Presentation to Christchurch City Council full council meeting 15 February 2023

Professor James Higham

Kia ora. Good morning Mayor Mauger, Councillors and Staff

'Informed Leaders' is an initiative of eleven leading academics from New Zealand universities that have shared concerns about the proposal to build an international airport at Tarras. Our concerns are based on extensive bodies of published research in a range of disciplinary fields, produced by leading New Zealand and international researchers.

We believe that decisions that carry significant and long-term consequences should be fully informed by rigorous science. We are independent of commercial interests. We only seek to inform discussion and debate by providing timely insights that are independent of the advice which Christchurch International Airport Ltd will soon produce.

The 'Leaders' who we want to be 'Informed' are the people who sit around this table.

The letter that we sent two weeks ago has now been supported by an additional 34 New Zealand and international academics. It is our shared view that the proposed Tarras Airport should not proceed. Today, three of us will speak very briefly to our disciplinary perspectives on the proposed airport.

My name is James Higham, I am a distinguished professor of sustainable tourism at the University of Otago.

To begin with, air transportation is critically important to New Zealand. It connects us to our international markets and to the world. However, we have long known about the catastrophic consequences of climate change and the need to avert the sorts of climate disasters that have hit the North Island in recent days.

Over the last four years we have seen unprecedented consensus on the challenges we face with tourism in New Zealand. New directions are now embedded in various strategic documents. The proposed Tarras Airport development is fundamentally at odds with the policy statements, strategy documents and commitments that give direction to tourism renewal after the COVID pandemic **(See Figure A below and Appendix A, at the end of this document).**

The Tarras Airport proposal is fundamentally at odds with current policy statements, strategy documents and international commitments.

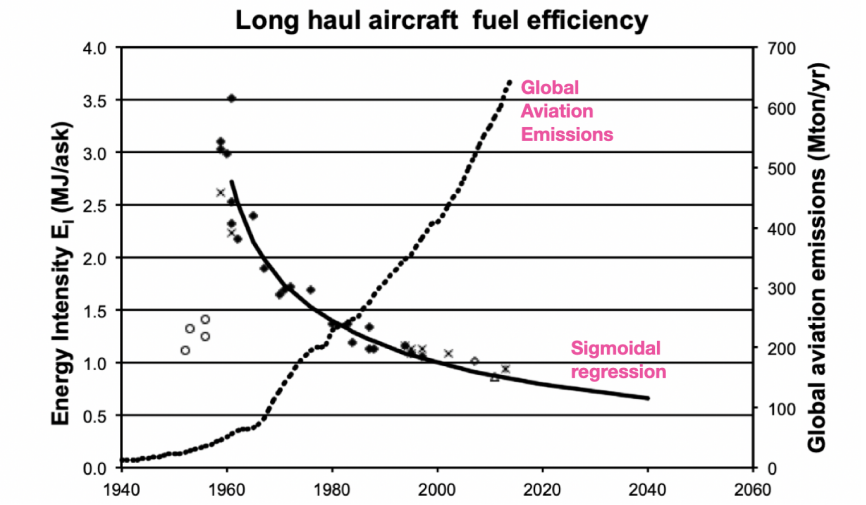
- Christchurch City Council declared climate emergency 23 May 2019
- Environment Canterbury declared climate emergency May 2019
- Queenstown Lakes District Council declared climate emergency 27 June 2019
- Central Otago District Council declared climate emergency 25 September 2019
- New Zealand Government declared climate emergency 2 December 2020
- Local Government New Zealand Climate Change Declaration 2017
- Destination Queenstown Destination Management Plan 2023
- Tourism Central Otago Destination Management Plan 2022
- Parliamentary Commissioner for the Environment's reports (Dec 2019 and Feb 2021)
- Tourism Industry Aotearoa (TIA) Tourism Carbon Challenge November 2020
- Tourism New Zealand's "100% Pure NZ" Statement of Intent June 2021
- Tiaki Promise - November 2018
- Tourism Futures Taskforce - December 2020

Figure A

Aviation has a long history of defying what we might consider to be possible. But decarbonising air transportation is *by far* the greatest technical challenge this industry has ever confronted. Despite promises of zero carbon aviation, progress is very, very slow.

