



# EXPLORE FLIGHT

WE'RE WITH YOU WHEN YOU FLY

NASA Sustainable Flight National Partnership

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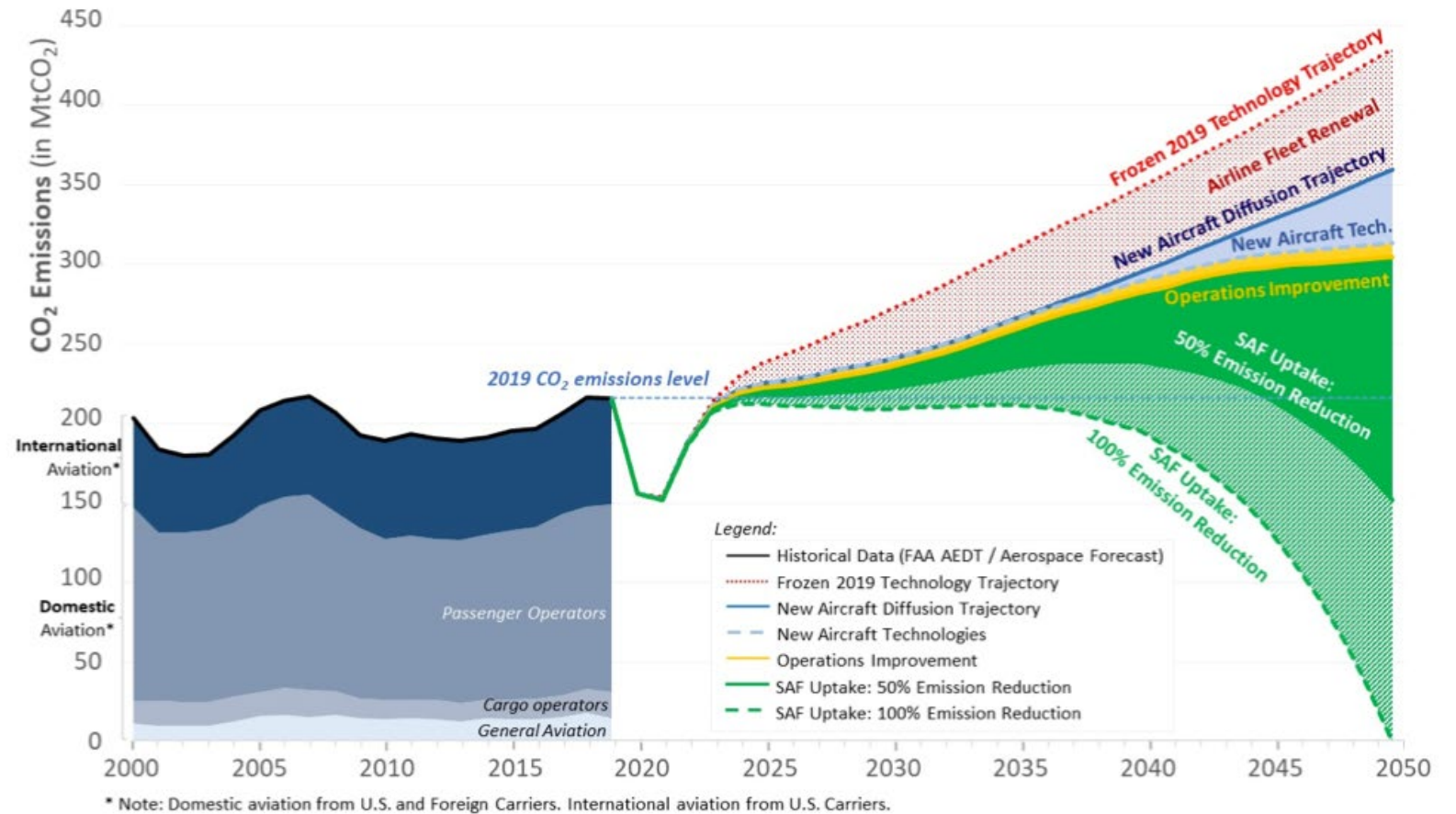
AIAA SciTech Forum: Spotlight Session on Aviation Technology: "Future Challenges – How to Meet Climate Neutrality by 2050"  
January 6, 2022

# Global Context for Sustainable Aviation

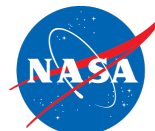
## U.S. Government Aviation Climate Action Plan



To address the U.S. economy-wide goal of net-zero GHG emissions by 2050, the U.S. aviation-sector is pursuing a basket of measures



More than 97% of U.S. aviation CO<sub>2</sub> emissions is from the combustion of jet fuel. 80% of domestic aviation emissions and 94% of international aviation emissions come from en-route operations above 10k ft.

