Sustainability through Cryogenic Hydrogen-Electric Aviation: Research of the Center for High-Efficiency Electrical Technologies for Aircraft (CHEETA)

Phillip Ansell

University of Illinois at Urbana-Champaign, USA

Email: ansell1@illinois.edu

***Abstract*— In 2018, the global aviation community produced over 1 billion metric tons of CO_2 emissions. Alongside non- CO_2 -related greenhouse gas emissions and large anticipated growth in air transportation across future decades, aircraft systems serve as an increasingly important factor in the pursuit of global sustainability. Developing fully renewable variants of commercial aircraft is an ambitious task, as the required power and stored energy capabilities of these systems exceed those found in many other transportation sectors. However, the use of liquid hydrogen as a lightweight energy storage medium, alongside the high-power capabilities of superconducting power systems, has recently emerged as an enabling factor in making renewable aircraft systems realizable. Research conducted by a multi-institutional consortium through the Center for High-Efficiency Electrical Technologies for Aircraft (CHEETA) seeks to facilitate future cryogenic hydrogen-electric aircraft systems through the development of several multi-disciplinary enabling technologies. These technologies are situated around a 180-passenger, hydrogen-electric aircraft configuration. This system utilizes a new class of lightweight hydrogen tanks for storing LH_2 and a fuel-cell electrochemical power system to provide electrical power to a series of superconducting electric motors. The cryogenic LH_2 is also used as a means of maintaining the superconducting state of high-power transmission lines and motor windings. The use of a fully electric propulsion system also permits new capabilities in the distribution and coupled installation of the aircraft propulsion system. As such, significant attention is given to the configuration of the vehicle platform, design of the fan components, and integration of the thermal and spatial considerations needed for hydrogen-electric aircraft. A further consideration is also given to the design and protection of the power system, configuration of current leads and power electronics, and management of electrical and thermal loads. The outcomes of the research from CHEETA will be shared across a panel session dealing with the role of cryogenic systems in transportation.**

***Keywords (Index Terms)* — CHEETA, superconducting motor, liquid hydrogen, cryogenic LH2, hydrogen-electric aircraft.**

IEEE CSC & ESAS SUPERCONDUCTIVITY NEWS FORUM (global edition), October 2021.
Submitted August 2, 2021; Selected September 8, 2021.
Invited presentation J4Or2A-01 given at CEC/ICMC2021, 19-23 July 2021, Virtual.