NASA Advisory Council Meeting – Aeronautics Report

Dr. John-Paul Clarke
Vice Chair, NAC Aero Committee
NASA Headquarters (virtual)
March 1, 2022

NAC Aeronautics Committee met on December 15, 2021

- Topics covered during the virtual meeting:
    - ARMD FY22 Budget Overview
    - ARMD Programs Overview

Aeronautics Committee Membership

Mr. Darin DiTommaso, Chair
GE Aviation

Dr. John-Paul Clarke, Vice Chair
University of Texas at Austin

Mr. Peter Bunce
General Aviation Manufacturers Association

Mr. Michael Dumais
Raytheon Technologies

Mr. Jay Dryer
Office of the Secretary of Defense

Ms. Lisa Ellman
Commercial Drone Alliance

Dr. Naveed Hussain
Boeing Research and Technology

Dr. Nicole Key
Purdue University

Mr. Natesh Manikoth
Federal Aviation Administration

Ms. Susan Pfingstler
United Airlines

Dr. Helen Reed
Texas A&M University

Dr. Hassan Shahidi
Flight Safety Foundation

Mr. David Silver
Aerospace Industries Association

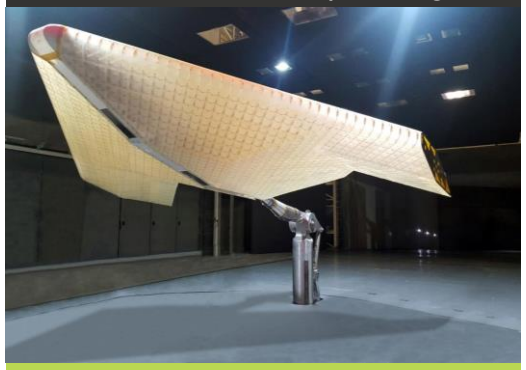
ARMD PROGRAMS

Airspace Operations and Safety Program

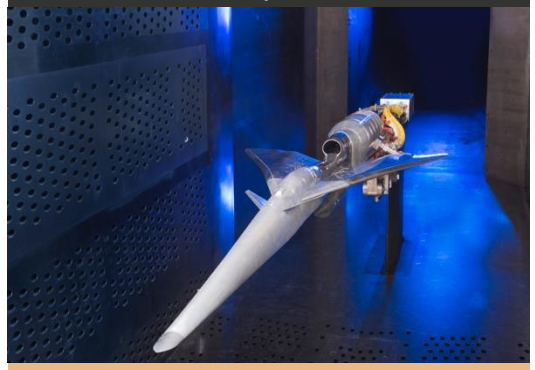
Advanced Air Vehicles Program

Integrated Aviation Systems Program

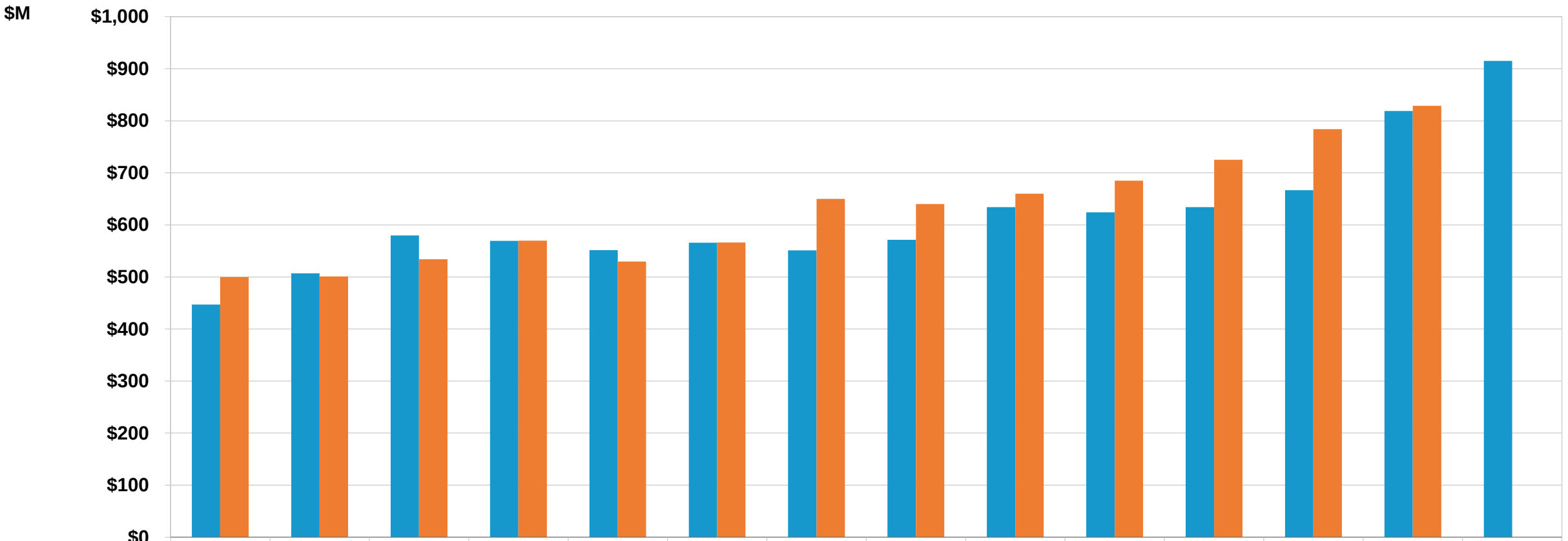
Transformative Aeronautics Concepts Program