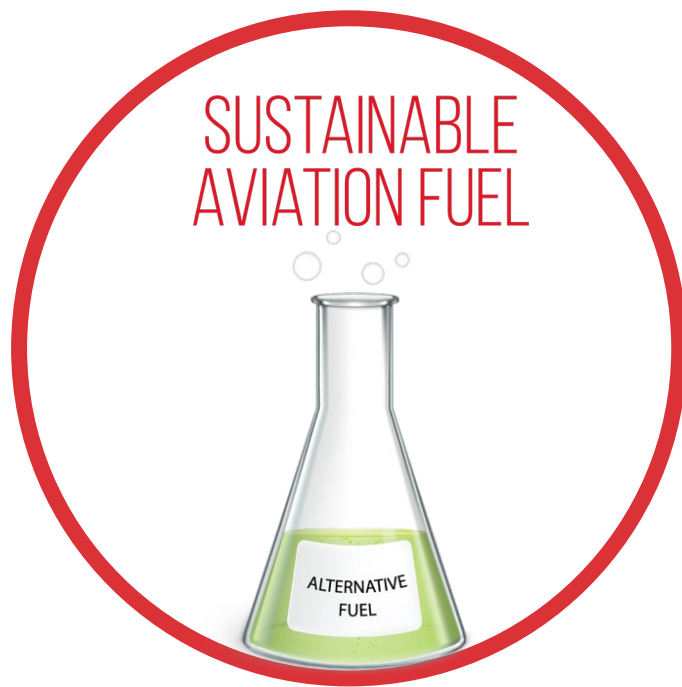


# Aviation Pillars for a Sustainable Future

Global Aviation Industry GOAL: net-zero carbon emissions by 2050



NASA = Primary Role



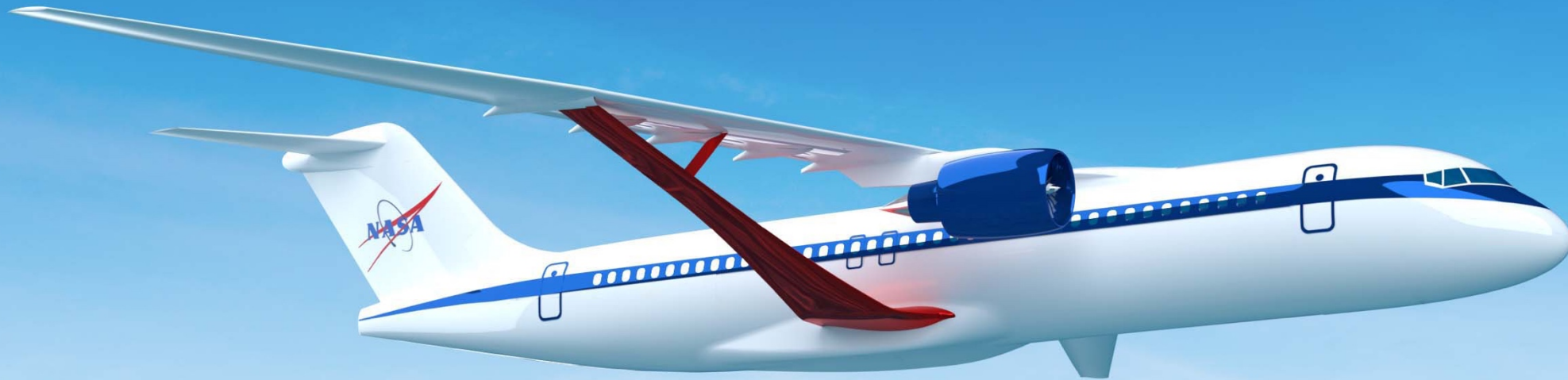
NASA = Supporting Role



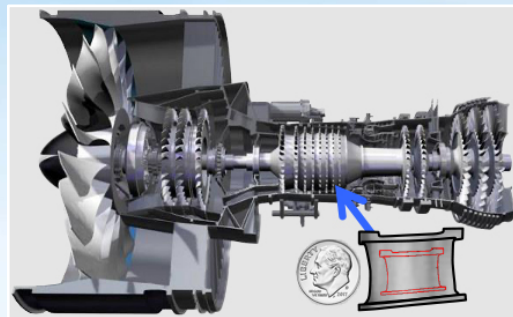
NASA = Primary Role

# Subsonic Transport Technologies

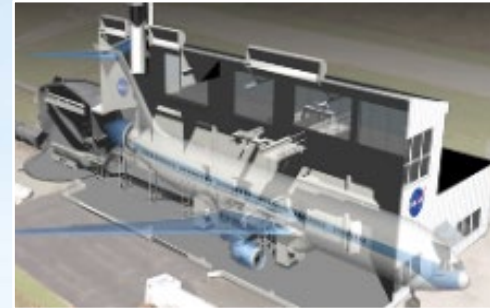
Ensure U.S. industry is the first to establish the new “S Curve” for the next 50 years of transports



