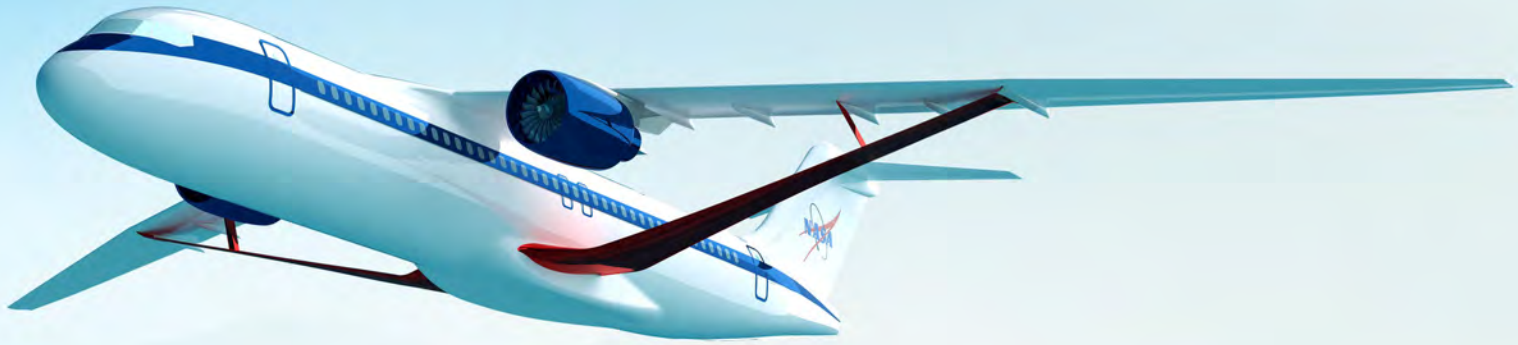
National Aeronautics and Space Administration



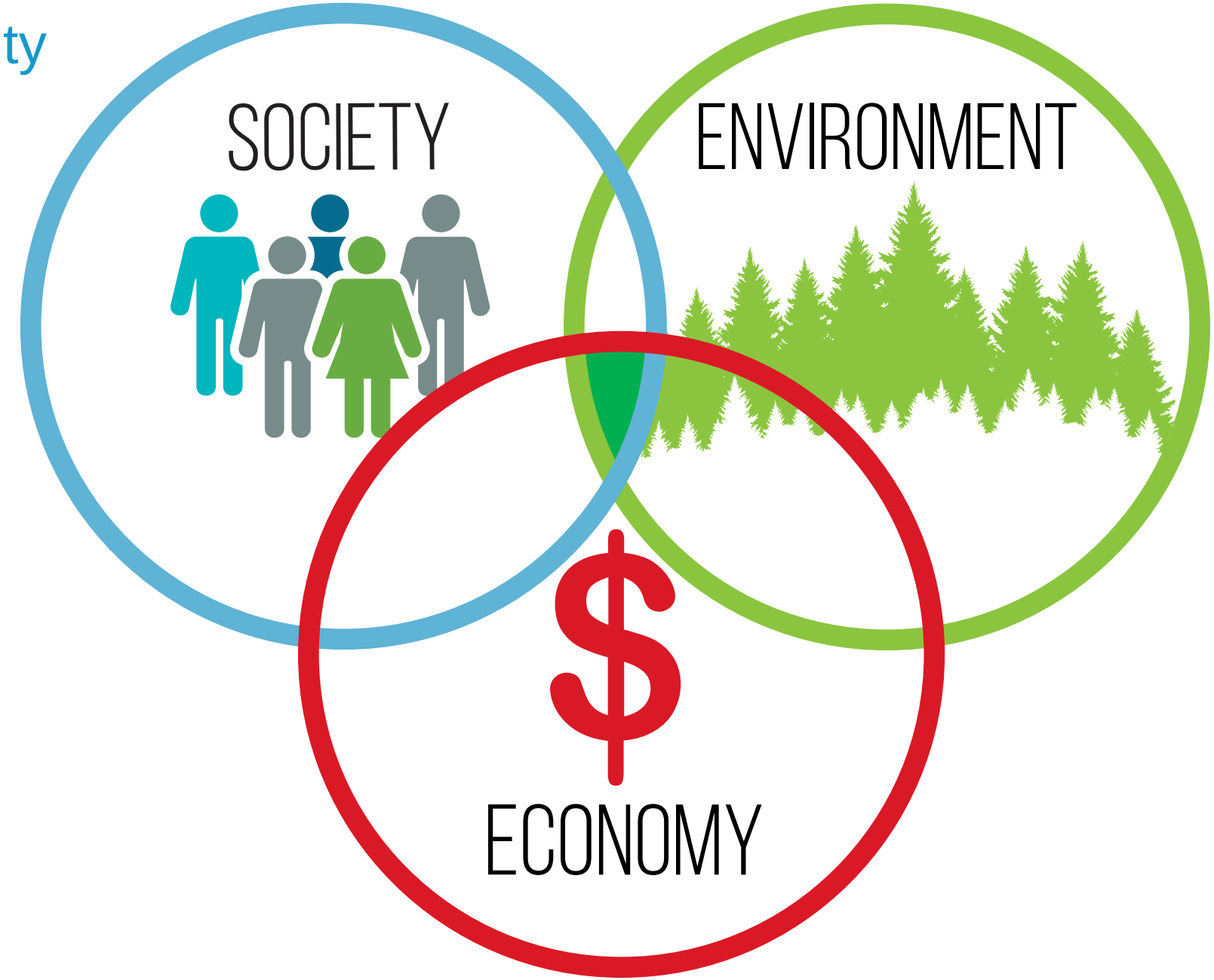
Overview of NASA Sustainable Flight National Partnership (SFNP)

Dr. Richard A. Wahls (Rich) & Jennifer Cole
Sustainable Flight National Partnership Mission Integration Manager, Aeronautics Research Mission Directorate
2025 UTIAS Workshop on Advanced Technology for Civil Aviation
University of Toronto Institute for Aerospace Studies, Toronto, Ontario, Canada
May 30, 2025
nasa.gov

Topics

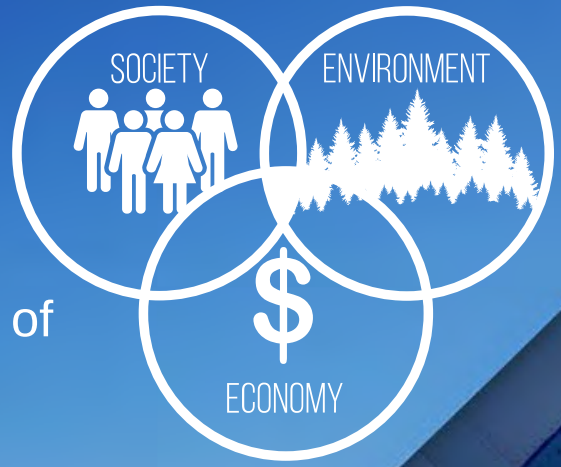
- Context – the Big Picture
- NASA Sustainable Flight National Partnership
- Concluding Remarks

