



Federal Aviation
Administration

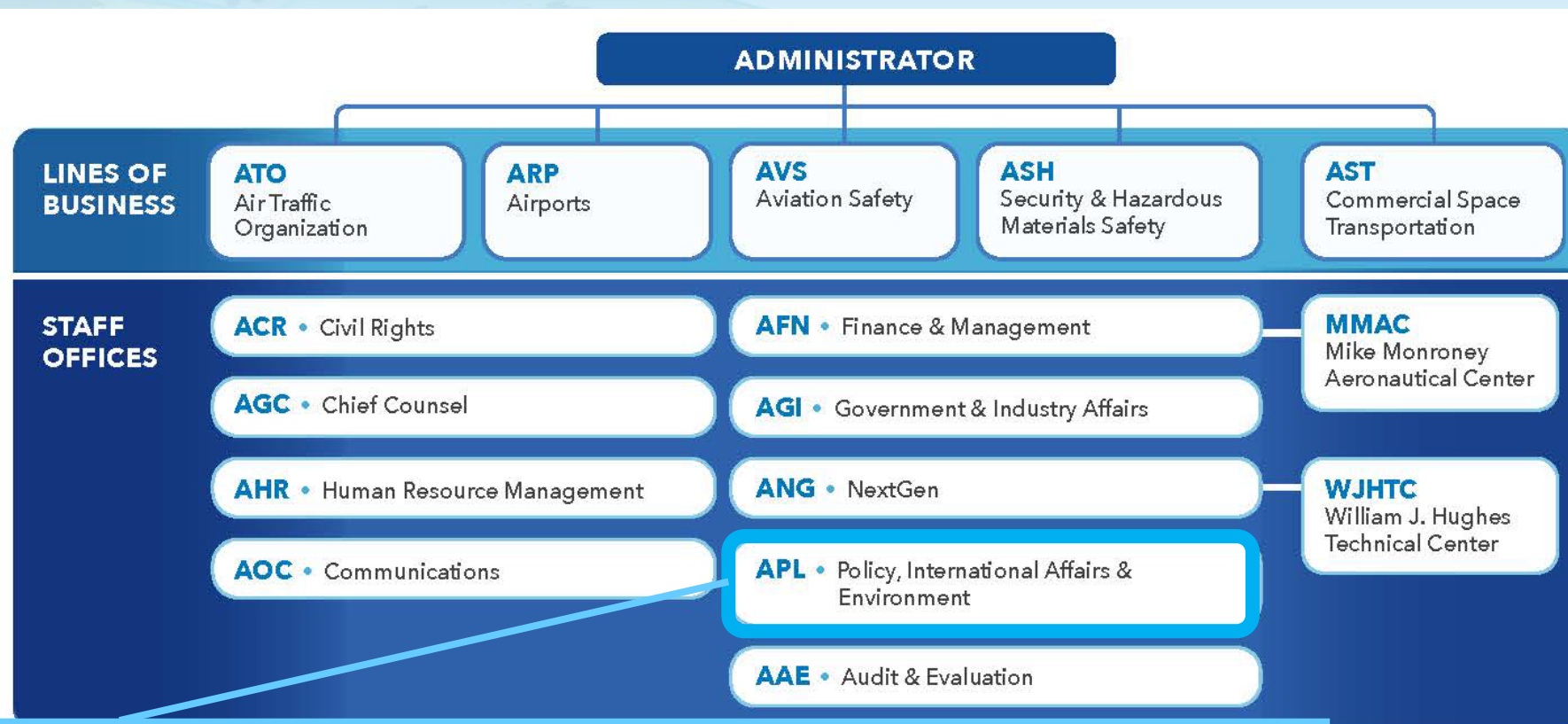
Fueling Aviation's Sustainable Transition – U.S. Policies and Actions to Decarbonize the Aviation Sector

Presented by: **Prem Lobo**

Presented to: **8th International Workshop on Aviation and Climate Change,
Toronto, ON, Canada**

Date: **June 2, 2023**

FAA Office of Environment and Energy (AEE)

