Advanced Air Vehicle Program

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NASA Aeronautics Research Six Strategic Thrusts

Safe, Efficient Growth in Global Operations

- Enable full NextGen and develop technologies to substantially reduce aircraft safety risks

Innovation in Commercial Supersonic Aircraft

- Achieve a low-boom standard

Ultra-Efficient Commercial Vehicles

- Pioneer technologies for big leaps in efficiency and environmental performance

Transition to Low-Carbon Propulsion

- Characterize drop-in alternative fuels and pioneer low-carbon propulsion technology

Real-Time System-Wide Safety Assurance

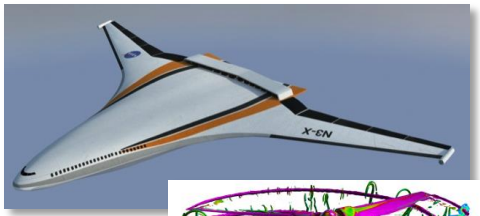
- Develop an integrated prototype of a real-time safety monitoring and assurance system

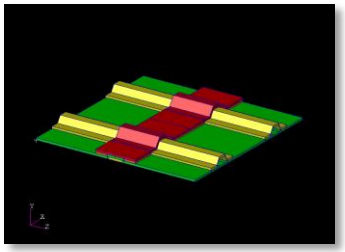
Assured Autonomy for Aviation Transformation

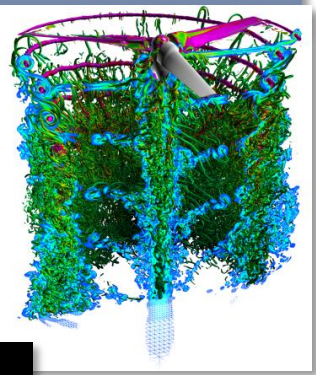
- Develop high impact aviation autonomy applications

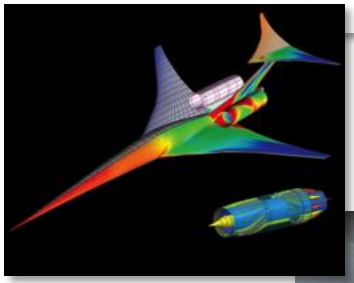
FY15 Advanced Air Vehicles Program

DRAFT: Cutting-edge research that will generate innovative concepts, technologies, capabilities & knowledge to enable revolutionary advances for a wide range of air vehicles.









Advanced Air Transport Project (AATT) Conducts fundamental research to improve aircraft performance and minimize environmental impacts from subsonic air vehicles

Revolutionary Vertical Lift Technology Project (RVLT) Develops and validates tools, technologies & concepts to overcome key barriers, including noise, efficiency, & safety for vertical lift vehicles

Advanced Composites Project (ACP) Conducts research to reduce the timeline for certification of composite structures for aviation

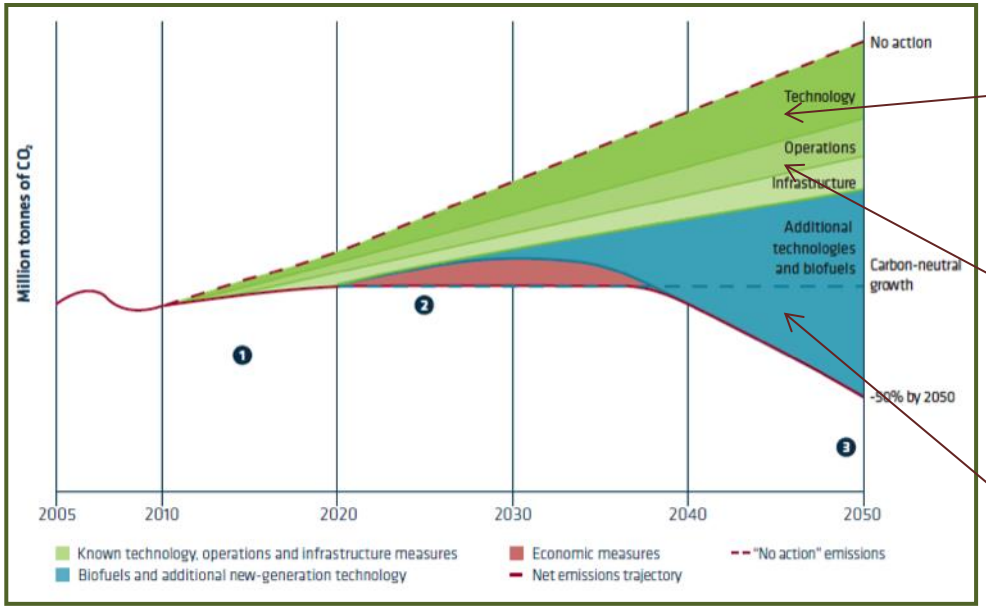
Commercial Supersonics Technology Project (CST) Explores theoretical research for potential advanced capabilities & configurations for low boom supersonic aircraft.