Analysis of industry promises reveals that many of the proposed sustainable technology solutions are announced, then hyped in the media, only to subsequently fail and disappear. Meanwhile, studies clearly calculate that efficiency gains in jet aircraft have been far outweighed by exponential growth in passenger numbers. Overall emissions are growing, not shrinking, as we close in on 2030 **(See Figure B below and Appendix B, at the end of this document).**

Improved aviation energy efficiency does not reduce gross aviation emissions



Source: Gössling and Peeters (2015)

Figure B

Close analysis reveals that the psychological, political, commercial, and scientific dimensions of aviation are deeply interconnected. A coordinated approach is needed to transition away from high carbon socio-technical systems.

Incremental advances in existing technologies will not solve the crisis in aviation emissions that we face **(Appendix C at the end of this document)**.

There is insufficient time today to even scratch the surface of available research, but the themes are clear:

- Firstly the technical challenges in decarbonising aviation are absolutely enormous;
- Secondly, the challenge of radically reducing aviation emissions is insurmountable without demand management;
- And thirdly, there is no scope for the 'aviation technology optimism' that underpins the Tarras Airport proposal.

There is insufficient time to read out in full the words of Sir Jonathan Porritt, Chair of Air New Zealand's Sustainability Advisory Panel, or the words of the CEO of Airbus, both of which are sobering and directly relevant to our considerations. We will be providing you each with a copy of our submissions today, including these two quotes in full. I really hope that you will read them closely.

> [The following was not read out loud]
>
> *For those who argue that aviation represents a uniquely unacceptable part of our carbon-intensive lifestyles, Air New Zealand's success (more flights, more passengers, more freight) will be seen as very problematic. And the truth of it is that we shouldn't turn away from that uncompromising analysis: the hard-edged physical reality of accelerating climate change tells us that there's absolutely no way emissions from aviation can keep on growing indefinitely into the future, especially when the carbon footprint of every other aspect of our lives is simultaneously being driven down and down. And that's the dilemma for anyone who cares passionately about addressing the multiple threats of climate change: either stop flying altogether (the logical but somewhat unworldly idealist's position), or fly as little and as discriminatingly and responsibly as possible (the often uncomfortable pragmatist's position).*
>
> **Sir Jonathon Porritt, Chair, Air New Zealand Sustainability Advisory Panel (2017).**
>
> "Availability or lack of availability of clean hydrogen at the right quantity in the right place at the right price in the second half of the decade is a big concern for me. The infrastructure for producing and distributing green hydrogen is still in the early stages of development. But the clock is ticking for it to be in place to fuel commercial aviation by the 2030s, and probably many other sectors much earlier. [...] I believe it is difficult to overstate the scale of the energy challenge."
>
> **Guillaume Faury, CEO of Airbus, quoted in "Airbus boss warns of delay in decarbonising airline industry." The Guardian, 30 November 2022.**

We really appreciate this opportunity to speak in the Public Forum. Today, we will email a copy of our submission to all councillors, and to your CEO. We also ask that you attach our script in full to the public record of this meeting.

We will keep you appraised of new information and research as it arises, and we welcome questions directly from any of you. We are available to provide independent advice to the city of Christchurch, and we will soon also launch a comprehensive index of relevant research on informedleaders.com. This will be updated regularly.

The responsibility you bare around Christchurch Airport's plans - directly or indirectly - is significant. Please be an informed leader as you guide the airport company via your directorships of CCHL, the Statement of Expectations and associated mechanisms. These decisions affect all New Zealanders now, and for generations to come.

Thank you for starting this open dialogue with us.

I will now hand over to **Professor Ilan Noy**.

Professor Ilan Noy

Kia ora, everyone.

I only want to speak in my role is the Chair of the Economics of Disasters, and I will not at all talk about climate change. My two colleagues will talk about climate change.

Indeed, I want to argue that even if there were no greenhouse gas emission issues involved in the Tarras development, it will still be a senseless development. I think what's unique about this proposal to develop Tarras is that the ratepayers of Christchurch will in any case lose whether or not Tarras succeeds.

If Tarras fails, which I think is by far the most likely outcome, the owners of CIAL, the citizens of Christchurch, will lose a lot of money. If Tarras does succeed, which I don't think is a plausible scenario, Christchurch ratepayers will still lose, because this will drive away business, tourism and services from Christchurch.