Aerosciences Evaluation and Test Capabilities Portfolio



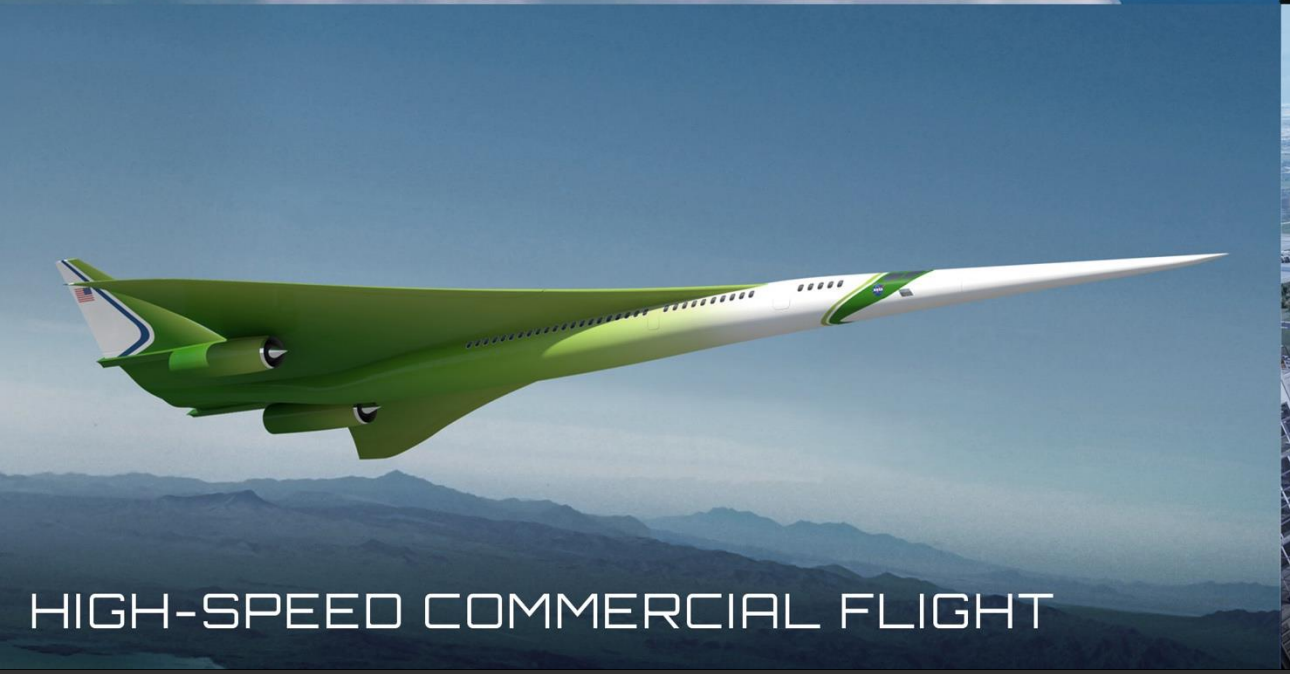
ARMD Budget FY 2009 to FY 2022



	FY09	FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19	FY20	FY21	FY22
Pres Budget	$447	$507	$580	$569	$552	$566	$551	$571	$634	$624	$634	$667	$819	$915
Enacted	$500	$501	$534	$570	$530	$566	$650	$640	$660	$685	$725	$784	$829	

Committee Finding – ARMD Budget

- The Committee is pleased to see NASA's Aeronautics Research Mission Directorate (ARMD) receiving a higher budget during recent years in both the President's Budget request and in the official budget appropriated by Congress. While pleased with the increase in funding, the Committee also sees an opportunity for NASA Aeronautics to advocate for more funding to its programs and projects investigating and implementing sustainable aviation technology and practices, sensing high potential for Congress and the public to see the benefit of these activities. One such area is the use of Unmanned Air Vehicles and Advanced Air Mobility that have the potential to substantially reduce emission by replacing automobiles and delivery vans with electric powered air vehicles.