Sustainability



Vision for Sustainable Aviation

- Aviation is broadly recognized for its value to society and is a cornerstone of our quality of life and economic prosperity
- Subsonic commercial airliners remain the 24/7 global backbone of domestic and international long-haul air transportation
- Aviation system growth meets worldwide demand meeting economic, operational, and environmental requirements
- Small aircraft provide growing value relative to other modes of transportation while incubating technology for airliners
- Aviation is safe, clean, quiet, efficient, economical, operable, marketable



Aviation is Vital to our Nation's Economy & Quality of Life

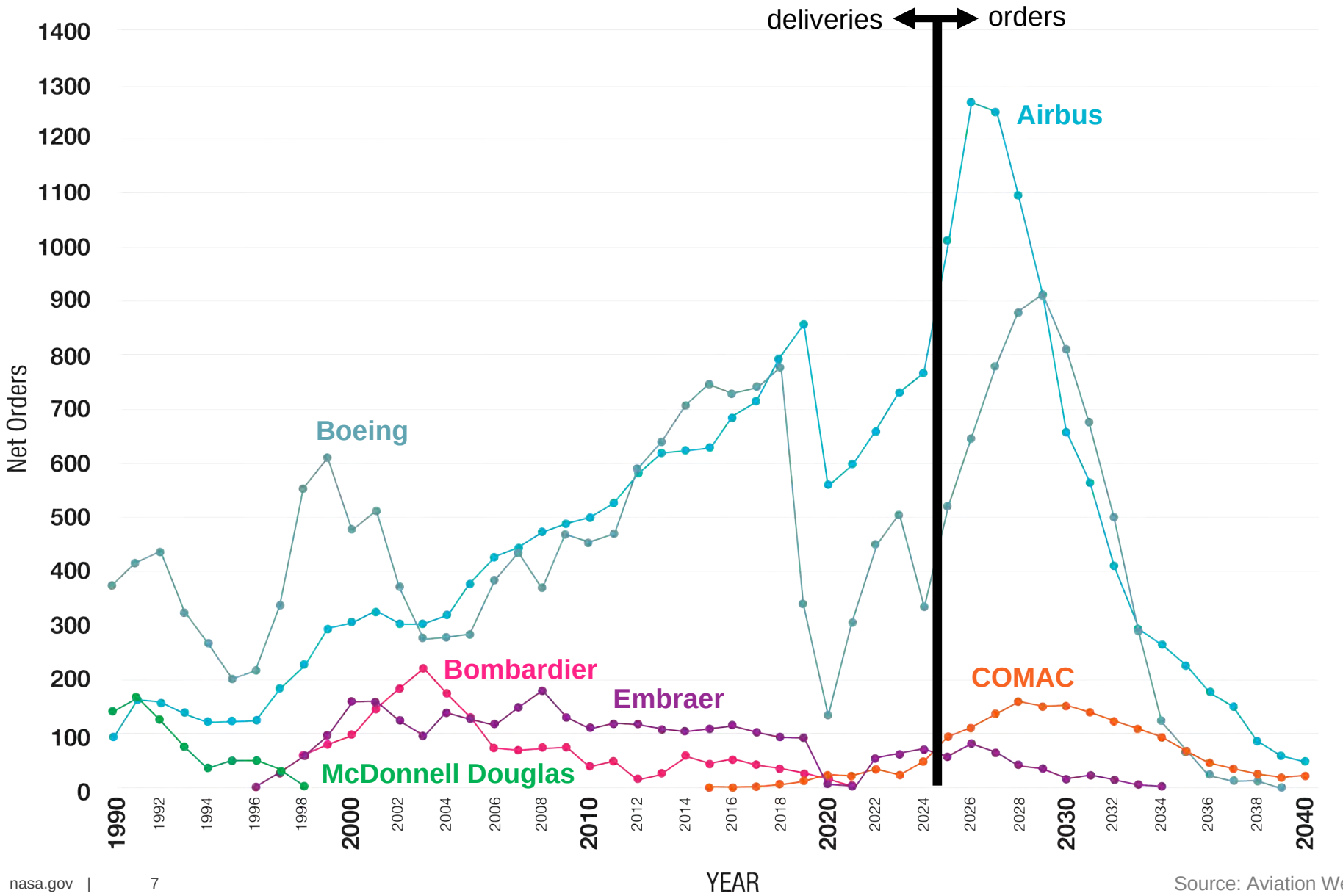


- $1.25 trillion economic impact from commercial aviation in 2022*
- $77.3 billion positive manufacturing trade balance in 2022**
- 8.97 million flights by U.S. carriers worldwide in 2022***
- 24 million tons of freight transported by U.S. airlines in 2022***
- 2.2 million aerospace/defense jobs; 603,000 in aeronautics/aircraft in 2022**

* From Airlines for America
** From Aerospace Industries Association
*** From Bureau of Transportation Statistics

Global Competition

Net Orders – 1990 through 2040 (Commercial Jets)



Market Size Today
~25K aircraft

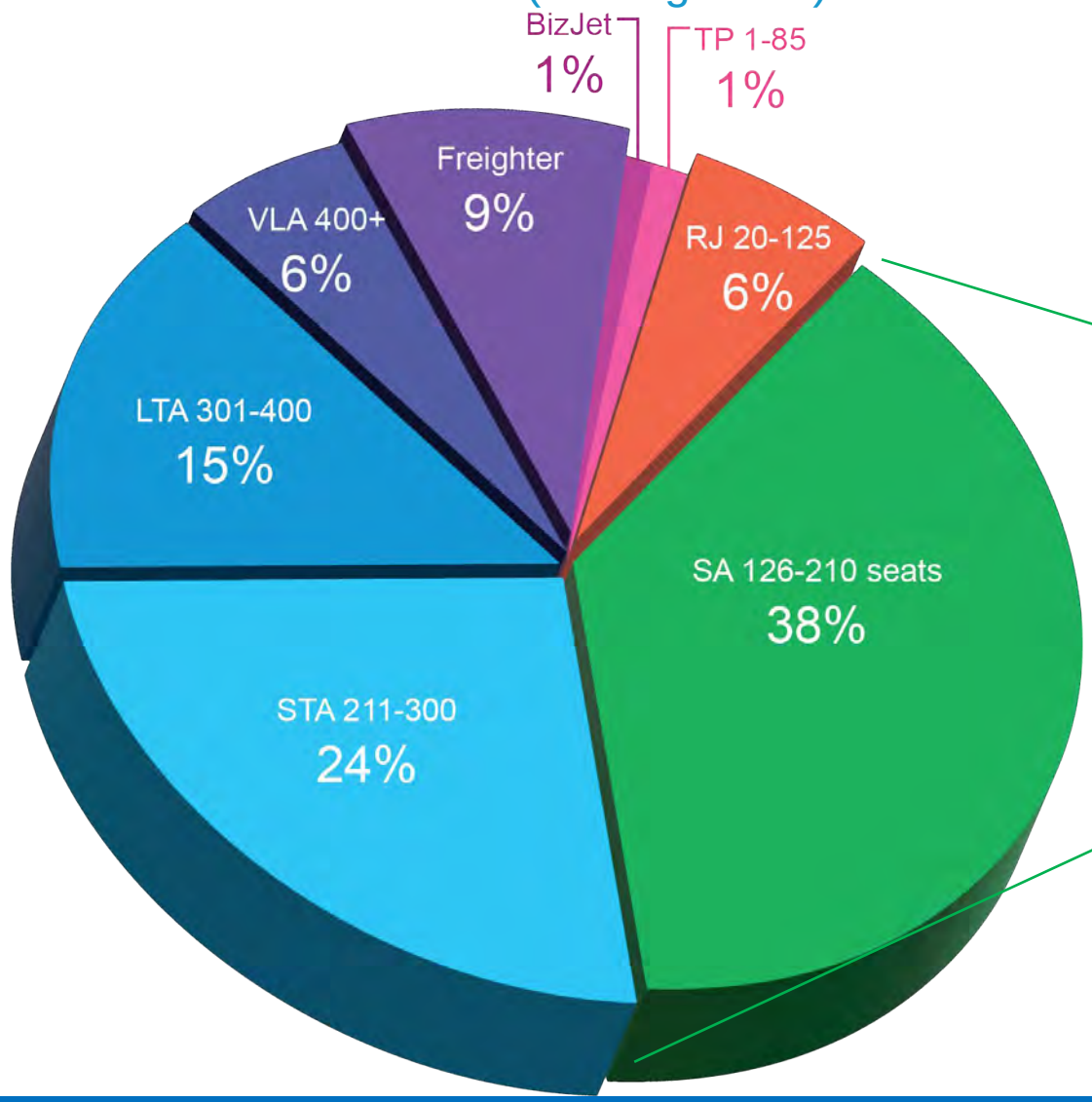
Growth & Replacement
~40K over next 20 years
~$7-8T