So I only want to talk about two economic concepts that are worthwhile mentioning in this context, and that's the "broken windows effect" and the "sunk cost fallacy" effect.

So if you look at the graph there the recovery in Christchurch, after the earthquakes in 2010 and 2011 is a classic example of the broken windows effect. The activity in the construction sector was the main driving force for the good economic performance of Christchurch in the past decade. And that has masked weakness in other sectors. **(See Figure D below)**

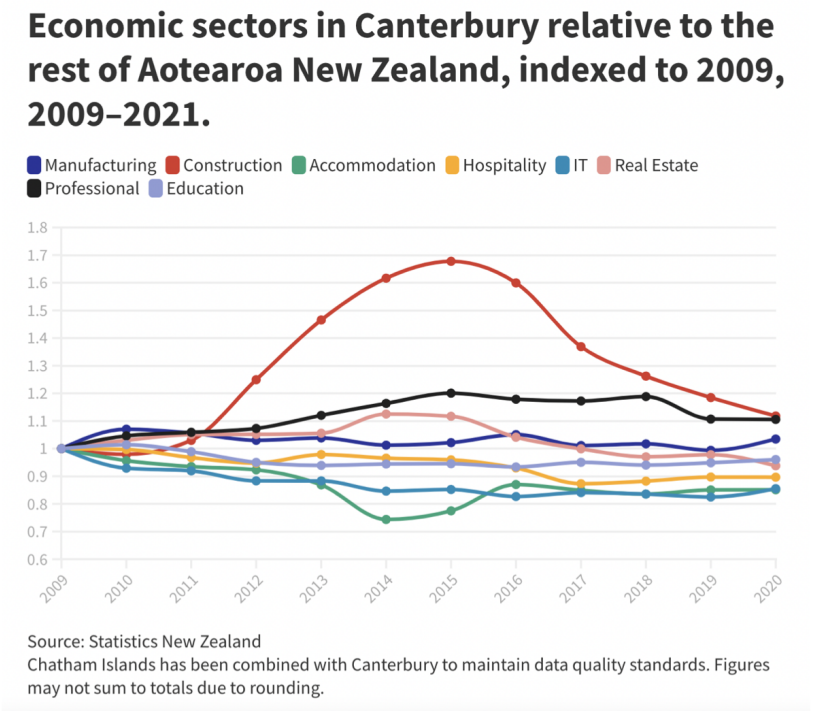


Figure D

Ultimately, reconstruction is now winding down. And with that, Christchurch will need to find alternative economic drivers. Developing Tarras will exactly deprive Christchurch of those economic engines that could have, and most plausibly would have, been the likely drivers of long term prosperity in the city.

CIAL is not the Otago Economic Development Agency and I see very little reason why the ratepayers of Christchurch would want to undertake a risky development project for Otago.

The second concept I want to talk about is the sunk cost fallacy. The sunk cost fallacy is the idea that when you decide whether you want to continue investing in a project you only decide that based on looking forward rather than looking backwards.

Whatever was already spent, is gone and is now irrelevant. You have spent, I think close to $45 million on purchasing land there and more on the costs associated with the administrating and servicing of this. Whatever was already spent, is gone.

The question you should be asking is should you sink more money in this project. The longer it takes the Council to realise that this project will end up harming Christchurch, the more money would have already been sunk into it.

I know you will probably say that the council only sets the strategic direction for CIAL. And surely that's the case. But surely that direction is not shooting the council in the foot and crippling the economy of Christchurch for the foreseeable future.

Thank you.

Professor Bronwyn Hayward

Kia ora.

Academics aren't good at speaking quickly, so I'll try and do it in three minutes so you have time to ask some questions. I'm very grateful to James and Ilan.

I'm Bronwyn Hayward, a professor of political science and public policy. I'm a co-lead author and coordinator of the Cities and Infrastructure Chapter for the IPCC, looking at best practice ways cities can protect our communities and our infrastructure in a changing climate.

I just want to make three brief points.