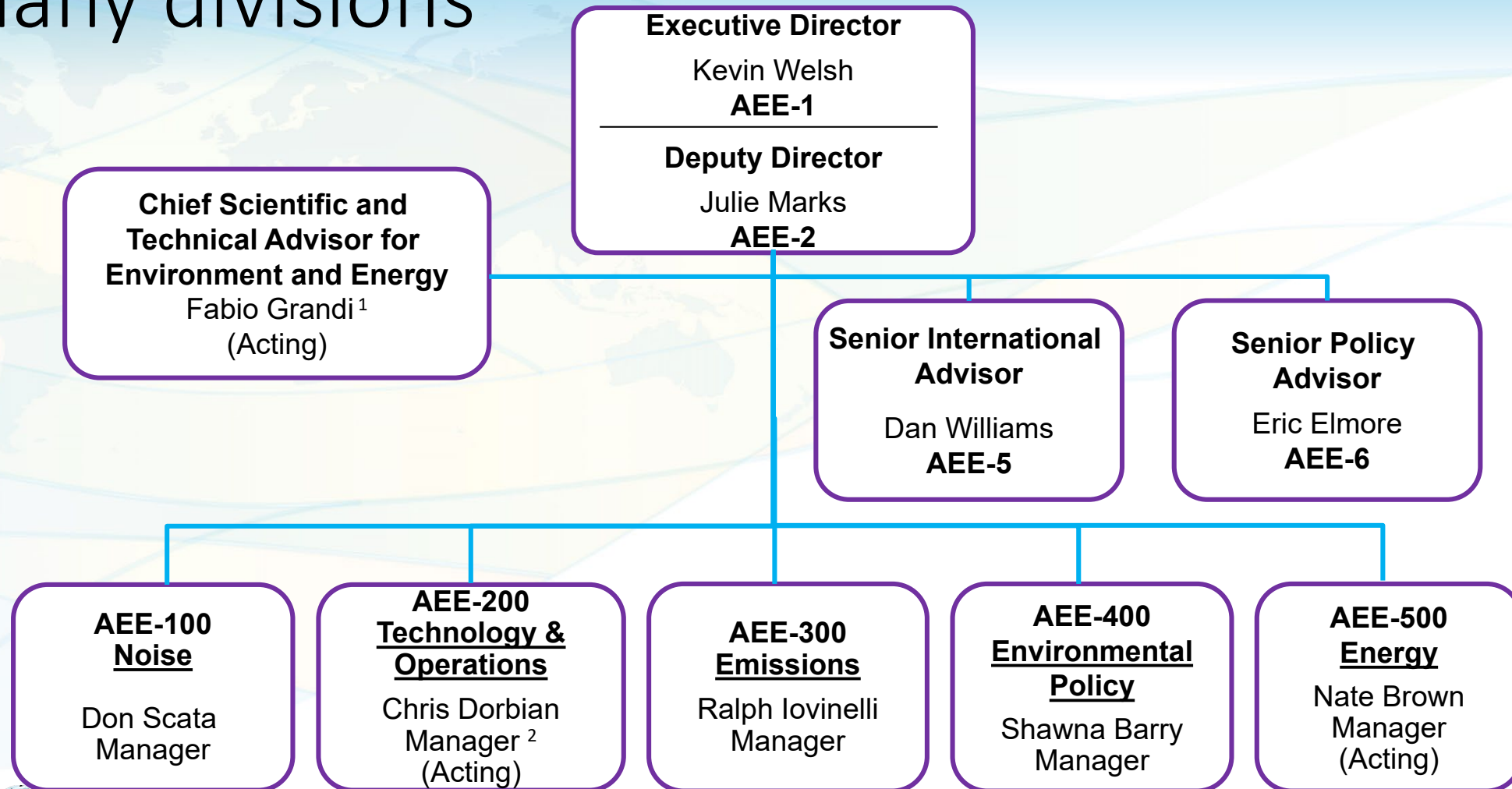


Office of Environment and Energy (AEE)

- Office within APL, responsible for broad range of environmental policies
- About 45 staff members (*in process of expanding*)
- Responsible for roughly 1/3 of FAA RE&D Budget and IRA Programs



AEE supports sustainable aviation across our many divisions



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

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

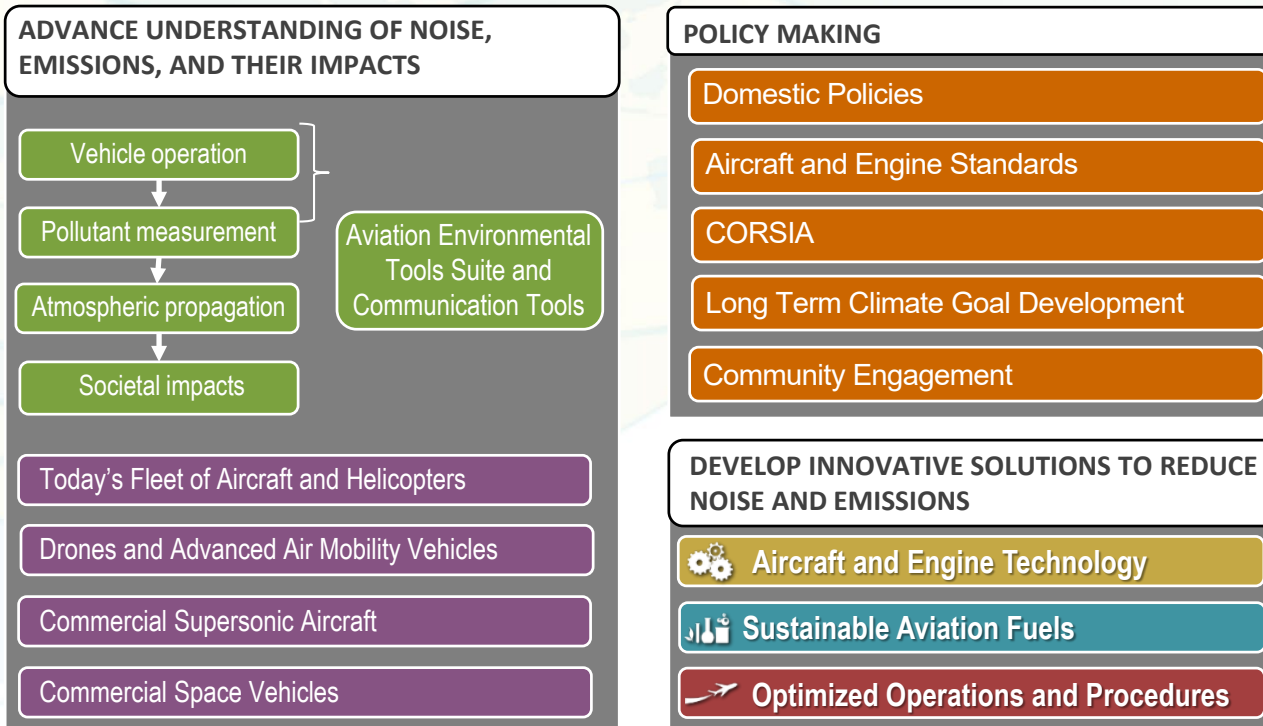


AEE mission and vision

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

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

E&E Program:



www.faa.gov/go/clean/



www.volpe.dot.gov



U.S. Aviation Climate Action Plan

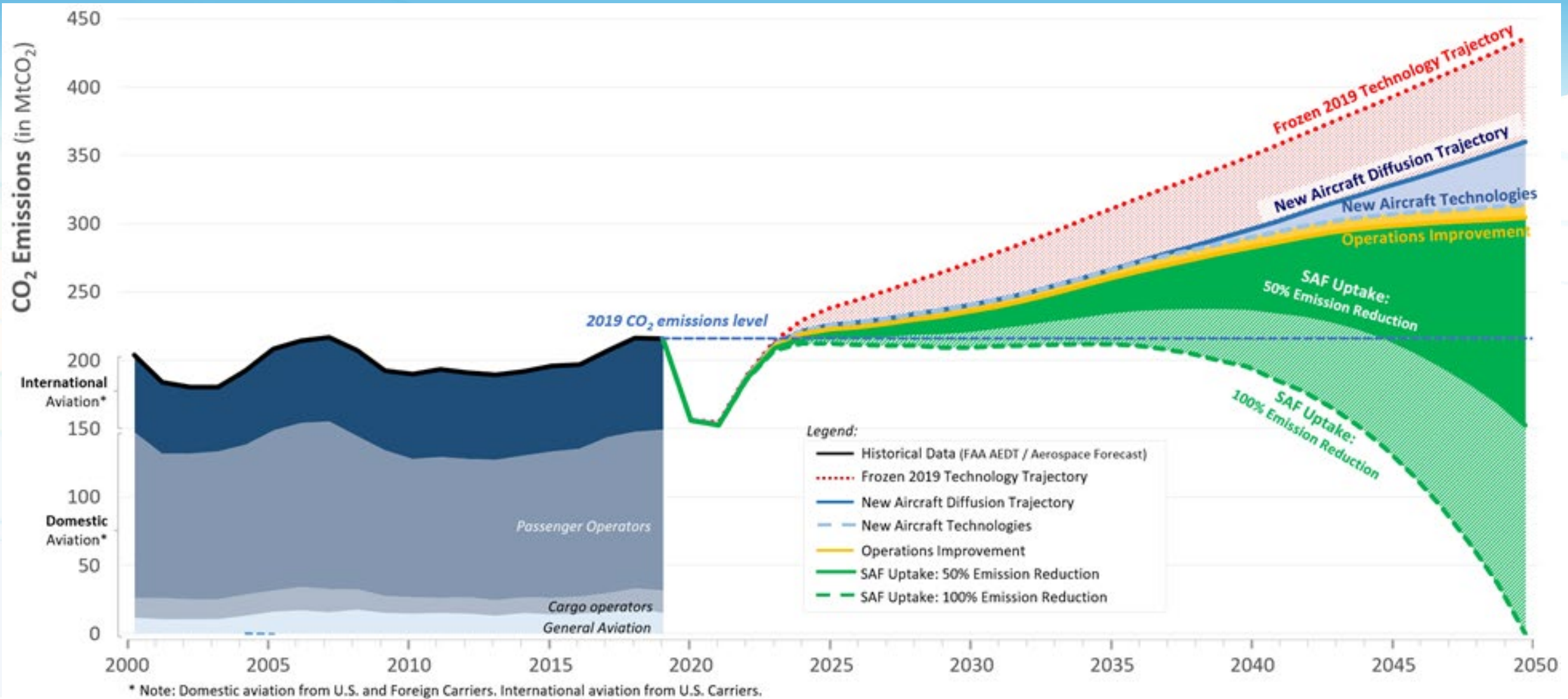
State Action Plan submission to International Civil Aviation Organization (ICAO)

- On November 9, 2021, Secretary of Transportation Pete Buttigieg announced the *United States Aviation Climate Action Plan*, which describes a whole-of-government approach to put the aviation sector on a path toward achieving net-zero emissions by 2050.
- The plan builds on individual and sector-wide commitments announced by the U.S. aviation industry, and highlights specific actions and policy measures to foster innovation and drive change across the entire U.S. aviation sector.
- Climate Action Plan Press Release:
<https://www.faa.gov/newsroom/us-releases-first-ever-comprehensive-aviation-climate-action-plan-achieve-net-zero>
- Climate Action Plan Document:
https://www.faa.gov/sites/faa.gov/files/2021-11/Aviation_Climate_Action_Plan.pdf



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Aviation CO₂ 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



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Continuous Lower Energy, Emissions & Noise (CLEEN) Program

- FAA led public-private partnership with 100% 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	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



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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
- 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



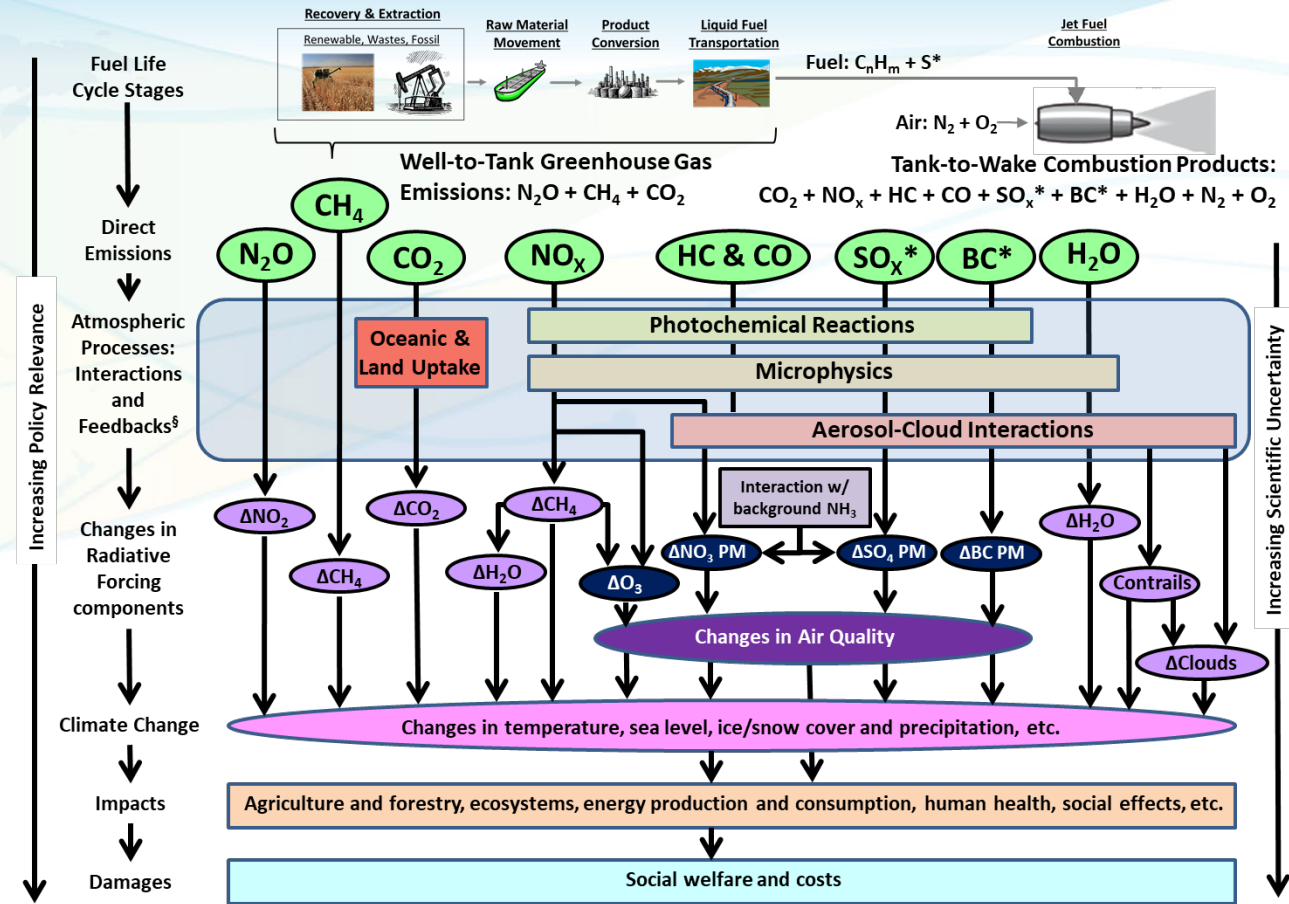
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Non-CO₂ Impacts of Aviation on Climate