Aeronautical Evaluation & Test Capabilities Project (AETC) Ensures the strategic availability, accessibility, & capability of a critical suite of aeronautics ground test facilities to meet Agency & national aeronautics testing needs

Advanced Air Vehicles Program
Three Strategic Thrusts Address the Aviation Community Strategy for Reducing Carbon Emissions

Strategic Thrusts 1, 3, and 4 support the three major approaches to meeting industry-wide goals for carbon neutrality and reduction

Community Targets for Reducing CO2 Emissions



(See www.atag.org)

Thrust 3 – Ultra-Efficient Aircraft Technologies

Thrust 1 – NextGen / Efficient Flight Path Management

Thrust 4 – Low-Carbon Propulsion

Transition to Low-Carbon Propulsion Thrust

There are three focus areas:

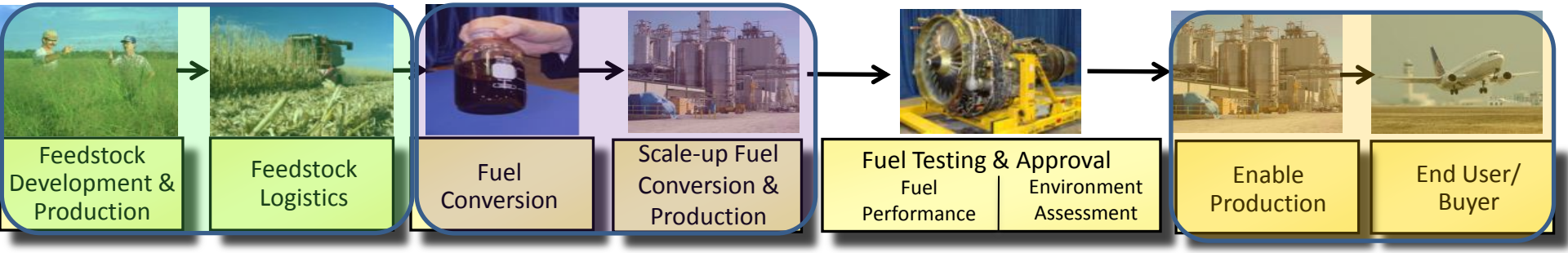
1. Characterization of Alternative Fuels
2. Pioneering new Propulsion Concepts/Cycles

} AAV Program, Advanced Air Transport Technology Project

3. Foundational, enabling combustion science/modeling – TAC Program, Transformative Tools, & Technologies Project

- Two AATT Technical Challenges (draft):
  - **Alternative Fuel Emissions at Cruise:** Fundamental characterization of a representative range of alternative fuel emissions at cruise altitude (FY15 completion)
  - **Gas-Electric Propulsion Concept:** Establish viable concept for 5-10 MW hybrid gas-electric propulsion system for a commercial transport aircraft (TRL 2)
  - Other AATT TCs support (e.g. advanced core and configurations)
- Note close synergy between Thrust 4 & Thrust 3 (Ultra Efficient Commercial Vehicles) – Advanced propulsion cycles needed for ultra-efficient vehicles will also be critical for low carbon propulsion systems)
- Potential opportunities through the TAC Program Convergent Aeronautical Solutions Project – with future transition to the AAVP or IASP portfolios.

Alternative Jet Fuels
Agency Coordination & National Strategy Development



- Participating Departments & Agencies - Agriculture, Commerce, Defense, Energy, EPA, FAA/DOT, NASA, NSF, State.
- Delineation & articulation of Agencies' respective involvement along the drop-in alternative jet fuel development path.
- Development of a National Strategy (draft form presently) describing recognized challenges in alternative jet fuel, associated R&D Goals & Objectives – spanning time horizons through Far-term (>10years).
- Documentation development informed by non-federal stakeholder interaction & acknowledged non-R&D context (policy, economic factors/challenge, & international considerations.