High Stakes Competition
US leadership at risk
Chinese market projected at ~20%

Source: Aviation Week Network – Fleet Discovery Civil Database 02/19/2025 projects future deliveries from net order database

Fuel burn…directly proportional to cost and emissions

2018 Fuel Burn – Global (~96B gallons)



Volume (~75% of future deliveries)
Fuel burn/emissions (38%)
2030s Clean-Sheet Design Opportunity

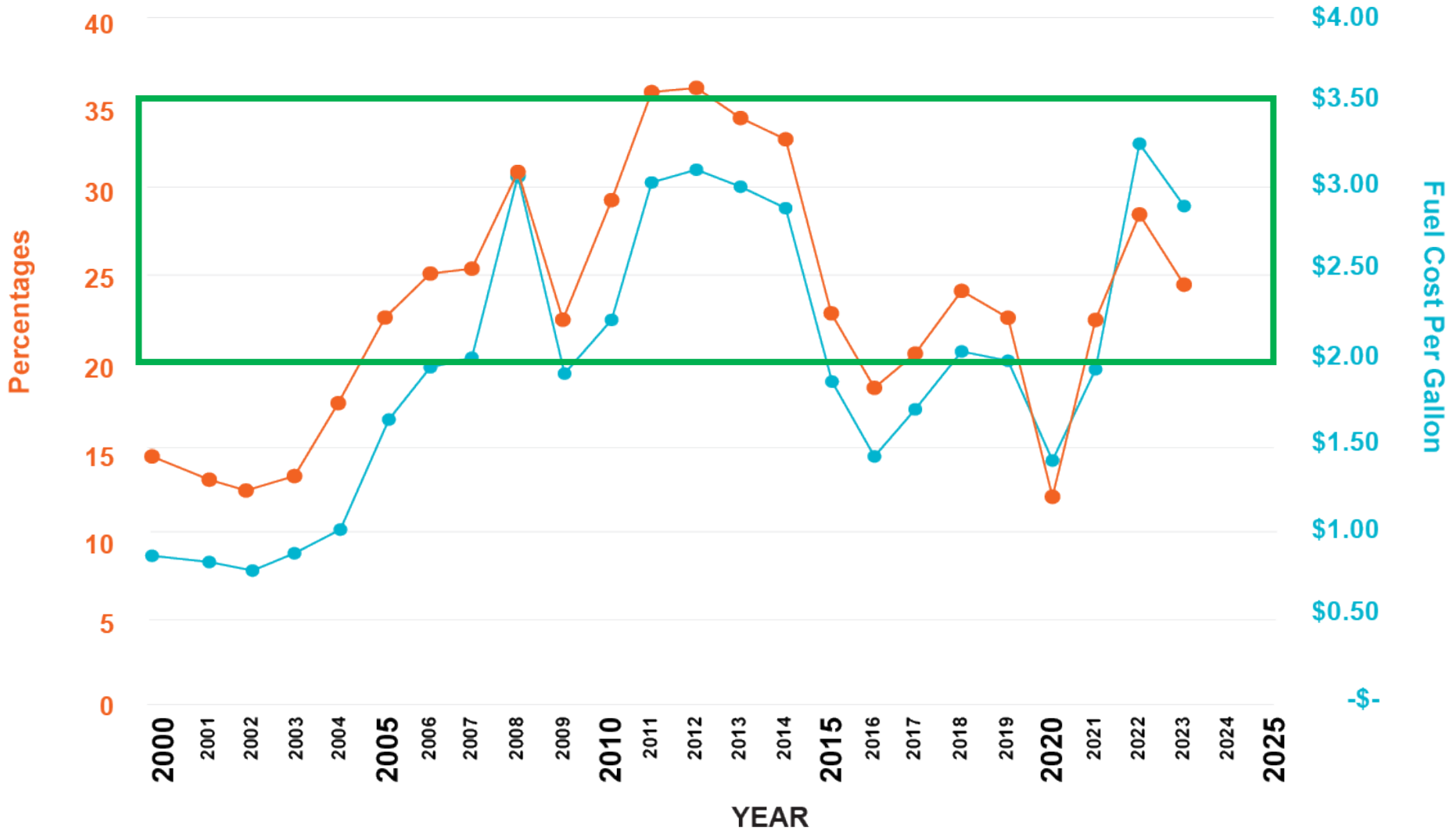
BizJet: Business Jet (all)
TP: Turboprop (seats)
RJ: Regional Jet (seats)
SA: Single Aisle (seats)
STA: Small Twin Aisle (seats)
LTA: Large Twin Aisle (seats)
VLA: Very Large Twin Aisle (seats)
Freighter: all (mostly twin aisle class)

Source data: DoT/Volpe Center, Flemming et al,: basis of 2022 ICAO Environmental Report, Chapter 1, p24
https://www.icao.int/environmental-protection/Documents/EnvironmentalReports/2022/ICAO%20ENV%20Report%202022%20F4.pdf

92% of commercial aviation fuel burn from aircraft larger than 125 seat-class

Fuel Contribution to Operation Costs

U.S. Airlines (Passenger & Cargo)