Aircraft combustion emissions also have non-CO₂ impacts on the climate. Primary concern is the impact of aviation induced cloudiness.

Summary of Actions

- Improve the scientific understanding of the impacts of non-CO₂ aircraft emissions to enable the development of cost-beneficial solutions to address both air quality and climate impacts.
- Develop decision support tools that could be used by industry to cost-effectively mitigate the overall climate impacts of aviation via contrail mitigation.



⁵Account for radiative, chemical, microphysical and dynamical couplings along with dependence on changing climatic conditions and background atmosphere

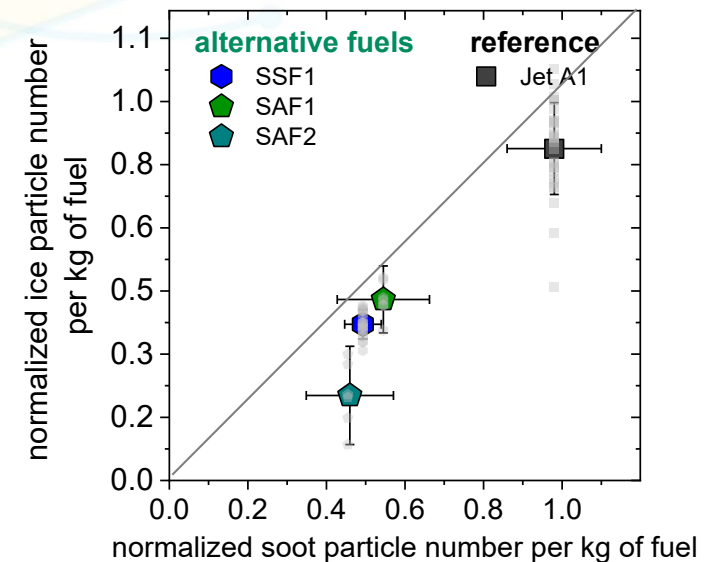
*Sustainable aviation fuels can be produced with zero sulfur related emissions and reduced black carbon emissions

Modified from Brassuer et al 2016



In-Flight Measurements

- FAA, NASA, NRC-Canada, and DLR have been collaborating with industry to conduct measurements from SAF use
 - Ground and in flight measurements
- Focus of measurements has been to understand how fuel aromatic content and fuel sulfur content can be modified to change contrail properties