NASA Alternative Jet Fuel Characterization Research

- **Laboratory tests** to determine alternative fuel combustion and emissions characteristics – flame-tube experiments, sector rig tests
- **Ground-based engine tests -** evaluate alternative fuel effects on emissions under real-world conditions (AAFEX-I, -II)
- **Ground-based cloud chamber tests -** examine PM on contrail formation
- **Airborne experiments -** evaluate fuel effects on emissions and contrail formation at cruise
  - **ACCESS-I: Feb-April, 2013**
  - **ACCESS-II: May, 2014**
    - Established successful techniques for sampling aircraft exhaust and contrails in the near and far-field behind DC-8, can be extended to other flight venues
    - Obtained one-of-a-kind, extensive, high quality data set of NOx, CO, aerosol & Black Carbon emission indices for a typical commercial airliner at cruise — highly valuable for model development & aviation air quality/climate impact assessments.
    - Obtained first direct measurements of contrail EI_{ice} at cruise altitudes
    - Developed highly productive collaborations with DLR & NRC – dialogue on potential future collaboration

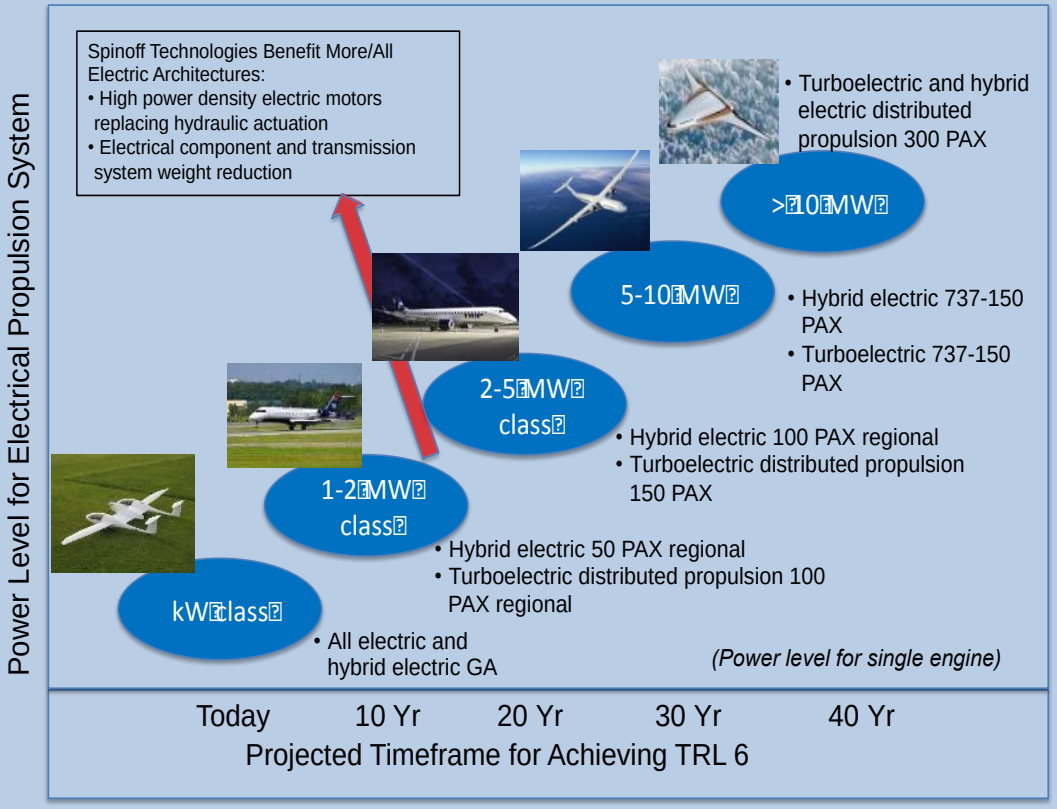
Advanced Air Vehicles Program
Hybrid Electric Propulsion Systems for Aviation

Low Carbon Propulsion

NASA studies and industry roadmaps have identified hybrid electric propulsion systems as promising technologies that can help meet national environmental and energy efficiency goals for aviation

Potential Benefits

- Energy usage reduced by more than 60%
- Harmful emissions reduced by more than 90%
- Objectionable noise reduced by more than 65%



What is needed?

- Conceptual designs of aircraft and propulsion systems
- Higher power density generators and motors
- Flight-weight power system architectures and simulations
- Higher energy density energy storage systems (non-NASA)
- Extensive ground and flight testing

Summary

- NASA is taking a leadership role in developing new options for low-carbon propulsion.
- Contributions related to characterization of alternative fuels are coordinated with our partners in government and industry.
- Research on alternate propulsion concepts continues to grow - an important aspect of the ARMD portfolio
- Strong partnerships have been a key enabling factor for research supporting the Low Carbon Strategic Thrust.
  - Cross-Agency coordination on a new National Alternative Jet Fuel Strategy that also involves engaging the external community
  - Multi-Agency and international participation on key experiments (ACCESS)
  - Under NASA's lead, the alternative jet fuel characterization has been the first substantial focus area for collaboration under the International Forum for Aviation Research (IFAR).
  - Inspiration for surge in focus on hybrid systems for larger aircraft are borne out of NASA Advanced Concept Studies (internal and external).
  - New partnerships with traditional partners (e.g. the Navy to leverage their efforts on more-electric systems for ships).