Fuel cost highly variable and represents ~20-35% of airline operation cost

2023
U.S. Airlines (pax & cargo) spent ~$57B on fuel; or ~25% of operating cost

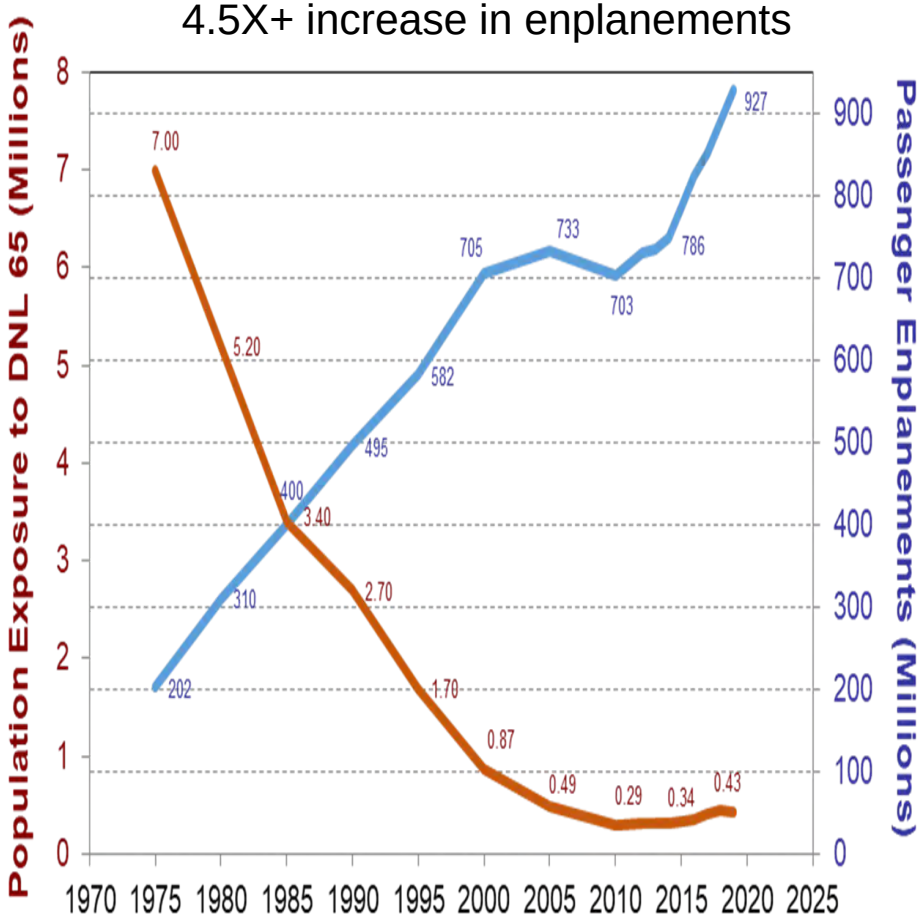
Increased energy efficiency is always good

Aviation Noise Impact

Population exposed is a key societal metric dependent on aircraft technology, and number of ops and procedures

