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Memorandum on the Nelson Airport's Runway Extension Proposal

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This memorandum is intended as an evaluation of Nelson Airport's plan to protect its ability to extend its runway. The ICCT is an award-winning, independent, global, non-profit research organization that provides data-driven research to advance policies that reduce the health and environmental impacts of the transportation sector, including aviation.

ICCT supports the proposed runway extension at Nelson airport in anticipation of the use of zero-emission planes that are projected to be heavier than their fossil-fueled counterparts. Decarbonizing aviation will require a global effort that relies on both, the traditional technical and operational efficiency improvements historically experienced by the industry, and the adoption of revolutionary new technologies like sustainable aviation fuels (SAF), and zero-emission planes (ZEP). Large, long-haul aircraft will require SAF to decarbonize. However, the airline routes from Nelson Airport, all of which are below 500 km long, could be serviced entirely by future zero-emission planes.

Zero-emission planes could be powered by batteries, hydrogen fuel cells, or hydrogen combustion gas turbines. These are emerging technologies and are a few years away from commercial deliveries. Battery electric and hydrogen fuel cell aircraft will likely enter service before 2030, while efforts are underway to bring hydrogen combustion aircraft into service in 2035.[1] Given that the runway extension is anticipated in the next 10-15 years, and that aircraft will require a few years to be adopted in airline fleets, let's only consider battery electric and hydrogen fuel cell aircraft in the year 2035 (13 years from now).

Battery electric aircraft, assuming projected improvements in battery technology, could carry 9 passengers up to 250 km.[2] Larger aircraft will be harder to electrify due to the

[1] Mukhopadhaya, Jayant, and Dan Rutherford, *Performance Analysis of Evolutionary Hydrogen-Powered Aircraft*, (ICCT, Washington, D.C., 2022), https://theicct.org/publication/aviation-global-evo-hydrogen-aircraft-jan22/.
[2] Mukhopadhaya, Jayant, and Brandon Graver, *Performance Analysis of Regional Electric Aircraft*, (ICCT: Washington, D.C., 2022), https://theicct.org/publication/global-aviation-performance-analysis-regional-electric-aircraft-jul22/

low energy density of batteries. The weight of the batteries onboard would result in aircraft that are 25-40% heavier than comparable fossil-fueled aircraft. These aircraft are smaller than the 50- to 70-seat aircraft that operate out of Nelson Airport today. While they may be able to fly to Wellington and Christchurch, airlines would have to replace one fossil-fueled flight with 3-6 electric flights.

Aircraft powered by hydrogen fuel cells are projected to be able to carry 58 passengers more than 500 km.[3] These aircraft would be approximately as big, or slightly bigger, than those that operate out of Nelson Airport. If an ATR 72-600 (currently the biggest aircraft to operate out of Nelson Airport) were to be retrofitted with hydrogen fuel cell propulsion, the compressed hydrogen tanks and fuel cells would likely increase the maximum takeoff mass (MTOM) of the aircraft by 5-10%.

This increase in MTOM relative to current ATR72-600s would present problems for operations at Nelson Airport at its current runway length of 1,347 m. The ATR 72-600s stated takeoff field length (TFL) at MTOM of 1,315 m is less than the current runway length.[4] The TFL is calculated for the International Standard Atmosphere's definition of sea-level conditions: 15 °C and 1.01 kilopascals. However, when temperatures are higher than 15 °C, which is becoming more likely due to climate change, the reduced density of the air increases the runway length requirement for the aircraft.[5] If temperatures are high enough, which is sometimes the case at Nelson Airport, a fully loaded ATR 72-600 aircraft cannot take off safely from the current runway. Consequently, the aircraft needs to be unloaded by taking off passengers or cargo.