**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

# Subsonic Transports: Integrated Technology Development



FY20	FY21	FY22	FY23	FY24	FY25	FY26	FY27	FY28	FY29
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Technology Readiness Target

Model Based Systems Analysis & Engineering



Sustainable Flight Demonstrator (SFD)

Flight Test

AATT - Transonic Truss Braced Wing

Flight Test

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

Flight Test

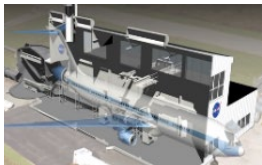
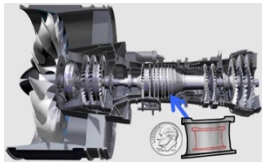
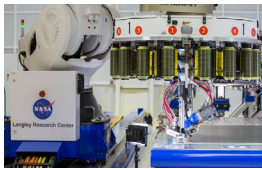
AATT - Electrified Aircraft Propulsion

Flight Test

Leverage the Asset  
-  
Future Spirals

Planned  
-----  
Notional  
.....

Achieve TRL 6 in time for Industry Product Decision-Making

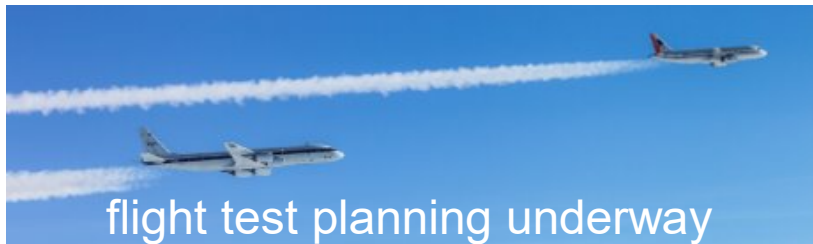


# Sustainable Aviation Fuels

## NASA-Boeing Sustainable Aviation Fuel (SAF) Test Shows Substantial Particle Emissions Reductions



- Aircraft engine emissions impact **air quality** & **climate**.
- SAFs + advanced lean-burn engines are a powerful combination for reducing these environmental impacts.
- Ground test completed at Boeing Field in Oct. 2021. Results quantifying emissions are benefits forthcoming.



**CFM LEAP Engine  
Burning 100% SAF**

**Sampling  
Probe**

**NASA  
Mobile  
Lab**

<https://www.nasa.gov/aeroresearch/nasa-tests-sustainable-aviation-fuel-emissions>  
<https://twitter.com/BoeingAirplanes/status/1457757855113678851>

Photo Credit: Boeing / Paul Weatherman  
ECO Demonstrator PROGRAM

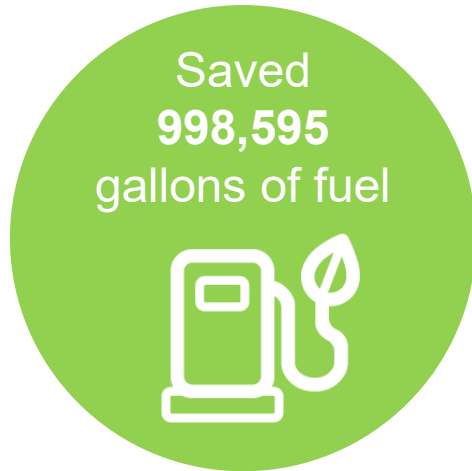


# Airspace Operational Tools Yield Immediate Benefits



## Airspace Technology Demonstration (ATD) Integrated Arrival/Departure/Surface Operations

Benefits to date from field demonstrations of ATD-2 technologies at the Charlotte Douglas International Airport (29 Sep 2017–30 Apr 2021)



FUEL



EMISSIONS



MAINTENANCE



Reduced delay  
by 830.3 hours

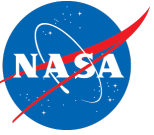


Saving passengers an  
estimated **\$3,985,599** in  
value of time and operators  
an estimated **\$1,223,030** in  
flight crew costs



Significant  
energy reduction  
when scaled up

# NASA's Vision for Sustainable Aviation Operations



- Integrated trajectories optimized for environmental benefit
- Advanced flight deck capabilities to operate on those trajectories
- Tailored services that support safe integration of all diverse operations



# Sustainable Flight National Partnership Benefits



Small Core Gas Turbine for  
5%-10% fuel burn benefit  
(HyTEC Project)

High-Rate Composites for  
6x manufacturing rate increase  
(HiCAM Project)

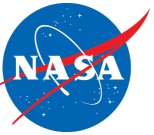
Sustainable Aviation Fuels for  
reduced lifecycle carbon  
emissions  
(AATT Project)