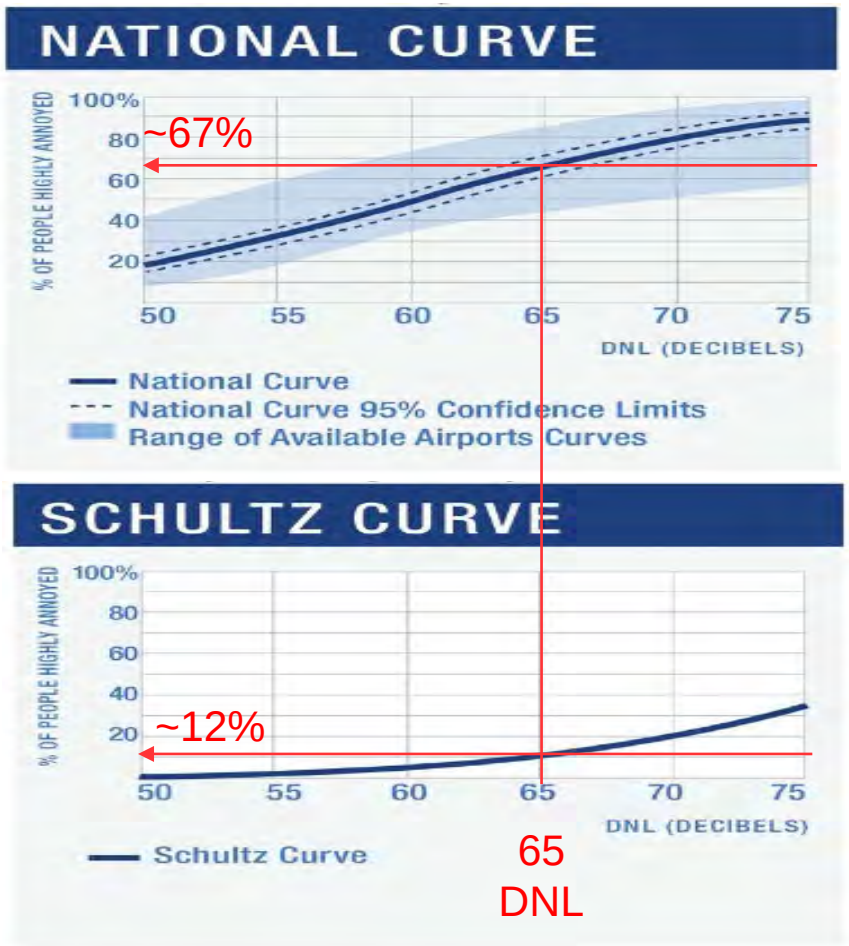
History – FAA Data

90%+ reduction in exposure with
4.5X+ increase in enplanements



FAA Neighborhood Noise Survey 2021

People are significantly more annoyed
by 65 dB DNL now than in the 1970s



Noise Reduction Remains a Key Environmental Driver









Four Transformations for Sustainability, Greater Mobility, and Economic Growth



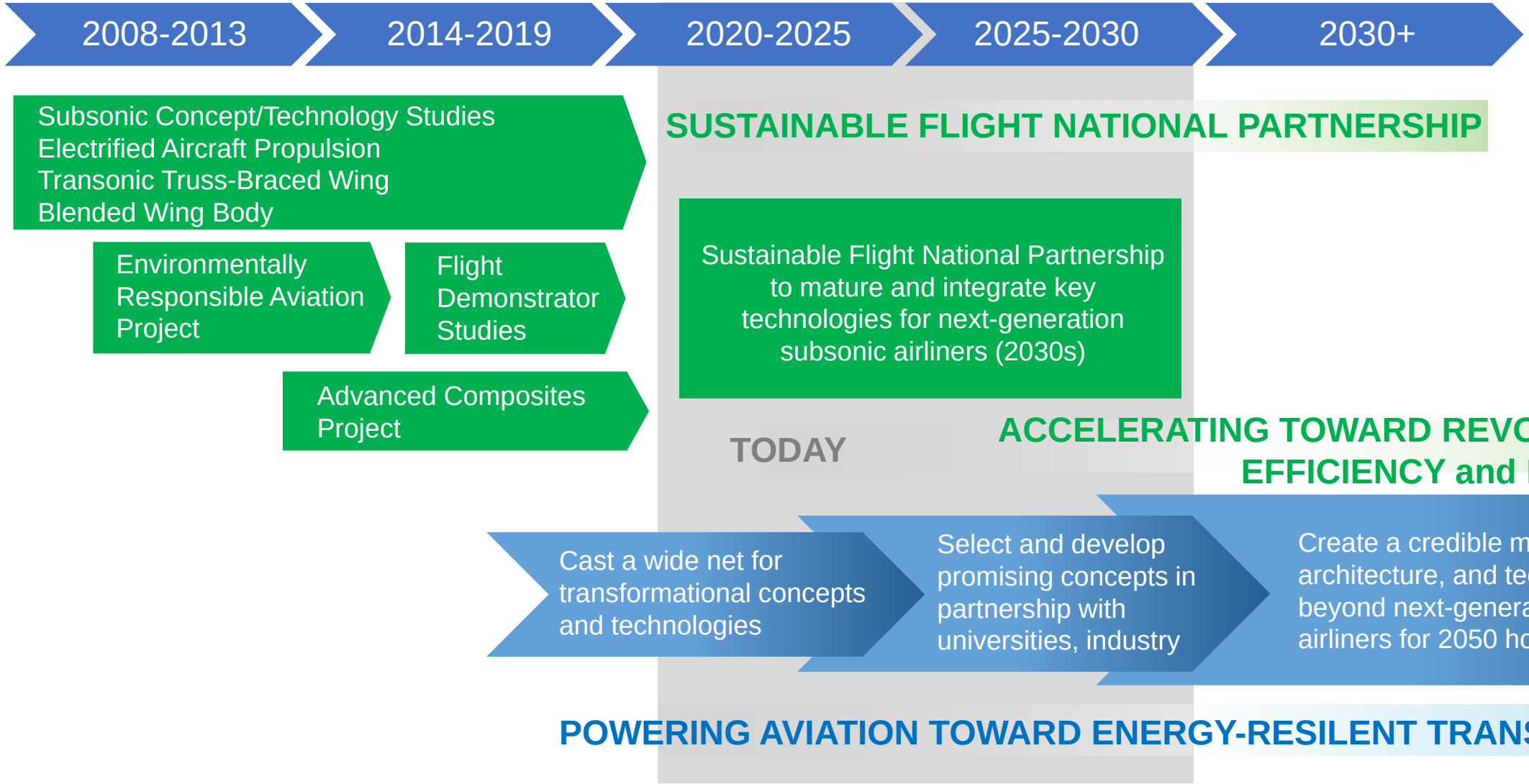
Sustainable Flight National Partnership

Established value – global connectivity 24/7
Sustainable growth is the challenge

Emerging new/enhanced value from aviation
Sustainability required from day one

Commercial Airliners & Cargo are Integral to Our Quality of Life

NASA Sustainable Aviation Strategy



Investment in innovation today paves the way
to the next generation and the generations beyond

Sustainable Flight National Partnership

Accelerating Toward Revolutionary Efficiency and Economic Impact in the 2030s

Engine efficiency and emission reduction

Integrated trajectory optimization



Airframe efficiency and manufacturing rate

Expanded fuel options

Globally competitive next-generation airliners using up to 30% less fuel,
current/future fleets flying optimal trajectories with reliable, affordable fuel options



ULTRA-EFFICIENT AIRLINERS

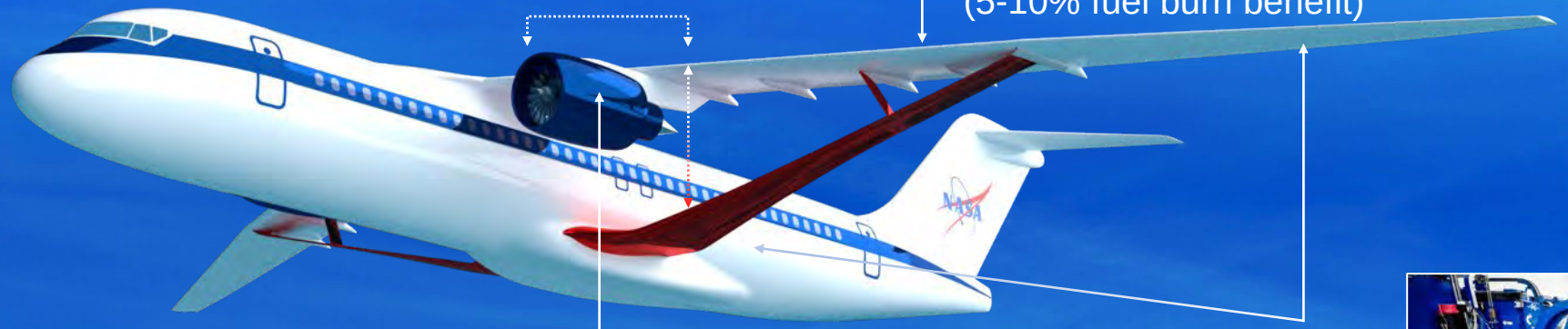
Real Progress. Real Value.

Ultra-Efficient Airliner Technologies

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

Integrated Aircraft System Efficiency
Propulsion Airframe Integration Opportunity

Aerodynamic Efficiency
Transonic Truss-Braced Wing
(5-10% fuel burn benefit)



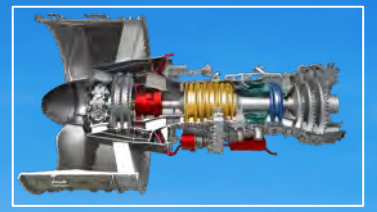
Lightweight Composites
4-6x manufacturing rate
(5-8% fuel burn benefit)





Electrified Aircraft Propulsion
~5% fuel burn and maintenance benefit

Engine Efficiency
Small Core Gas Turbine
(5-10% fuel burn benefit)

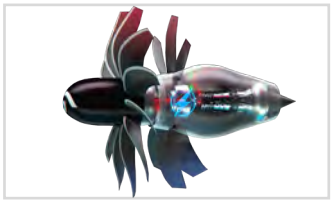


Ultra-Efficient Airliner Integrated Technology Development

Sustainable Flight National Partnership (SFNP) Technology Portfolio









FY20 | FY21 | FY22 | FY23 | FY24 | FY25 | FY26 | FY27 | FY28 | FY29

Technology Readiness Target

Model Based Systems Analysis & Engineering
Framework developed
"Digital Flight Test"

X-66 Sustainable Flight Demonstrator (SFD)
Partner Selection
Paused
CDR
Flight Test

Transonic Truss Braced Wing (AATT)
Mid-Term Eval
TC Completion

Hi-Rate Composite Aircraft Manufacturing (HiCAM)
Demo(s) Down-select
Mfg & Structural Demonstrations

Hybrid Thermally Efficient Core (HyTEC)
Partner Selection
CDR
Core Demonstration

Electrified Powertrain Flight Demonstration (EPFD)
Flight Tests
Partner Selection

Electrified Aircraft Propulsion Technologies (AATT)
TC Completion
MW Altitude Capability (NEAT)

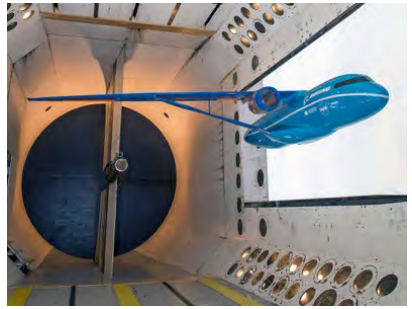
Achieve TRL 6 in time for industry product decision-making

Test Duration
Planned
Notional

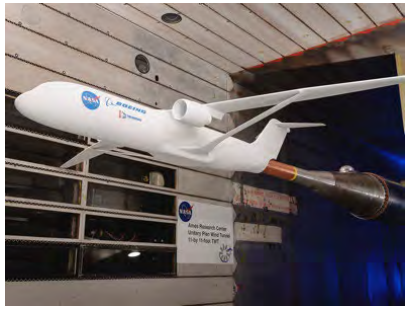
Transonic Truss-Braced Wing Technology Maturation

Increase confidence in technology to be robustly integrated in the aircraft system





