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M3Or4A-01 [Invited]: Enabling Aircraft Distributed Electric Propulsion through Cryogenic Hydrogen Energy: Research of the Center for Cryogenic High-Efficiency Electrical Technologies for Aircraft (CHEETA)

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Driven by global growth in demand for high-speed mobility, as well as a need to ensure profitability and sustainability of aviation into the future, it has been recognized that a strategic transition towards alternative propulsion and energy sources is necessary. To facilitate ensured energy availability and dramatic decreases in warming potential of commercial air travel into the future, a fundamental shift towards a cryogenic Hydrogen storage system for a full-electric transport aircraft concept is proposed. This concept leverages the high specific energy content of liquid hydrogen (LH2) with fuel cell energy conversion and an electrically-driven distributed propulsion system to provide an ultra-efficient propulsion drivetrain. For this concept, the LH2 system is not just used as an energy storage mechanism, but also as a cryogen to enable highly efficient superconducting electric systems. The end result of this concept is an integrated vehicle system with a quiet, efficient propulsion system that produces zero CO2, NOx, and particulate matter emissions at the vehicle level.

For such a concept to be feasible, significant progress in cryogenic and superconducting systems and technologies must be developed. In order to make novel advances in technology for cryogenic electrified propulsion systems and distributed propulsion air-vehicle concepts, a NASA-sponsored University Leadership Initiative was recently awarded to establish the Center for Cryogenic High-Efficiency Electrical Technologies for Aircraft (CHEETA). This presentation will provide an overview of the upcoming research activities supported through CHEETA, including several challenges, opportunities, and impact areas associated with next-generation cryogenic electrified aircraft propulsion technologies. The result of this research center aims to provide disruptive improvements in the rated and specific power of cryogenic electrical machines and power electronics, superconducting materials, cryogenic storage systems, fuel cell systems, complex electro-thermal multiphysics modeling, and electrified distributed propulsion integration and design.

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