First, I'd really like to thank Mayor Phil Mauger for a really positive and powerful statement that he made in his campaign that we need to future proof our city and district by recognising the impact of climate change and the changing regulations we're going to have to meet; that we need to make sure that we're working with the leading climate change experts who can advise the council; and that he wishes to support the big investment that's spent over the next ten years on climate change and to see that huge investment spent wisely.

It's a terrific statement. It was in line with 71% of other mayoral candidates surveyed last year, but it was one of the clearest.

The second point that I want to make though, is that there is a serious misalignment with the council's own decisions and strategic goals, and its ownership in an investment via CIAL in Tarras.

One of your goals is to think strategically and act as one organisation. But as Ilan has just pointed out, we are in effect competing with ourselves, with our local tourism and Canterbury businesses, against Otago in this process. And coming from Otago originally and loving this province, Otago will win in this process.

Being best performance driven and accountable for results is also important to you. And this is not an accountable way to invest in a new airport, in new infrastructure, at a time when we know that air travel has a significant impact on carbon emissions.

And the future liability that that opens the council to. As our attribution science improves, we're able to calculate exactly what contribution a large infrastructure build like this makes to the really big storms that we're seeing, for example, in Auckland.

And I just note that France, for example, has banned all air travel now between cities for shorter than three hour periods where you could drive.

But thirdly, and most importantly, and allowing the issue of investment and tariffs to drag on, we're not reflecting the council shared values: its declaration of a climate emergency, which I was critical of at the time and tried to say you have to be able to live up to what you're committing to. I'd rather we held the declarations of emergency for these terrible moments we're experiencing now. But Tarras will become an increasingly unpopular and polarising political decision. Public attitudes are already hardening around climate change, not just this climate crisis, but the West Coast flooding, Canterbury droughts and fires.

Ratepayers want your climate leadership. And they don't want what they will increasingly perceive as a vanity project, and capture by corporate industry. In particular, this organisation that you have become invested with has not acted, from public anecdotal responses, in an open and transparent way in the sale of land that's already raised concern about the integrity of the whole process.

But more importantly, than all of that, you have set a goal of being carbon neutral by 2030 as a council. I'm really proud of it: you've established a climate change strategy and a carbon neutral target target for Christchurch.

Please put your money where your values are. Please rethink this decision, now. We don't have to wait for a legal case. You don't have to wait endlessly for Tarras to produce some information they keep promising will arrive.

These are your values. This is our city. These are our decisions.

Thank you so much for having us today.

Appendix A

THE TARRAS AIRPORT PROPOSAL IS FUNDAMENTALLY AT ODDS WITH CURRENT POLICY STATEMENTS, STRATEGY DOCUMENTS AND INTERNATIONAL COMMITMENTS

Christchurch City Council Climate declared climate emergency 23 May 2019

https://newsline.ccc.govt.nz/news/story/christchurch-city-council-declares-climate-emergency

"The scientific evidence that our planet is in crisis is irrefutable. By declaring a global climate and ecological emergency we are raising awareness about the urgency of the need for everyone to take action to reduce carbon emissions to zero''. "We are acknowledging that we need to better prepare ourselves for the impacts of climate change and that we need to work with our communities on mitigation measures and co-created adaptive planning tools".

Queenstown Lakes District Council declared climate emergency - 27 June 2019

https://www.qldc.govt.nz/your-council/climate-change-and-biodiversity

"We are with you, climate change is the most significant issue of our time, with the potential to change all of our lives beyond recognition. Nobody should be silent on this crucial issue. You are seeking a powerful statement, but our actions will speak louder than words." Mayor Jim Boult, as quoted in Crux.

Central Otago District Council Climate declared climate crisis - 25 September 2019

https://oag.parliament.nz/2021/risk-management/appendix2.htm

"We were all very concerned that we didn't want this to be window dressing or virtue signalling…This was actually to have actions attached to it." Mayor Tim Cadogan, as quoted in Crux.

Local Government New Zealand Climate Change Declaration 2017

Signed by Mayors of various councils including Dunedin, Southland, Christchurch, Queenstown Lakes, Clutha, Central Otago, Invercargill and Mackenzie District Councils as well as Otago Regional Council, Environment Southland and Environment Canterbury.

https://www.lgnz.co.nz/assets/Uploads/Climate-Change-Declaration.pdf

Climate change presents significant opportunities, challenges and risks to communities throughout the world and in New Zealand. Local and regional government undertakes a wide range of activities that will be impacted by climate change and provides infrastructure and services useful in reducing greenhouse gas emissions and enhancing resilience.