Four Transformations for Sustainability, Greater Mobility, and Economic Growth

The Aviation Carbon Reduction Challenge

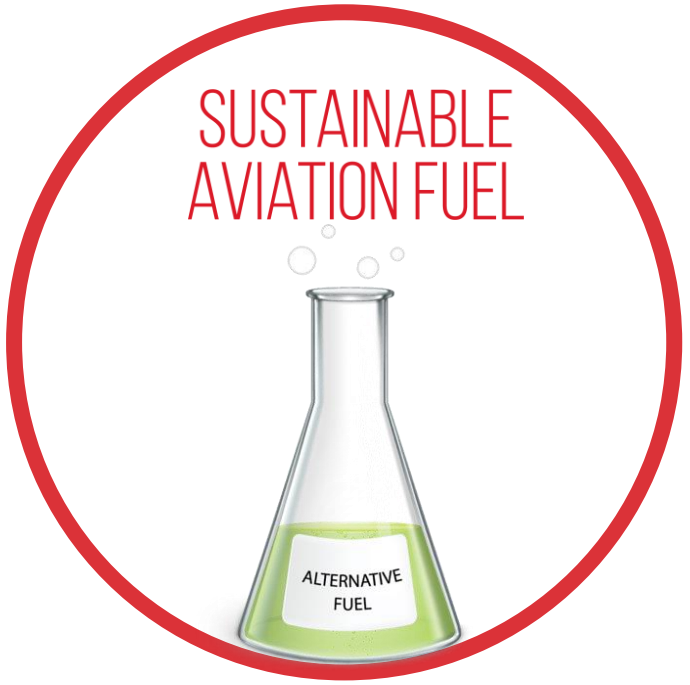
- By 2050, an estimated 10 billion passengers will fly each year a distance of 22 trillion revenue passenger kilometres.
- With today's fleet and operational efficiency, this activity would require over 620 Mt of fuel and generate close to 2000 megatonnes (Mt) of CO_2.
- Imagine enabling the same level of demand while reducing net CO_2 emissions to zero by 2050

Meeting the challenge is the opportunity for the U.S. to lead the globe in innovation and reductions in CO_2 aviation emissions and to maintain economic competitiveness in a critical export industry ($6 trillion-plus market over the next 20 years).

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

Sustainable Flight National Partnership Benefits

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

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

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

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

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

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

Airspace Operational Tools Yield Immediate Benefits

Airspace Technology Demonstration (ATD)

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

Saved **1,101,768** gallons of fuel

FUEL

Saved **23,211,172** lbs. of CO_2 = **172,597** urban trees

EMISSIONS

Saved **6,016** hours of engine run time

MAINTENANCE

REDUCED DELAY BY 933.6 hours

Saving passengers an estimated **$4,481,569** in value of time and operators an estimated **$1,375,224** in flight crew costs

BENEFITS TODAY

Committee Findings – ARMD Programs Overview – ATD-2

The Committee commends ARMD for establishing the value of the research done by Airspace Technology Demonstration 2 (ATD-2) and for transferring the technology to the FAA. Stemming from this success, the Committee encourages NASA to keep the ball rolling with continued, subsequent successes in more air traffic management and sustainability-related activities. Committee members note there is still much work to be done in the areas of increasing capacity and requirements to meet the net zero by 2050 goal, and steps like the ATD-2 completion and transfer could be just one of many more to come.

University Leadership Initiative Engaging the University Community

4 rounds of solicitations
$126M of awards

Seeking & awarding proposals addressing all Strategic Thrusts

- 19 awards with 59 universities
- 6 HBCUs and 9 MSIs
- 333 proposals submitted
- 245 different proposing Principal Investigators
- 2468 team members
- 20–50 students per team

NASA's University Leadership Initiative represents a new type of interaction between ARMD and the university community, where universities take the lead, build their own teams, and set their own research path.