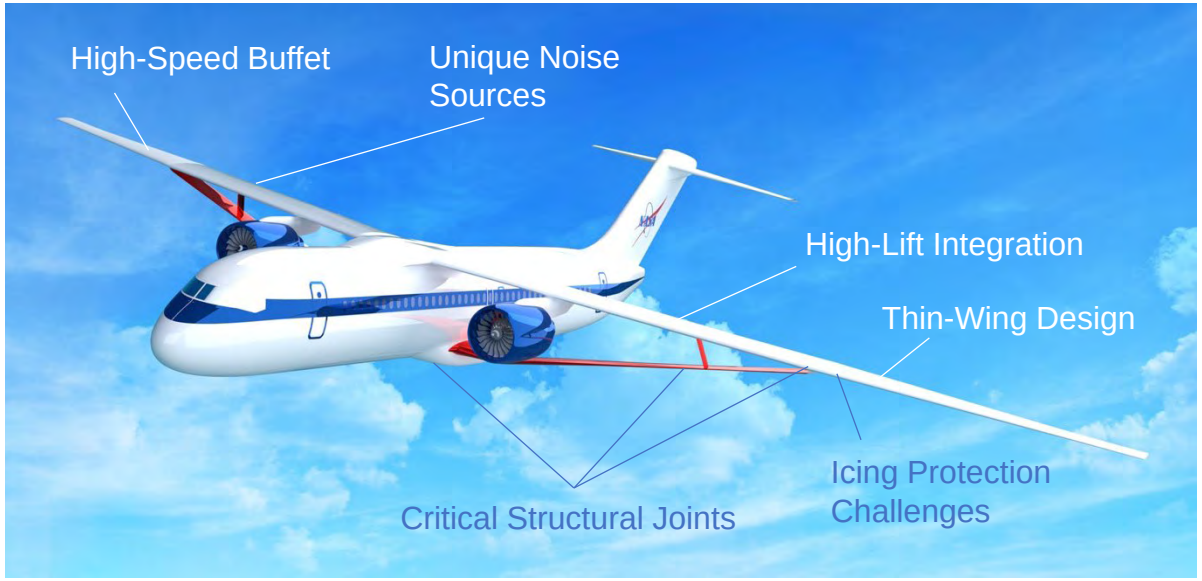
2013



2016



2022



Now: Reduce risks of TTBW technology not addressed by the X-66 demonstrator

Maturation of the concept through progressive design/analysis studies and wind-tunnel tests since 2009
2024 testing focused on icing, high-lift system integration, and deep stall

Hi-Rate Composite Aircraft Manufacturing (HiCAM)

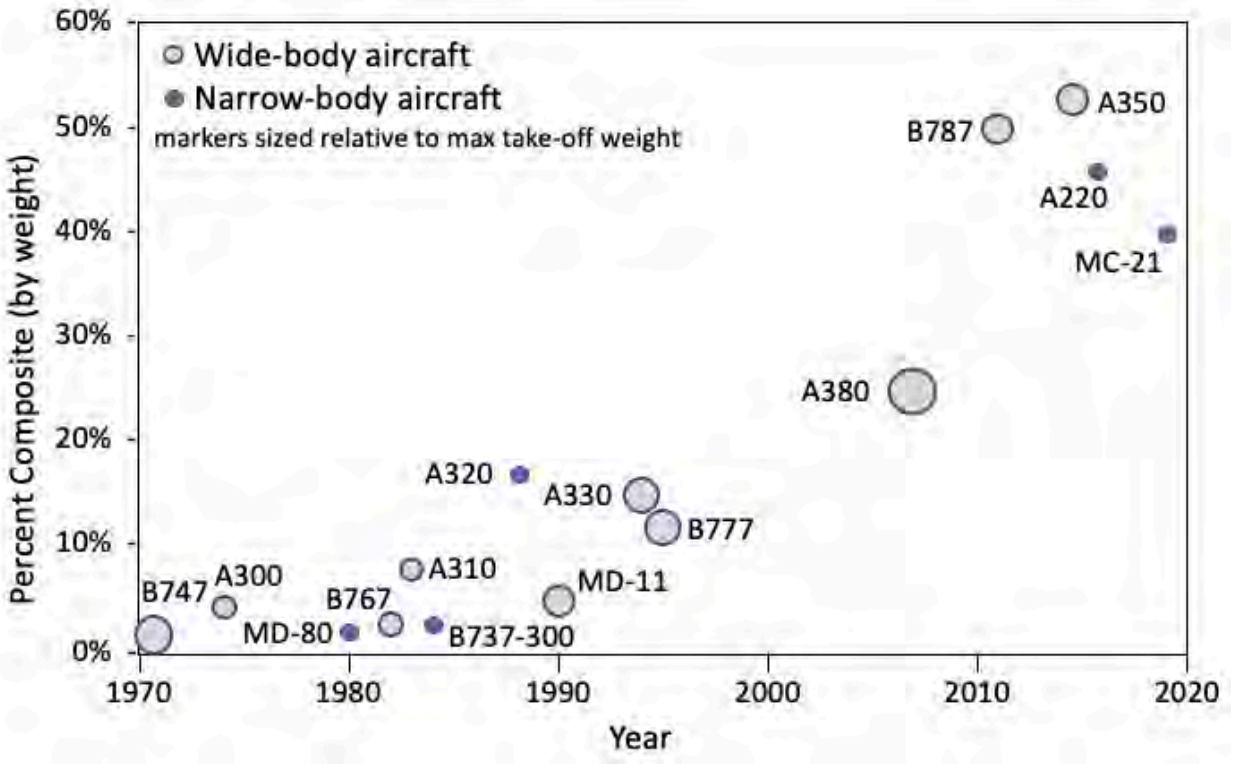
4–6x production rate increase without cost or weight penalty

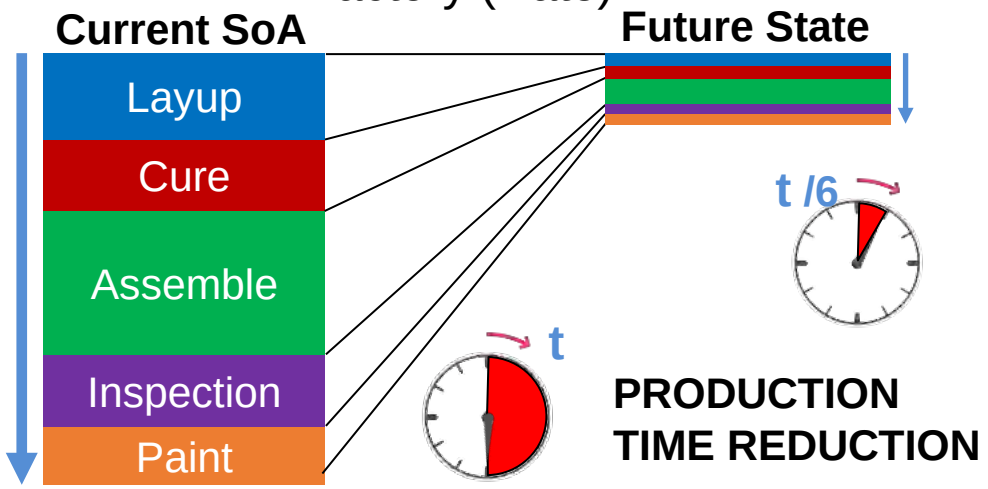
Production Rate per Month

- Metals SOA: 60
- Composites SOA: 10-15
  Target: 80-100

Two Relevant Environments

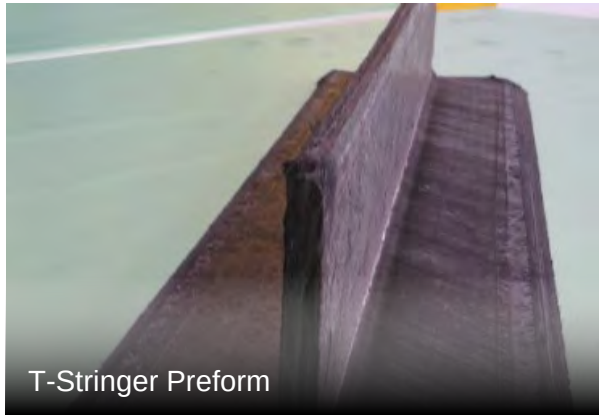
Flight (Weight) ← Cost → Factory (Rate)