This problem will only be more pronounced with aircraft retrofitted with fuel cell propulsion. As mentioned earlier, a retrofit ATR 72-600 with hydrogen fuel cell propulsion will weigh 5% to 10% more when fully loaded. This would likely require a runway that is up to 10% longer than the original aircraft's stated TFL. The proposed extension to make the runway 1,510 m in length is a 12% increase compared to the current runway and a 15% increase compared to the stated TFL of the ATR 72-600. This would be long enough to accommodate retrofitted zero-emission aircraft.

Commercial airline routes from Nelson Airport, all of which are <500 km long, are entirely flown on turboprop aircraft suitable for zero-emission technologies. **Figure 1** shows the expected operational range of battery electric (250 km, inner oval) and hydrogen fuel cell aircraft (500 km, outer oval) from Nelson Airport (NSN). While electric aircraft would have a smaller capacity, they are significantly more energy efficient than fossil-fueled aircraft and might merit adoption, nonetheless. Fuel cell aircraft are similarly sized to those currently operating from the airport. They could provide zero-emission (only producing water as a by-product) on all existing routes from Nelson Airport.

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[3] Preliminary results from currently unpublished ICCT research.

[4] "ATR 72-600 Aircraft | ATR Aircraft." n.d. ATR. Accessed August 16, 2022. https://www.atr-aircraft.com/our-aircraft/atr-72-600/.

[5] The increased temperature reduces the density of the air which increases the minimum speed required for the aircraft to takeoff. Achieving this higher minimum speed requires a longer runway.

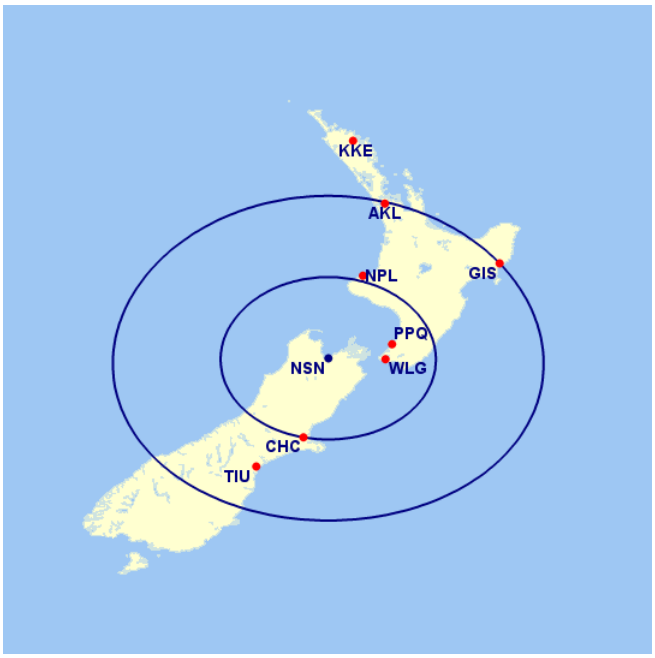

Figure 1. Operational range of battery electric (250 km, inner oval) and hydrogen fuel cell aircraft (500 km, outer oval) from Nelson Airport (NSN)

While runway length is one aspect, other infrastructure improvements will be required to support zero-emission aircraft. We recommend that Nelson Airport also consider:

1) Developing charging infrastructure to support electrification of aircraft and other ground operations equipment such as buses and trucks.
2) Developing hydrogen storage infrastructure to store both compressed gaseous and liquid hydrogen.
3) Support standards ensuring that only hydrogen produced entirely from renewable energy (referred to as green hydrogen) is supplied at their airport.
4) Investigating on-site hydrogen production, compression, and liquefaction infrastructure.

All current airline routes out of Nelson Airport can feasibly be serviced by upcoming battery electric and hydrogen fuel cell aircraft. Being prepared to service these aircraft when they begin delivering to airlines will speed up decarbonization of the aviation industry. Nelson Airport's plans to protect the ability to extend its runway is a necessary response to the expected infrastructural needs of future zero-emission aircraft likely to service Nelson.