Committee Findings – ARMD Programs Overview - ULI

The Committee applauds NASA for the University Leadership Initiative (ULI) activity and its benefits to aviation in the United States. ULI brings the best academic minds together to work on solutions to aeronautical challenges – enabling collaboration across universities and promoting aeronautics programs for students to enter. The Committee sees ULI bringing new innovative ideas for the electrification of aircraft, material development, and sustainability to industry.

Backup

Aviation is Vital to our Nation's Economy

Pre-COVID

- $78 billion positive trade balance; the largest positive trade balance of any U.S. manufacturing sector
- $1.8 trillion total U.S. economic activity
- 10.9 million direct/indirect jobs
- 21.3 billion tons of freight transported by U.S. airlines in 2019

NASA Aeronautics – Vision for Aviation in the 21st Century

ARMD continues to evolve and execute the Aeronautics Strategy *https://www.nasa.gov/aeroresearch/strategy*

6 Strategic Thrusts

- Safe, Efficient Growth in Global Operations
- Safe, Quiet, and Affordable Vertical Lift Air Vehicles
- Innovation in Commercial Supersonic Aircraft
- In-Time System-Wide Safety Assurance
- Ultra-Efficient Subsonic Transports
- Assured Autonomy for Aviation Transformation

U.S. leadership for a new era of flight

Aeronautics FY 2022 Budget Request

$ Millions	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026
Aeronautics	**$828.7**	**$914.8**	**$933.7**	**$954.1**	**$975.2**	**$996.8**
Airspace Operations and Safety	92.0	104.5	106.3	108.1	108.1	108.1
Advanced Air Vehicles	211.4	243.7	254.6	270.9	288.5	269.5
Integrated Aviation Systems	278.7	301.5	305.5	310.7	309.2	349.9
Transformative Aeronautics Concepts	129.7	148.0	150.3	147.4	152.4	152.4
Aerosciences Evaluation and Test Capabilities	116.9	117.0	117.0	117.0	117.0	117.0

- Initiates a Sustainable Flight National Partnership to enable highly efficient next generation aircraft and ensure U.S. leadership in aviation
  - Demonstrate the first-ever high-power hybrid electric propulsion for large transport aircraft
  - Develop a full-scale sustainable flight demonstrator X-plane to validate integrated systems and their benefits
  - Advance small turbine cores that will increase engine thermal efficiency and reduce fuel burn
  - Improve the rate of composite manufacturing by 4 to 6 times faster than current production rates
  - Develop technologies needed to increase use of sustainable aviation fuels
  - Develop the next evolution of air traffic management to safely increase operational efficiency which reduces fuel burn and emissions
- Conducts the first flight of the X-59 Low Boom Flight Demonstrator in 2022. These flight tests will provide data to the global aviation community to reassess the ban on supersonic flight over land and implement noise regulations acceptable to local communities
- Supports Advanced Air Mobility to ensure U.S. leadership in an emerging aviation market that studies have projected to generate an annual market value of $115 billion by 2035
- Conducts the first flight of the X-57 all-electric aircraft to better inform standards development for small electric aircraft that will be common in an Advanced Air Mobility environment
- Increases funding to develop revolutionary, beyond next-generation zero-emissions aircraft concepts and technologies through the highly successful University Leadership Initiative