New Zealand Government declares a Climate Emergency 2 December 2020

https://www.beehive.govt.nz/release/climate-emergency-declaration-will-be-matched-long-term-action
https://www.ourclimatemoment.org.nz/declaration

"[We] recognise the devastating impact that volatile and extreme weather will have on New Zealand and the wellbeing on New Zealanders, on our primary industries, water availability, and public health, through flooding, sea level rise, and wildfire damage; [We] note that climate change is one of the greatest challenges of our time, that the Government has made significant progress on meeting that challenge through the Paris Agreement and the Climate Change Response (Zero Carbon) Amendment Act 2019, and that New Zealand has committed to taking urgent action on greenhouse gas mitigation and climate change adaptation;"

Destination Queenstown Destination Management Plan 2023

https://www.queenstownnz.co.nz/regenerative-tourism-2030/

Travelling to a thriving future

Queenstown Lakes is gaining momentum to meet the great challenge and opportunity of our time: to achieve a regenerative visitor economy and, critically, for it to reach carbon zero by 2030. Reaching carbon zero is the north star that orients the region's next phase of prosperity. Progress toward this vision will be made when local residents, communities, organisations, and businesses collaborate on the strategic pillars and projects outlined in this plan. These actions will ensure that Queenstown Lakes remains a special place for our children's children – one we can continue to be proud to share with visitors for years to come.

Tourism Central Otago Destination Management Plan 2022

https://www.codc.govt.nz/repository/libraries/id:2apsqkk8g1cxbyoqohn0/hierarchy/sitecollectiondocuments/strategies-and-policies/tourism/Destination%20Management%20Brochure_August%202022%20FINAL%20%28REDUCED%29.pdf

Honouring the past, embracing the present, navigating the future.

Central Otago District Council (CODC) was an early adopter of destination management (Central Otago Tourism Strategy 2018 -2028) understanding that a more balanced approach is necessary for tourism to make a positive and sustainable contribution to the district economy, the well-being of its communities and environments. Using a values-based tourism model the strategy set out to double the value of tourism without doubling the number of visitors. It led to a range of game-changing projects designed to get the ball rolling towards a better future.

Parliamentary Commissioner for the Environment's reports

Pristine, popular… imperilled: The environmental consequences of projected tourism growth (December 2019)
https://pce.parliament.nz/publications/pristine-popular-imperilled-the-environmental-consequences-of-projected-tourism-growth

Not 100% Pure… but four steps closer to sustainable tourism (February 2021)
https://pce.parliament.nz/publications/not-100-but-four-steps-closer-to-sustainable-tourism/

Tourism Industry Aotearoa (TIA) Tourism Carbon Challenge – Novemberw 2020

https://sustainabletourism.nz/take-action/useful-links/the-carbon-challenge/

The climate challenge is urgent, and the tourism industry must be a driver of change. We must act immediately to accurately measure our individual and collective carbon footprint, work together to significantly reduce carbon emissions by 2030, and be net zero carbon before 2050

Tourism New Zealand's '100% Pure NZ' Statement of Intent - June 2021

https://www.tourismnewzealand.com/assets/about/publications/intent/tnz-statement-of-intent-soi-web.pdf

The last year has given New Zealanders the opportunity to reconnect with their land as domestic visitors during a unique moment in time, and they have reflected on what they want their manaakitanga to the world to look like in future. The investment TNZ made four years ago to redefine 'value' through the Enrich 2025 concept recognised that tourism needed to contribute holistically to New Zealand, delivering net benefit outcomes for New Zealanders and communities. In this SOI, we build on that foundation and the Treasury Living Standards Framework to show how TNZ will embrace and drive forward the need for tourism to be different in New Zealand, for New Zealanders. This work can only be achieved in partnership, and we have drawn on the work of the Tourism Futures Taskforce and our industry engagement in refining the role TNZ will play in tourism's recovery and rebuild

Tiaki Promise – November 2018

https://www.tiakinewzealand.com/en_NZ/

https://youtu.be/06-CGGFUQTQ

Seven private and public sector organisations came together to create the Tiaki Promise: Tourism New Zealand, Air New Zealand, the Department of Conservation, Tourism Industry Aotearoa, Local Government New Zealand, New Zealand Māori Tourism, and Tourism Holdings Ltd.The *Tiaki Promise* is a commitment to care for New Zealand, for now and for future generations.