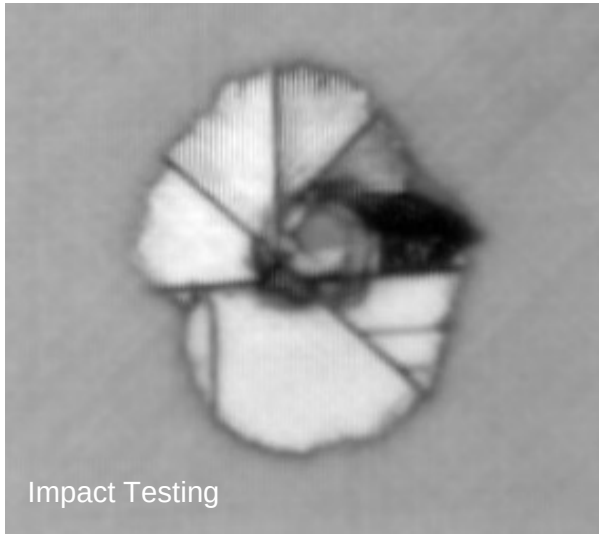




Hi-Rate Composite Aircraft Manufacturing

Phase 1 – Small Scale Tech Maturation

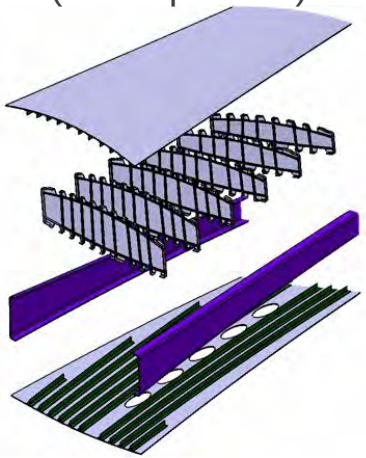

T-Stringer Preform


Impact Testing

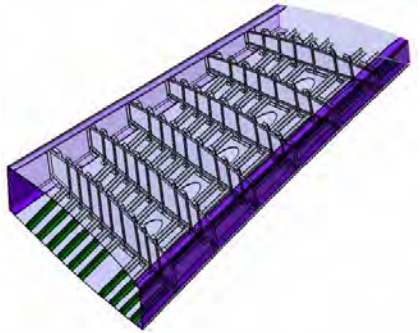
Phase 2 – Large Scale Demos (notional)

Wing box section near engine pylon

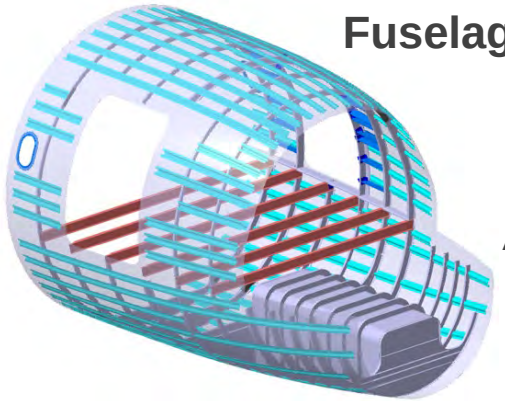
Subcomponents
(~10 replicates)



Assembled Component
(~3 replicates)



Fuselage forward section



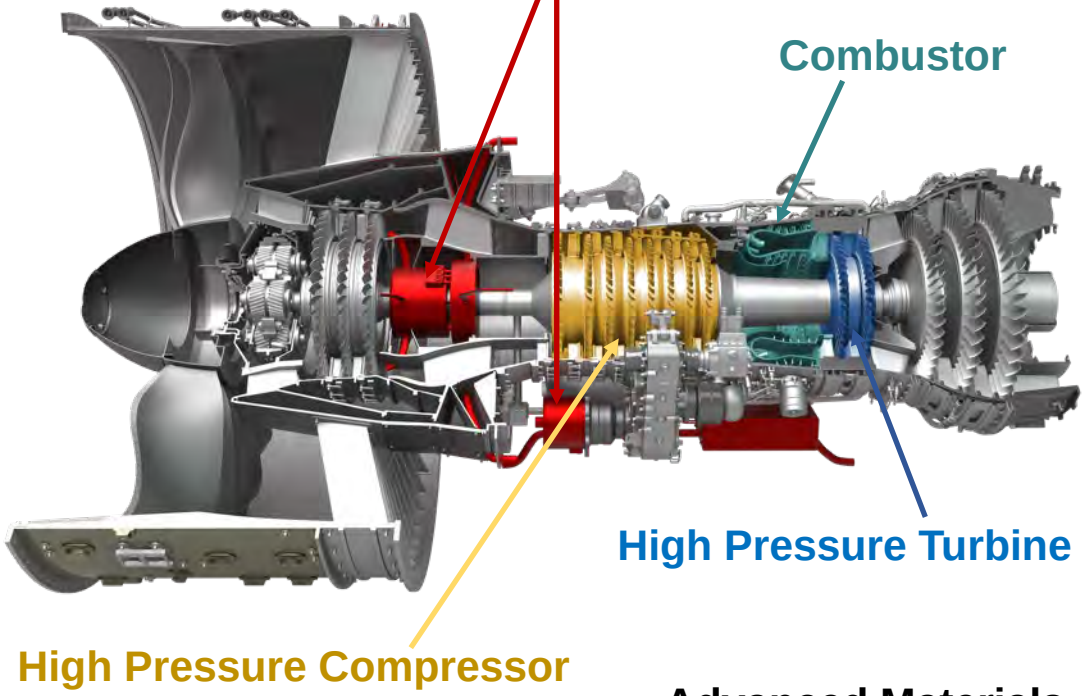
Subcomponents
(~10 replicates)

Assembled Component
(~3 replicates)

Work by NASA Composites Consortium members leads to large-scale demonstrations beginning in FY 2027. Enabling high rate, more integrated lightweight structures for next-generation wing and fuselage needs.

