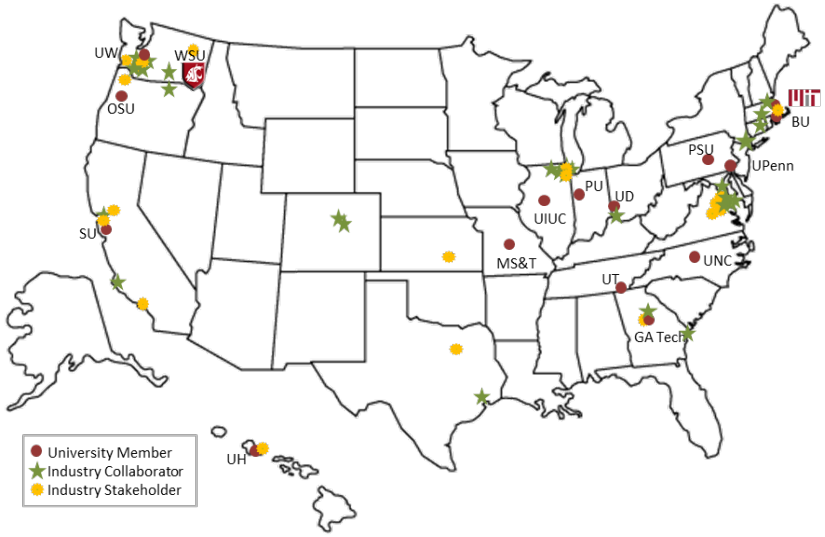
ASCENT COE Update – Funding Summary

University	Funding
Georgia Institute of Technology	$ 6,300,000
Massachusetts Institute of Technology	$ 5,900,000
Missouri Univ. of Science and Technology	$ 5,300,000
University of Dayton	$ 4,000,000
Pennsylvania State Univ. (Penn State)	$ 3,500,000
Washington State University	$ 3,400,000
Purdue University	$ 2,900,000
Stanford University	$ 2,100,000
Boston University	$ 1,700,000
University of Illinois	$ 1,500,000
University of North Carolina	$ 1,300,000
University of Pennsylvania	$ 900,000
University of Tennessee	$ 600,000
Oregon State University	$ 300,000
University of Hawaii	$ 300,000
University of Washington	$ 100,000
Total	***$ 40,200,000***

Note: totals as of February 2018

Funding levels provided to ASCENT universities since September 2013

(does not include cost share generated by universities)



Geographical Distribution of ASCENT

Noise Technology Workshops

- FAA working with Institute of Noise Control Engineering, National Academy of Engineering, NASA and Volpe Center
- May 8-9, 2017 Workshop (Hosted by National Academies)
  Technology for a Quieter America: Commercial Aviation, A New Era
- Final report: https://inceusa.org/publications/technology-for-a-quieter-america/
- Workshop / report themes:
  - Importance of commercial aviation to U.S. economy.
  - What it will take for U.S. to maintain global leadership in aviation.
  - Specific, forward-looking topic on more environmentally friendly aircraft designs.
- Workshop / report focus:
  - Required step-changes in aircraft engineering technology will need flight demonstrations, significantly increased funding, and public-private partnerships.
  - Changes are needed for continued U.S. global leadership and positive trade balance.
  - Aviation technology investments in Europe and China now significantly exceed those in U.S.
- Dec 13-14, 2018 Workshop (Hosted by National Academies)
  UAS and UAV (Drone): Noise Emissions and Noise Control Engineering Technology