Tourism Futures Taskforce – December 2020

https://www.mbie.govt.nz/immigration-and-tourism/tourism/tourism-recovery/tourism-futures-taskforce/tourism-futures-taskforce-interim-report/

The future visitor economy must be regenerative and resilient. It needs to deliver net benefits across all four wellbeings: social, cultural, environmental and economic.

Ministry of Business, Innvoation and Employment - Industry Transformation Plan

https://www.mbie.govt.nz/immigration-and-tourism/tourism/tourism-projects/tourism-industry-transformation-plan/environment-phase-of-the-tourism-itp-leadership-group-members/

Aotearoa Circle Tourism Adaptation Pathway – December 2022

https://www.theaotearoacircle.nz/tourism-adaptation-roadmap

Growing global concerns regarding climate change, environmental degradation and wider sustainability practices represent a threat to our tourism industry. New Zealand's international tourism is built around and reliant on its landscapes… Add to this, the growing concern about carbon emissions, or the 'environmental travel footprint' and New Zealand's distance from most source markets plus the increasing environmental impact that domestic travellers are having on the landscape, and the industry is facing serious challenges. This workstream will further New Zealand's understanding of how the tourism industry may be impacted under different climate change scenarios and leverage a cross-section of expertise in climate and land science, conservation, tourism, government (central, local and regional economic development) policy, and sustainable finance to propose possible ways forward for the industry.

Air New Zealand's Sustainability Advisory report (2017).

https://p-airnz.com/cms/assets/PDFs/sustainability-report-2017-v2.pdf

"For those who argue that aviation represents a uniquely unacceptable part of our carbon-intensive lifestyles, Air New Zealand's success (more flights, more passengers, more freight) will be seen as very problematic. And the truth of it is that we shouldn't turn away from that uncompromising analysis: the hard-edged physical reality of accelerating climate change tells us that there's absolutely no way emissions from aviation can keep on growing indefinitely into the future, especially when the carbon footprint of every other aspect of our lives is simultaneously being driven down and down. And that's the dilemma for anyone who cares passionately about addressing the multiple threats of climate change: either stop flying altogether (the logical but somewhat unworldly idealist's position), or fly as little and as discriminatingly and responsibly as possible (the often uncomfortable pragmatist's position)".
Sir Jonathon Porritt, Chair, Air New Zealand Sustainability Advisory Panel (2017).

International Aviation Climate Ambition Coalition COP26 - November 2021

https://ukcop26.org/cop-26-declaration-international-aviation-climate-ambition-coalition/

Planning "ambitious and concrete national action to reduce aviation emissions". "Working together, both through ICAO and other complementary cooperative initiatives, to advance ambitious actions to reduce aviation CO2 emissions at a rate consistent with efforts to limit the global average temperature increase to 1.5°C."

Ministry for the Environment: New Zealand Government's Paris 2015 climate commitments
https://environment.govt.nz/what-government-is-doing/international-action/about-the-paris-agreement/
A commitment to keep the global average temperature well below 2° C above pre-industrial levels, while pursuing efforts to limit the temperature increase to 1.5°C. New Zealand's NDC is to reduce greenhouse gas emissions by 30 per cent below 2005 levels by 2030.

Ministry for the Environment: Aotearoa New Zealand's National Adaptation Plan (2022).
Infrastructure. https://environment.govt.nz/publications/aotearoa-new-zealands-first-national-adaptation-plan/
Consider long-term climate impacts when we design and invest in infrastructure, so the right infrastructure is in the right places.