Hybrid Thermally Efficient Core Project (HyTEC)

Accelerate development and demonstration of advanced turbine engine technologies



Advanced Materials


Turbine blade materials testing


Engine hybridization testing


High-temperature materials testing

Integrated core demonstration in 2028

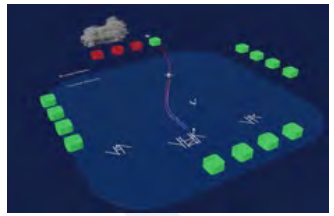
Contributing 5-10% fuel burn reduction and improved power extraction to SFNP goals



FUTURE AIRSPACE AND SAFETY

Real Progress. Real Value.

Sustainable Flight National Partnership Operational (SFNP Ops) Demo Plan









FY22	FY23	FY24	FY25	FY26	FY27	FY28	FY29	FY30	FY31

SFNP Ops 1: Pre-Departure Rerouting

Operator and ATC digital services in a metroplex and a complex multi-center environment

SFNP Ops 2: Integrated Airborne Rerouting

Integrated Pre & Post Departure Rerouting to inform FAA advanced flight data and trajectory management requirements

SFNP Ops 3: Fleet Wide Irregular Operations Recovery Management

Fleet-wide rerouting services for intelligent disruption management recovery strategies

SFNP Ops 4: Capstone Demo

4D trajectory optimization through an end-to-end digital workflow across NAS users

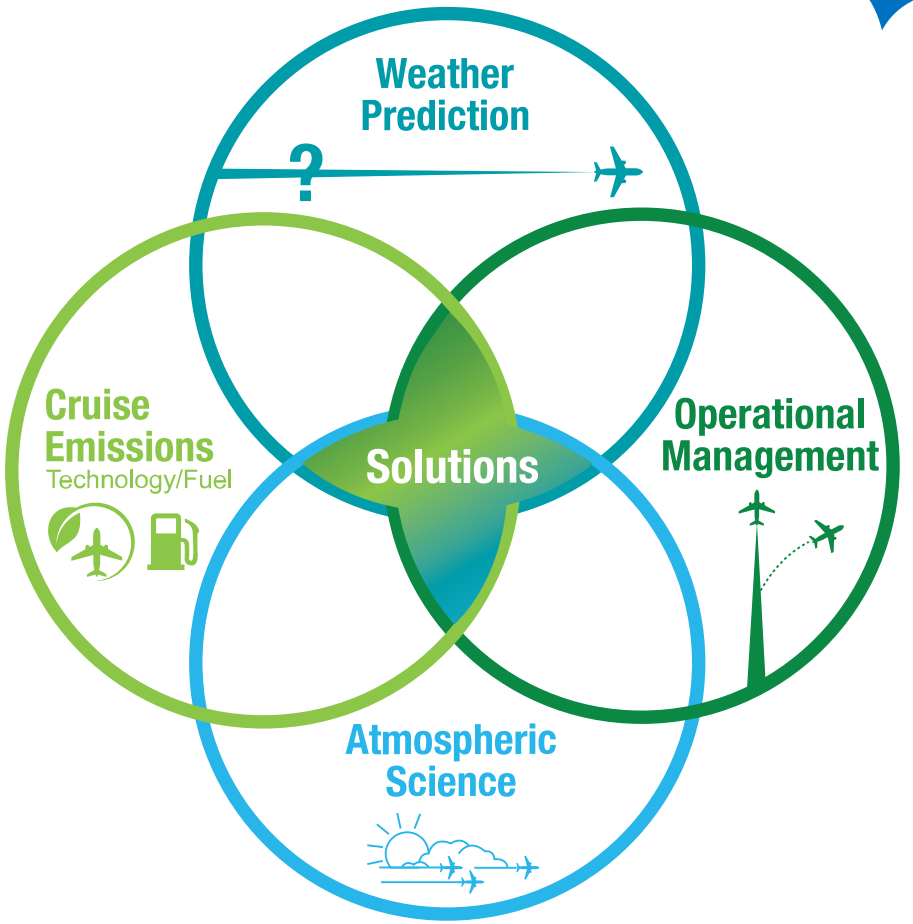
Using NASA, FAA, and partner assets to demonstrate reduction in emissions and fuel for aviation operations



CONTRAILS

Real Progress. Real Value.

National Academies Study - Contrails



- 2024 Jan 23 – Task Order Awarded
  "*Research Agenda for Reducing the Climate Impact of Aviation-Induced Cloudiness and Persistent Contrails from Commercial Aviation*"
- Report released May 8, 2025
- Jointly funded by NASA ARMD and SMD

Link to the NASEM Study Site
https://www.nationalacademies.org/our-work/research-agenda-for-reducing-the-climate-impact-of-aviation-induced-cloudiness-and-persistent-contrails-from-commercial-aviation

The Long Game: Aviation Eras on the Path Toward Sustainability

Accelerating Toward Revolutionary Efficiency→

2020s | 2030s | 2040s | 2050s | 2060s

Important Crosscutting

Era One: Evolution

Tube-and-Wing, Existing Infrastructure, Transition to Drop-In SAF, Increasing Electrification

SFNP Demonstrations

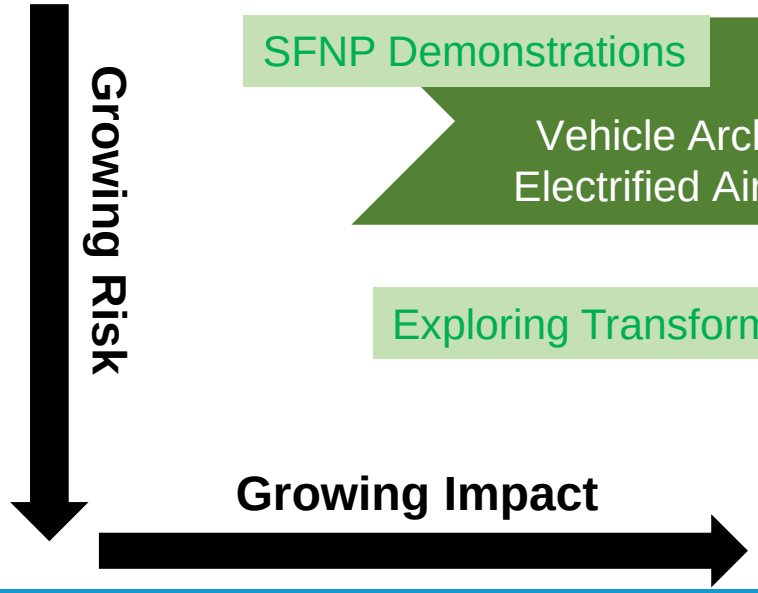
Era Two: Revolution

Vehicle Architecture Change, Major SAF Adoption, Mild Hybrid Electrified Aircraft Propulsion (EAP), Minor Infrastructure Change

Exploring Transformative Aviation

Era Three: Transformation

Major Vehicle Architecture Change, Non-Drop-In Fuel Adoption, Many-MW EAP, Major Infrastructure Change



Slide created in collaboration with FAA Office of Environment and Energy

Transformation doesn't happen overnight; the U.S. is making deliberate, long-term investment in broad-ranging technologies beyond industry's risk tolerance



Concluding Remarks

NASA’s Sustainable Flight National Partnership (SFNP)

- leading major demonstrations to accelerate revolutionary change
- no silver bullets with major aviation-wide challenges remaining

Time is critical as demand grows and as global competition doesn't wait



Energy-sector transformation is broader than aviation



Energy efficiency is necessary but not sufficient





Fleet and infrastructure Inertia is massive



Business physics of today's network is slow to change

Questions



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