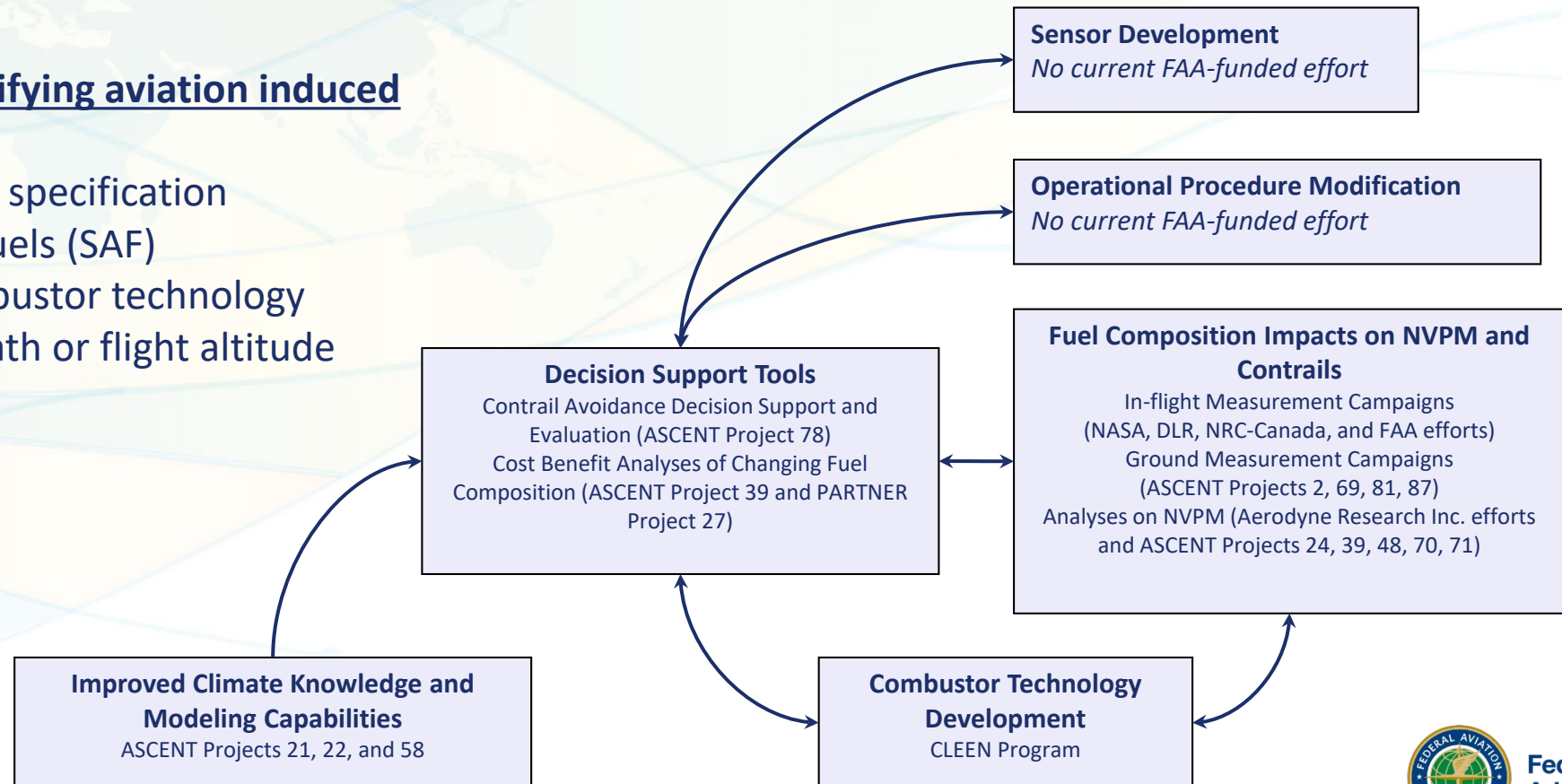


FAA Efforts on Aviation Induced Cloudiness (AIC)

FAA supporting research on multiple fronts to examine measures that *could* mitigate aviation's impact on climate change through modification to contrails and aviation induced cloudiness

Potential means of modifying aviation induced cloudiness

- Modify current jet fuel specification
- Sustainable Aviation Fuels (SAF)
- New engines and combustor technology
- Change lateral flight path or flight altitude