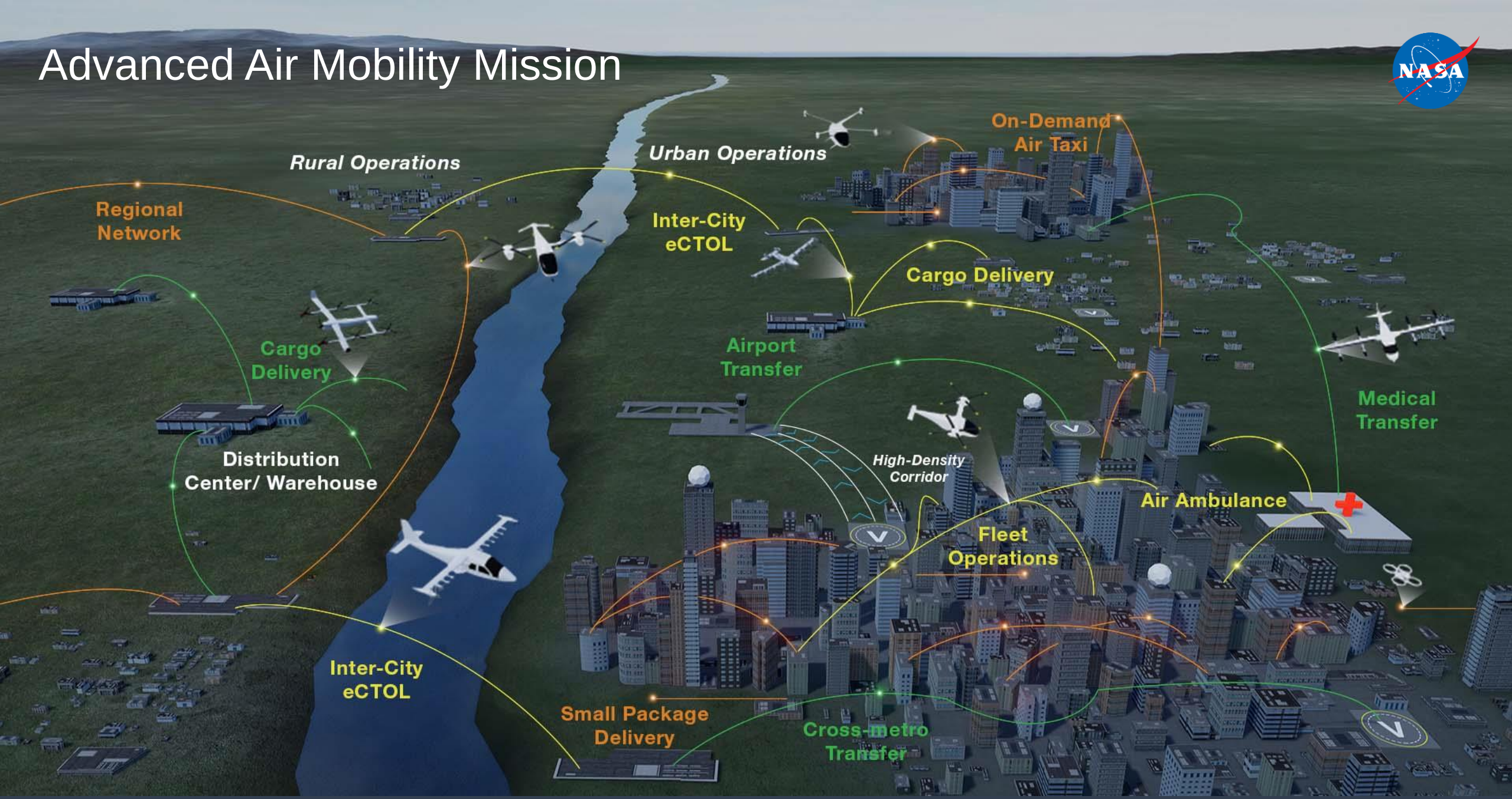
High-Speed Commercial Flight

Sustainable transformation of the speed of air travel

Addressing the unique barriers to sustainable, environmentally responsible high-speed flight

Generate key data to support development of en route certification standards based on acceptable sound levels

Advanced Air Mobility Mission



Safe, sustainable, affordable, and accessible aviation for transformational local and intraregional missions

2021 NAC Aeronautics Committee Work Plan

SPRING	SUMMER	FALL
Sustainability of Aviation		ARMD FY22 Budget Overview
Wildfire Mitigation Team		**ARMD Programs Overview**
Innovation in the NASA Aeronautics Portfolio		
Hypersonic Market Studies		
March 17, 2021 (Virtual)	Cancelled	December 15, 2021 (Virtual)




2022 NAC Aeronautics Committee Work Plan

SPRING	SUMMER	FALL
ARMD FY23 Budget Overview	Zero Emissions/Impact Strategy	University Initiative (ULI, USRC)
Sustainable Flight National Partnership	Low Boom Flight Demonstrator Mission Status	**Advanced Air Mobility Mission Update**
Future Airspace Vision	X-57 First Flight	

April 27, 2022 (Virtual)

August 3, 2022 (TBD)

November 30, 2022 (TBD)

Acronyms

- AATT - Advanced Air Transport Technology
- ARMD – Aeronautics Research Mission Directorate
- ATD – Airspace Technology Demonstration
- ATM-X – Air Traffic Management Exploration
- eCTOL - electric conventional takeoff and landing
- EPFD – Electrified Powertrain Flight Demonstration
- FY – Fiscal Year
- HiCAM – Hi-Rate Composite Aircraft Manufacturing
- HyTEC - Hybrid Thermally Efficient Core
- ULI - University Leadership Initiative