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Electric Aircraft: Solving the Propulsion Materials and Engineering Challenges

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***Abstract*—New Zealand companies have long been recognised as a global leader in renewable energy integration and holding deep expertise in commercial application of superconducting technology. This is supported by the New Zealand government who have put in place a strategy that mirrors this; to be net carbon-zero by 2050. The government have further invested in cooperative technology development programmes that will accelerate international development.**

Transportation is the largest source of our non-agricultural greenhouse gas emissions from the country – domestic aviation accounts for 10% of our emissions and long-haul travel maybe more. We depend on aviation, our exports depend on shipping, and our internal freight relies on trucks. We will use electrical energy to reduce our carbon footprint. The good news is that New Zealand is unique in its electricity production—over 80% of our electrical energy is generated from renewable sources, and we are targeting an increase to 100% using wind, solar, and geothermal energy. We have the opportunity for truly zero carbon electrical energy to power this revolution.

Electrification of aviation propulsion has the highest potential of drastically reducing emissions in a sector that is critical to New Zealand prosperity. Our domestic (Sounds Air) and international (Air New Zealand) are both committed to passenger electric flight introduction by 2026. The NZ government are supporting this and making the regulatory framework available to act as an international test-bed. This is driving significant commercial partnerships both within NZ and with overseas manufacturers.

We see large transport is the challenge for electrification—aircraft with more than 100 seats. Conventional technology cannot provide the power-to-weight required to electrify at this scale. Superconducting, and cryogenic, machines may provide a solution: they are small and light, relative to their power output. New Zealand has been working on superconductors since the

1980s and researchers in this field have recently teamed up with NZ's leading researchers in power electronics and cryogenics systems, and formed strategic international research partnerships.

We present an overview of the multidisciplinary research in this NZ national programme towards electric flight realization. We examine the technology integration within superconducting machines for aircraft using novel technology such as flux pump exciters, low ac-loss windings, additive manufacturing wide bandgap electronics and integrated cryogenic systems. We present an overview of the technology development, implications and how this research is globally relevant. We report on results from a superconducting motor that has been operated at 18,000 rpm and highlight the way forward.

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