SAF Program Focus



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



Sustainable Aviation Fuel
Grand Challenge



Coordination

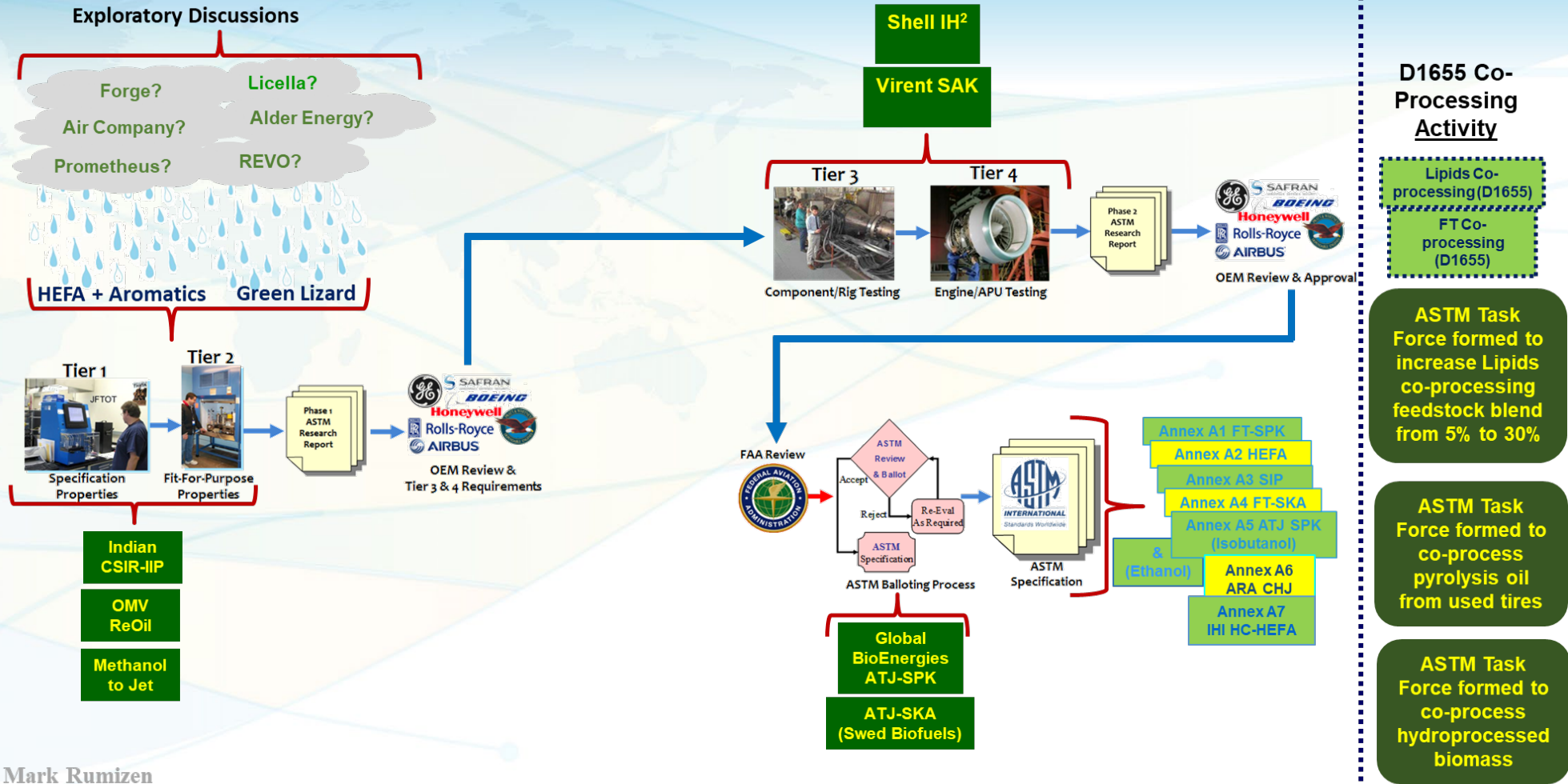
support SAF integration

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



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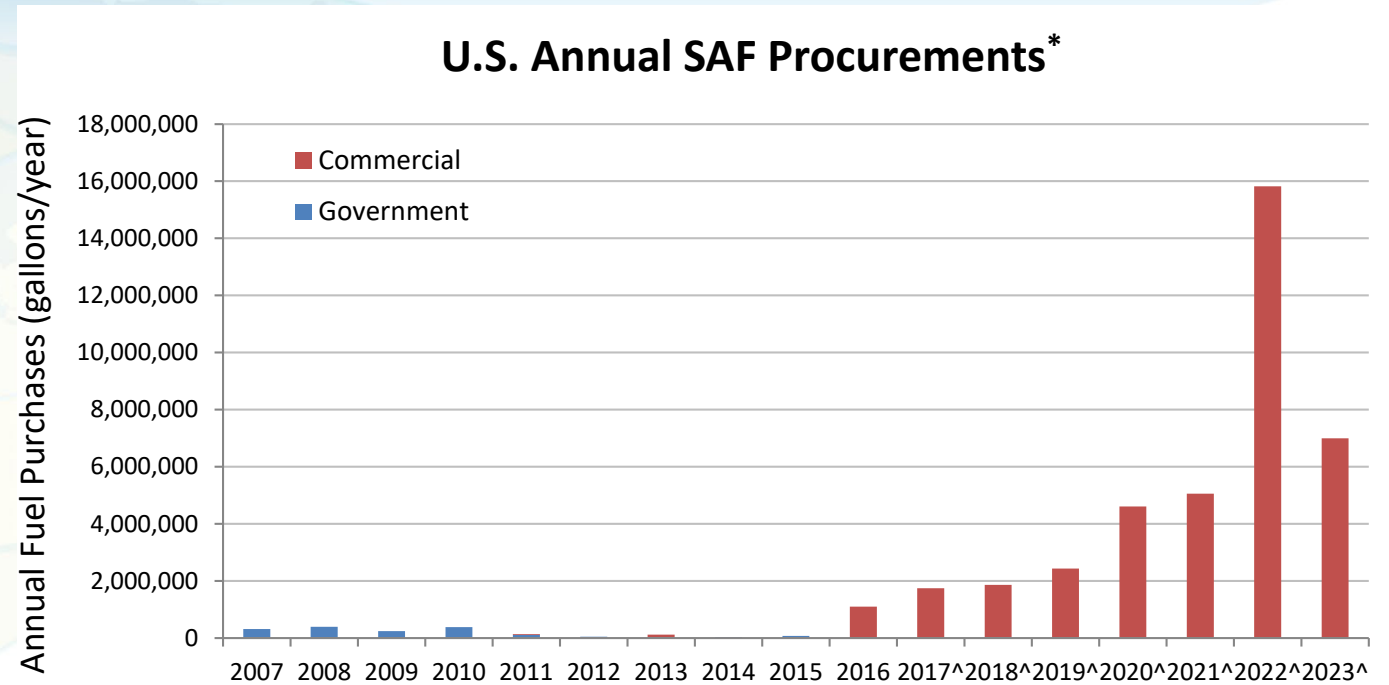
ASTM D4054 Alternative Jet Fuel Qualification Status



Mark Rumizen
May 18, 2023

U.S. SAF Commercialization

- Procurements continue to expand but scale is still small
- 15.8M gallons procured in 2022
- Expansion goals for many companies announced
- New SAF Tax credit takes effect Jan 1, 2023



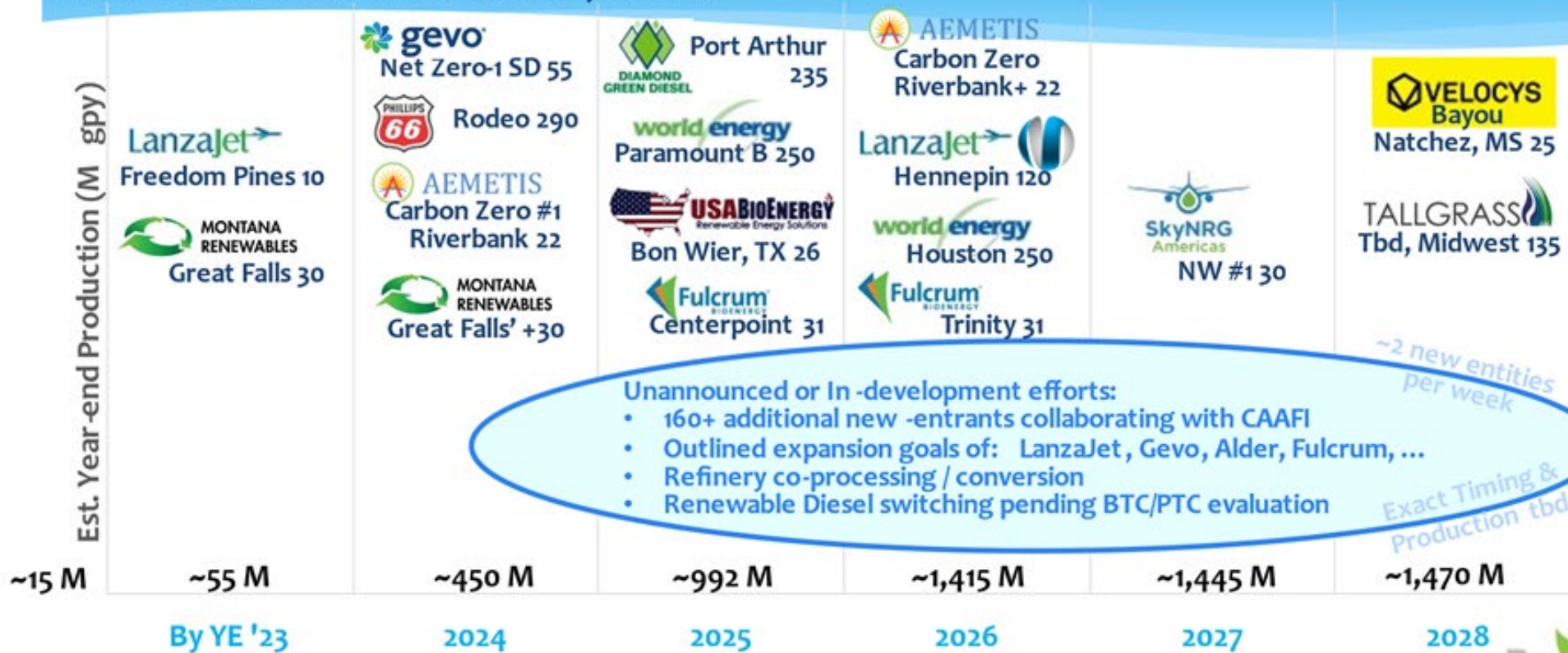
*Reflects voluntarily reported data on use by U.S. airlines, U.S. government, manufacturers, other fuel users, and foreign carriers uplifting at U.S. airports.