He Pou a Rangi Climate Change Commission
https://www.climatecommission.govt.nz/our-work/reducing-emissions/

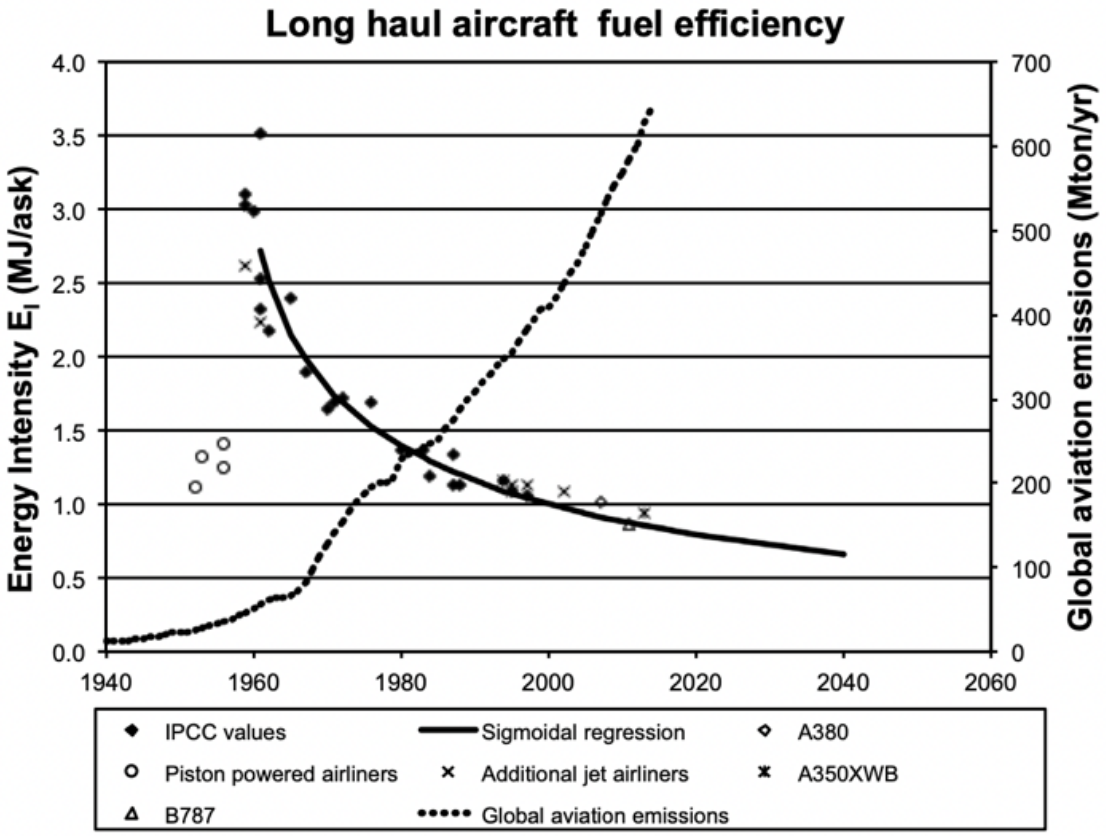
"Every investment, every decision, every action, needs to consider its emissions contribution and impact on our progress toward a climate-resilient society". Review of inclusion of emissions from international shipping and aviation in the 2050 target due December 2024.

New Zealand's Infrastructure Challenge – October 2021.
https://www.tewaihanga.govt.nz/assets/Uploads/Infrastructure-Challenge-Report.pdf
The size of the challenge is too large to fix by simply investing more. Adding more infrastructure doesn't always lead to better economic outcomes either. For example, more roads can also lead to more driving and hence more congestion, which is a cost to society. Rather, we need to invest more as well as reduce demand, increase efficiency and do better integrated spatial planning.

Appendix B

IMPROVED AVIATION ENERGY EFFICIENCY DOES NOT REDUCE GROSS AVIATION EMISSIONS

Energy efficiency and absolute emissions growth
Source: Gössling and Peeters (2015)



Gössling, S., & Peeters, P. (2015). Assessing tourism's global environmental impact 1900–2050. *Journal of Sustainable Tourism*, *23*(5), 639-659.

Appendix C

ABSOLUTE ZERO AVIATION EMISSIONS 2050 CAN NOT BE ACHIEVED WITH INCREMENTAL IMPROVEMENTS IN TODAY'S TECHNOLOGIES

Source: Absolute Zero: Delivering the UK's climate change commitments with incremental change to today's technologies (Universities of Cambridge, Bath, Nottingham, Strathclyde, Oxford and Imperial College).