Electrified Aircraft Propulsion for  
~5% fuel burn and maintenance  
benefit  
(EPFD & AATT Projects)

Integrated Trajectory Optimization  
for 1%-2% reduction in fuel  
required and minimization of  
contrail formation  
(ATM-X Project)

Transonic Truss-Braced Wing  
for 5%-10% fuel burn benefit  
(AATT Project)

# Long-Term Transport Technology & Innovation



## Generational studies to inform future technology investments



Prior SFW

N+2 Studies, ERA for the 2020s Impact

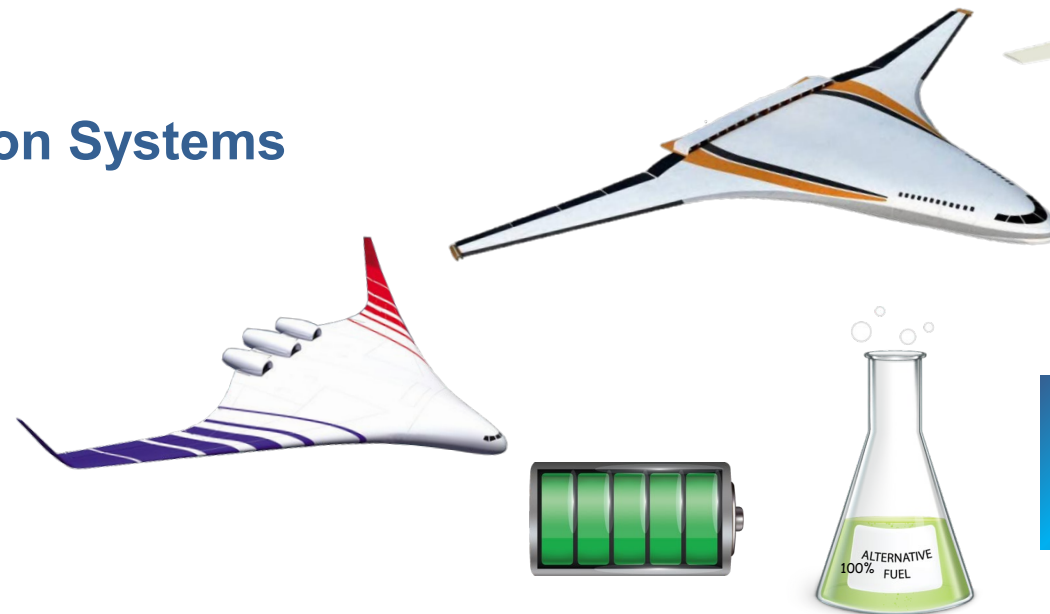
N+3 Adv Concept Studies SFNP for 2030s Impact

Concept Studies and Technology Development Needed for 2040s Impact



## Opportunities to Define Future Aviation Systems and Concepts

- Advanced Concept Studies for 2040+ EIS
- Net-Zero Emissions Concepts
- Promising Technology & Architectures
- Support Aviation Community with NASA-unique Contributions



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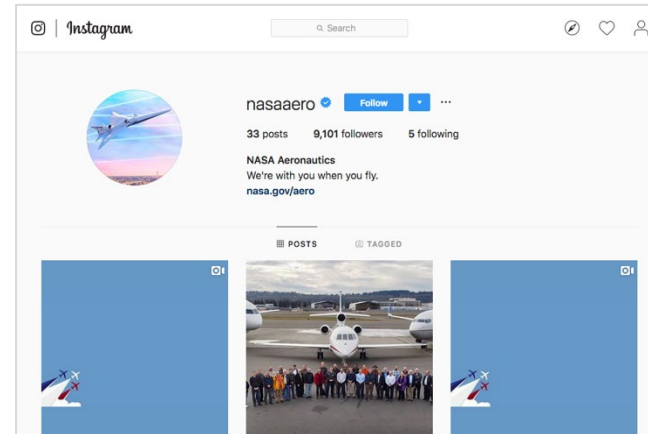
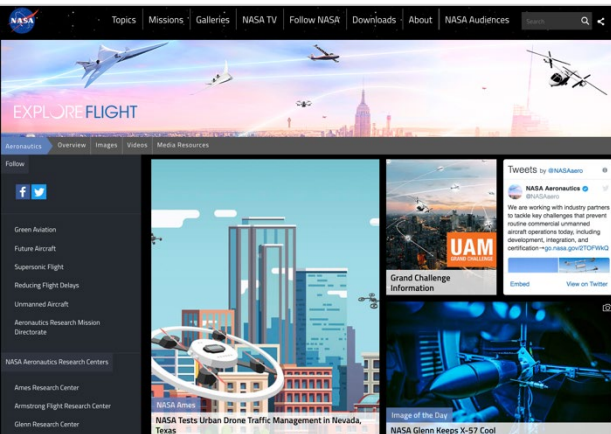
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