^ 2017-2023 calculation incorporates data reported by EPA for RFS2 RINs for renewable jet fuel.



U.S. SAF production forecast

Announced intentions, neat*



Unannounced or In-development efforts:

- 160+ additional new entrants collaborating with CAAFI
- Outlined expansion goals of: LanzaJet, Gevo, Alder, Fulcrum, ...
- Refinery co-processing / conversion
- Renewable Diesel switching pending BTC/PTC evaluation

- Not comprehensive; CAAFI estimates (based on technology used & public reports) where production slates are not specified. Does not include various small batches produced for testing technology and markets.
- Does not include fractions of substantial Renewable Diesel capacity (existing and in development) that can be shunted to SAF based on policy support

1 March 2023



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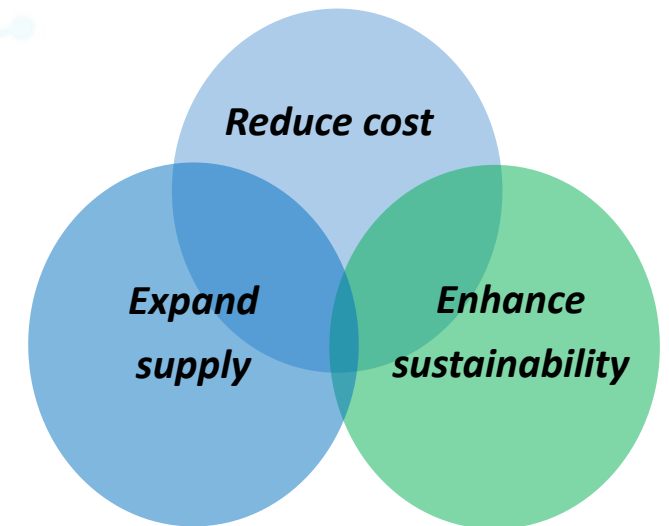
U.S. SAF Grand Challenge

- Agreement by the U.S. Departments of Transportation, Energy, and Agriculture to lead a whole of government approach
- 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
- Multi-agency roadmap to focus federal actions to support industry scale-up

MEMORANDUM OF UNDERSTANDING
SUSTAINABLE AVIATION FUEL GRAND CHALLENGE

Among the
THE U.S. DEPARTMENT OF ENERGY,
THE U.S. DEPARTMENT OF TRANSPORTATION and the
THE U.S. DEPARTMENT OF AGRICULTURE

September 9, 2021



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



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U.S. SAF Grand Challenge Roadmap Structure



- 26 Workstreams
- 139 Activities
- 2030 & 2030-2050 impact timeframes



SAF Grand Challenge Implementation – Next Steps

Sustainable Aviation Fuel Grand Challenge



Inaugurated on Sept. 9, 2021, the Sustainable Aviation Fuel Grand Challenge is the result of the U.S. Department of Energy (DOE), the U.S. Department of Transportation (DOT), the U.S. Department of Agriculture (USDA), and other federal government agencies working together to develop a comprehensive strategy for scaling up new technologies to produce sustainable aviation fuels (SAF) on a commercial scale.

The SAF Grand Challenge will guide federal actions to support industry to reduce the cost, enhance the sustainability, and expand the production and use of SAF to:

- Produce 3 billion gallons per year of domestic SAF production that achieve a minimum of a 50% reduction in life cycle greenhouse gas emissions compared to conventional fuel by 2030.
- Meet a goal of supplying 100% of projected domestic aviation jet fuel use, or 35 billion gallons of annual production, by 2050.

SAF Grand Challenge Roadmap

To achieve the SAF Grand Challenge 2030 and 2050 goals, the interagency team worked with other government agencies; stakeholders from national labs, universities, non-governmental organizations; and the aviation, agricultural, and energy industries to develop the [SAF Grand Challenge Roadmap: Flight Plan for Sustainable Aviation Fuel](#).

SAF Grand Challenge Partners

Successful implementation of the SAF Grand Challenge will require close collaboration of agencies across the federal government—particularly DOE, USDA, DOT and its



SAF Grand Challenge Roadmap

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The SAF Grand Challenge Roadmap overview figure depicts how the six action areas address barriers across the entire supply chain from innovations in feedstock supply through end use. Within each of the six action areas are workstreams that define critical topics to be addressed.



