NASA SBIR 2019 Phase I Solicitation

A1.04 Electrified Aircraft Propulsion

Lead Center: GRC

Participating Center(s): AFRC, LaRC

Technology Area: TA15 Aeronautics

The critical technical need for lightweight, high-efficiency power distribution systems that have flight critical reliability have led to requirements for weight reduction by a factor of 2-3 as well as improved efficiency. Higher efficiency reduces losses and makes thermal management more achievable in an aircraft. Another need for medium to large aircraft is the ability to operate at voltages above 600V. This capability results in reduced weight, however is called out specifically because it impacts all of the power system components. Technologies that address these gaps enable Electrified Aircraft Propulsion (EAP) which enables new aircraft configurations and capabilities for the point-to-point Urban Air Mobility (UAM) market and a new type of innovation for transport aircraft to reduce fuel consumption and emissions. EAP is an area of strong and growing interest in NASA's Aeronautics Research Mission Directorate (ARMD). There are emerging vehicle level efforts in the area of UAM/On-Demand Mobility like the X-57 electric airplane being built to demonstrate EAP advances applicable to thin haul/short haul aircraft markets, and an ongoing technology development subproject to enable EAP for single aisle aircraft.

NASA Projects working in the vehicle aspects of EAP include: Advanced Air Vehicles Program (AAVP)/Advanced Air Transport Technology (AATT) Projects, Integrated Aviation Systems Program (IASP)/ Flight Demonstrations & Capabilities (FDC) Project, AAVP/Revolutionary Vertical Lift Technology (RVLT) Project, and Transformative Aeronautics Concepts Program (TACP)/Convergent Aeronautics Solutions (CAS) Projects.

Turboelectric, hybrid electric, and all electric power generation as well as distributed propulsive power have been identified as candidate transformative aircraft configurations with reduced fuel consumption/energy use and emissions. However, components and management methods for power generation, distribution, and conversion are not currently available in the high-power ranges with the necessary efficiency, power density, electrical stability and safety required for thin haul/short haul, or transport-class aircraft.

Therefore, technical proposals are sought for the development of enabling power systems, turbofan engines, range extenders, electric machines, batteries, power converters, electrical fault management systems, protective devices (such as circuit breakers), and related materials that will be required for aircraft which use turboelectric, hybrid electric, or all electric power generation as part of the propulsion system.

Specifically, novel developments are sought in these areas:

- Light weight AC and DC electrical fault management systems and protective devices (such as circuit breakers)
- Aircraft power systems operating at or above 600V
- Turbofan engines in which > 20% of power is extracted electrically

- Lightweight multifunctional additively-manufactured heat exchangers/recuperators (using metallics and/or ceramics) which can operate up to 1400° F
- Range extenders which consume fuel and produce electricity with significantly higher efficiency than available turbogenerator or diesel generators
- Electric machines (motors/generators) with efficiency > 98% and specific power > 13 kW/kg
- Magnetic gear systems with gear ratio on the order of 10:1 that connect high speed motors to lower speed propulsors
- Converters (inverters/rectifiers) with efficiency > 99% and specific power > 19kW/kg
- Energy storage systems with specific energy > 400Whr/kg at the system level and cycle life > 10,000 cycles. This SBIR seeks energy storage technologies in the Technology Readiness Level (TRL) range from 2 to 6 for shorter-term infusion into NASA Aeronautics projects. Submissions for technologies in the TRL range 1 to 4 should seek partnering academic institutions and apply to STTR subtopic T15.03 - Electrified Aircraft Propulsion Energy Storage.
- Soft magnetic material with high magnetic saturation and/or lower losses for 100kHz-300kHz operation
- Hard magnetic materials with an energy product greater than neodymium iron boron
- Conductors with a specific resistivity less than copper or aluminum and cable insulation materials with increased dielectric breakdown strength as well as significantly higher thermal conductivity (? 1W/m·K) and resistance to ageing effects such as corona, ozone, humidity and dust operating at greater than 3kV
- Advanced material systems for motors

Individual components should target the 15kW-3MW size range and would be combined into power systems in the range of 200kW-10MW total power.

References:

- Electrified Aircraft Propulsion (EAP) is called out as a key part of Thrust 4 in the ARMD strategic plan: https://www.nasa.gov/aeroresearch/strategy
- Overview of NASA's EAP Research for Large Subsonic Aircraft: https://ntrs.nasa.gov/search.jsp?R=20170006235
- NASA X-57 Project: https://www.nasa.gov/aeroresearch/X-57/technical/index.html