U.S. Department of Energy
Advanced Research Projects Agency – Energy

Announcement of Teaming Partner List for an upcoming Topic:

Solicitation on Topics Informing New Program Areas: Interconnecting Systems for Medium-Voltage Power Distribution in Electric Aviation: Connecting Aviation By Lighter Electric Systems (CABLES)

The Advanced Research Projects Agency – Energy (ARPA–E) intends to issue a new Topic for the FOA "Solicitation on Topics Informing New Program Areas" and the "Solicitation on Topics Informing New Program Areas SBIR/STTR" in June 2020 to solicit applications for financial assistance to develop and demonstrate interconnecting systems for medium-voltage power distribution in electric aviation.

As described in more detail below, the purpose of this announcement is to facilitate collaborations among performing teams including the testing and resource support teams to respond to the upcoming Topic. The FOA, once the new Topic has been issued, will provide specific Program goals, technical metrics, and selection criteria and the FOA terms. For the purposes of the Teaming Partner List, the following summarizes current planning for the Topic:

ARPA-E has recently launched two programs on electric aviation relevant to narrow-body passenger aircrafts. The first program, ASCEND (Aviation-class Synergistically Cooled Electric-motors with integrated Drives) will deal with the development of lightweight and ultra-efficient integrated electric motors, drives, and thermal management systems to facilitate net-zero carbon emissions. The second program, REEACH (Range Extenders for Electric Aviation with Low Carbon and High Efficiency) will develop a system for the conversion of chemical energy contained in energy dense Carbon Neutral Liquid Fuels (CNLFs) to electric power for aircraft propulsion. However, a remaining challenge, especially in all-electric aviation, is power distribution. To address this, ARPA-E seeks the development of electric power cable, electric cable connector, and circuit breaker technology suitable for an all-electric aircraft.

The state-of-the-art maximum onboard electric power generation capacity in operating commercial airliners is approximately 1 MW on the Boeing 787 which is supplied via low-voltage AC distribution (115-235 V_{AC}, ±270 V_{DC}) to ancillary electrical power systems such as HVAC, avionics, actuators, and anti-icing. Airbus' testbed design for a narrow-body, hybrid-electric distribution system, the E-Fan X, includes a distribution system at 3 kV and a 2 MW electric propulsor which replaces one of four jet engines.[1] However, an all-electric propulsion system for a twin-aisle (e.g. NASA N3-X) aircraft would require at least 50 MW[2] (i.e. utility-scale power) during takeoff, which is significantly higher than the present onboard generation and power distribution system capabilities. Rolls-Royce and GE research projects funded by

[1] https://www.airbus.com/innovation/future-technology/electric-flight/e-fan-x.html#ove
[2] National Academies of Sciences, Engineering, and Medicine. 2016. *Commercial Aircraft Propulsion and Energy Systems Research: Reducing Global Carbon Emissions*. Washington, DC: The National Academies Press

NASA[3,4] have concluded that even with a high temperature superconductors (HTSs), voltages are optimally in the range of ±4.5-12 kV to achieve the power density required of power electronics and motors for 50 MW of total system power. The distribution of such a large amount of power may require the use of a prohibitive load of cables, connectors, and circuit breakers. Thus, ARPA-E is interested in evaluating transformative solutions such as the use of a medium-voltage distribution system and novel conducting materials that would be more likely to meet the weight and size requirements. In addition to the power density concerns, the distribution system will also have to meet the safety and reliability demands for aerospace applications in extreme environmental conditions (pressure, temperature, vibration, shock, etc.). In particular and most importantly, at medium voltage and low atmospheric pressures the risk of partial discharge becomes a concern. There are several unique challenges that will need to be addressed with various possible solution spaces to achieve greater than 50MW aerospace power distribution.

To accomplish this goal, ARPA-E is looking for diverse interdisciplinary teams to foster research and development of medium-voltage interconnecting systems for power distribution in electric aviation. The broad objectives of this Topic are to (i) identify appropriate wiring materials (i.e., conducting or superconducting) with optimum gravimetric power densities and minimum electrical losses, and evaluate corresponding vacuum or cryogenic systems if necessary; (ii) identify insulating materials with high dielectric strength, good thermal conductivity, low specific weight, conformality, malleability, and air-void minimization; (iii) assess connector designs and reliability; (iv) develop circuit breakers for aviation applications; and (v) address partial discharge related reliability issues that arise from low air pressure environments.

The targeted outcome of the program is to increase the power distribution capability on electric aircraft with minimal impact on weight while maintaining the high reliability and safety requirements of aviation.

As a general matter, ARPA–E strongly encourages different organizations with outstanding scientists and engineers, and across different scientific disciplines and technology sectors to participate in this Program. Interdisciplinary and cross-sector collaboration spanning organizational boundaries enables and accelerates the achievement of scientific and technological outcomes that were previously viewed as extremely difficult, if not impossible.

The Teaming Partner List is being compiled to facilitate the formation of new project teams. ARPA-E intends to make the Teaming Partner List available on ARPA–E eXCHANGE (http://ARPA–E-foa.energy.gov), ARPA–E's online application portal, starting in June 2020. The Teaming Partner List will be updated periodically, until the close of the Full Application period, to reflect the addition of new Teaming Partners who have provided their information.

Any organization that would like to be included on the Teaming Partner list should complete all required fields in the following link: https://ARPA–E-foa.energy.gov/Applicantprofile.aspx. Required information includes: Organization Name; Contact Name; Contact Address; Contact Email; Contact Phone; Organization Type; Area of Technical Expertise; and Brief Description of Capabilities.

By submitting a response to this Notice, you consent to the publication of the above-referenced information. **By facilitating this Teaming Partner List, ARPA–E does not endorse or otherwise evaluate the qualifications of the entities that self-identify themselves for placement on the Teaming Partner**

[3] Armstrong M., et al., "*Architecture, Voltage, and Components for a Turboelectric Distributed Propulsion Electric Grid*," NASA/CR—2015-218440

[4] Gemin P., et al. "*Architecture, Voltage and Components for a Turboelectric Distributed Propulsion Electric Grid (AVC-TeDP)*," NASA/CR—2015-218713

List. ARPA–E will not pay for the provision of any information, nor will it compensate any respondents for the development of such information. Responses submitted via email or other means will not be considered.

This Notice does not constitute a FOA. No FOA exists at this time. Applicants must refer to the final FOA, expected to be issued in June 2020, for instructions on submitting an application and for the terms and conditions of funding.