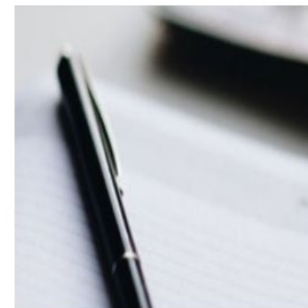
[Feedstock Innovation](#)



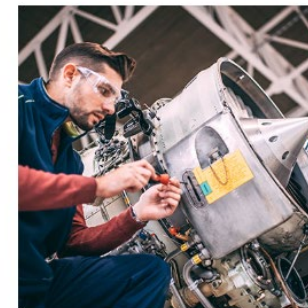
[Conversion Technology Innovation](#)



[Building Supply Chains](#)



[Policy and Valuation Analysis](#)



[Enabling End Use](#)



[Communicating Progress and Building Support](#)



<https://biomassboard.gov/sustainable-aviation-fuel-grand-challenge>



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Inflation Reduction Act (IRA) – Production support through 2027

IRA Tax Credits

SAF Tax Credit

§13203 : 2023-2024

- Achieves 50% lifecycle GHG reduction
- \$1.25 per gallon up to \$1.75 for additional lifecycle emissions reduction (\$0.01 for every 1% in GHG reduction)

Clean Fuels Production Credit

§13704 : 2025-2027

- Lifecycle GHG <50kg CO₂e/MMBTU (Jet Baseline = 94kg CO₂e/MMBTU)
- Enhanced value for SAF up to \$1.75 for 100% reduction



IRA - SAF and Low Emissions Technology Grant Program

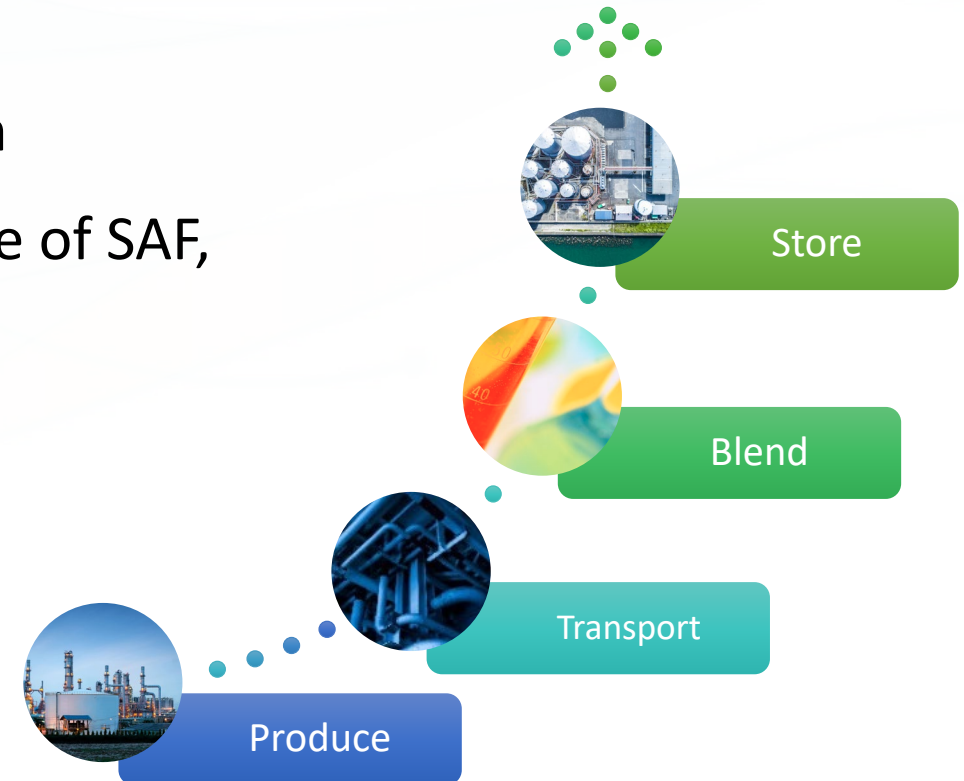
IRA Grant Program

§40007

\$297 million (total) competitive grant program

Enable production, transport, blend, or storage of SAF, and to develop or apply low-emission aviation technologies

Support scale-up domestic SAF production



FAST Grant Program

Fueling Aviation's Sustainable Transition

- New grant program under section 40007 of IRA
- Key Objective: *make investments to accelerate the production and use of SAF, thereby supporting the goals of the SAF Grand Challenge, to meet U.S. aviation climate goals to reduce aviation carbon emissions*
- FAST Grants Program Meeting held on December 14, 2022
- Developing Grant Solicitation for release later in the year



[Fueling Aviation's Sustainable Transition via Sustainable Aviation Fuels \(FAST-SAF\) and Low-Emission Aviation Technologies \(FAST-Tech\) Grant Program Meeting | US Department of Transportation](#)



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Global SAF Supply Chain Development

ASCENT Project 93 - Collaborative Research Network for Global SAF Supply Chain Development

In collaboration with the World Bank



Washington State University

Latin America and Caribbean

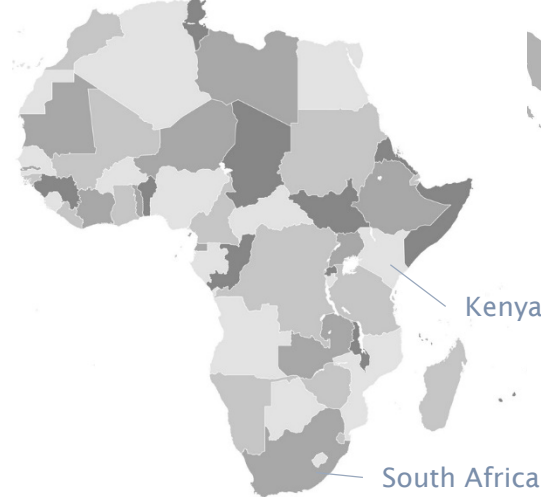


Southeast Asia



University of Hawaii

Sub-Saharan Africa



MIT/Hasselt University



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ASCENT Project 93 - Collaborative Research Network for Global SAF Supply Chain Development

- Project Objectives:

- Identify waste and biomass feedstock availability
 - Updated bottoms-up assessment of global SAF feedstock potential and key barriers
- Analyze new pathways to optimize SAF production
- Assess infrastructure needs and logistical requirements for a holistic approach to SAF supply chain development
 - Identify existing industries and infrastructure that could be leveraged for SAF production thus ensuring rapid development
- Develop a network of PhD students to work with universities in the regions of interest to extend supply chain analysis techniques and tools





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