[Please see diagram on next page]


2020-2029
2030-2049
2050 Absolute Zero
Beyond 2050
Road vehicles
Development of petrol/diesel engines ends; Any new vehicle introduced from now on must be compatible with Absolute Zero
All new vehicles electric, average size of cars reduces to ~1000kg.
Road use at 60% of 2020 levels - through reducing distance travelled or reducing vehicle weight
New options for energy storage linked to expanding non-emitting electricity may allow demand growth
Rail
Growth in domenstic and international rail as substitute for flights and low-occupancy car travel
Further growth with expanded network and all electric trains; rail becomes dominant mode for freight as shipping declines
Electric trains the preferred mode of travel for people and freight over all significant distances,
Train speeds increase with increasing availability of zero emissions electricity
Flying
All airports except Heathrow, Glasgow and Belfast close with transfers by rail
All remaining airports close
Electric planes may fly with synthetic fuel once there are excess non-emitting electricity supplies
Shipping
There are currently no freight ships operating without emissions, so shipping must contract
All shipping declines to zero.
Some naval ships operate with onboard nuclear power and new storage options may allow electric power
Heating
Electric heat pumps replace gas boilers. and building retrofits (air tightness, insulation and external shading) expand rapidly
Programme to provide all interior heat with heat pumps and energy retroifts for all buildings
Heating powered on for 60% of today's use.
Option to increase use of heating and cooling as supply of non-emitting electricity expands
Appliances
Gas cookers phased out rapidly in favour of electric hobs and ovens. Fridges, freezers and washing machines become smaller.
Electrification of all appliances and reduction in size to cut power requirement.
All appliances meet stringent efficiency standards, to use 60% of today's energy.
Use , number and size of appliances may increase with increasing zero-emnissions electricity supply
Food
National consumption of beef and lamb drops by 50%, along with reduction in frozen ready meals and air-freighted food imports
Beef and lamb phased out, along with all imports not transported by train; fertiliser use greatly reduced
Total energy required to cook or transport food reduced to 60%.
Energy available for fertilising, transporting and cooking increases with zero-emissions electricity
Mining material sourcing
Reduced demand for iron ore and limestone as blast furnace iron and cement reduces. Increased demand for materials for electrification
Iron ore and Limestone phased out while metal scrap supply chain expands greatly and develops with very high precision sorting
Demand for scrap steel and ores for electrification much higher, no iron ore or limestone.
Demand for iron ore and limestone may develop again if CCS applied to cement and iron production
Materials production
Steel recycling grows while cement and blast furnace iron reduce; some plastics with process emissions reduce.
Cement and new steel phased out along with emitting plastics . Steel recycling grows. Aluminium, paper reduced with energy supply.
All materials production electric with total 60% power availability compared to 2020
Material production may expand with electricity and CCS, CCU, hydrogen may enable new cement and steel.
Construction
Reduced cement supply compensated by improved material efficiency, new steel replaced by recycled steel
All conventional mortar and concrete phased out, all steel recycled. Focus on retrofit and adaption of existing buildings.
Any cement must be produced in closed-loop, new builds highly optimised for material saving.
Growth in cement replacements to allow more architectural freedom; new steel may become available.
Manufacturing
Material efficiency becomes promiment as material supply contracts
Most goods made with 50% as much material, many now used for twice as long
Manufacturing inputs reduced by 50% compensated by new designs and manufacturing practices. No necessary reduction output.
Restoration of reduced material supplies allows expansion in output, although some goods will in future be smaller and used for longer than previously.
Electricity
Wind and solar supplies grow as rapidly as possible, with associated storage and distribution. Rapid expansion in electrificiation of end-uses.
Four-fold increase in renewable generation from 2020, all non-electrical motors and heaters phased out.
All energy supply is now non-emitting electricity.
Demand for non-emitting electricity drives ongoing expansion in supply.
Fossil fuels
Rapid reduction in supply and use of all fossil fuels, except for oil for plastic production
Fossil fuels completed phased out
Development of Carbon Capture and Storage (CCS) may allow resumption of use of gas and coal for electricity