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INFRATIL UPDATE  
SEPTEMBER 2016

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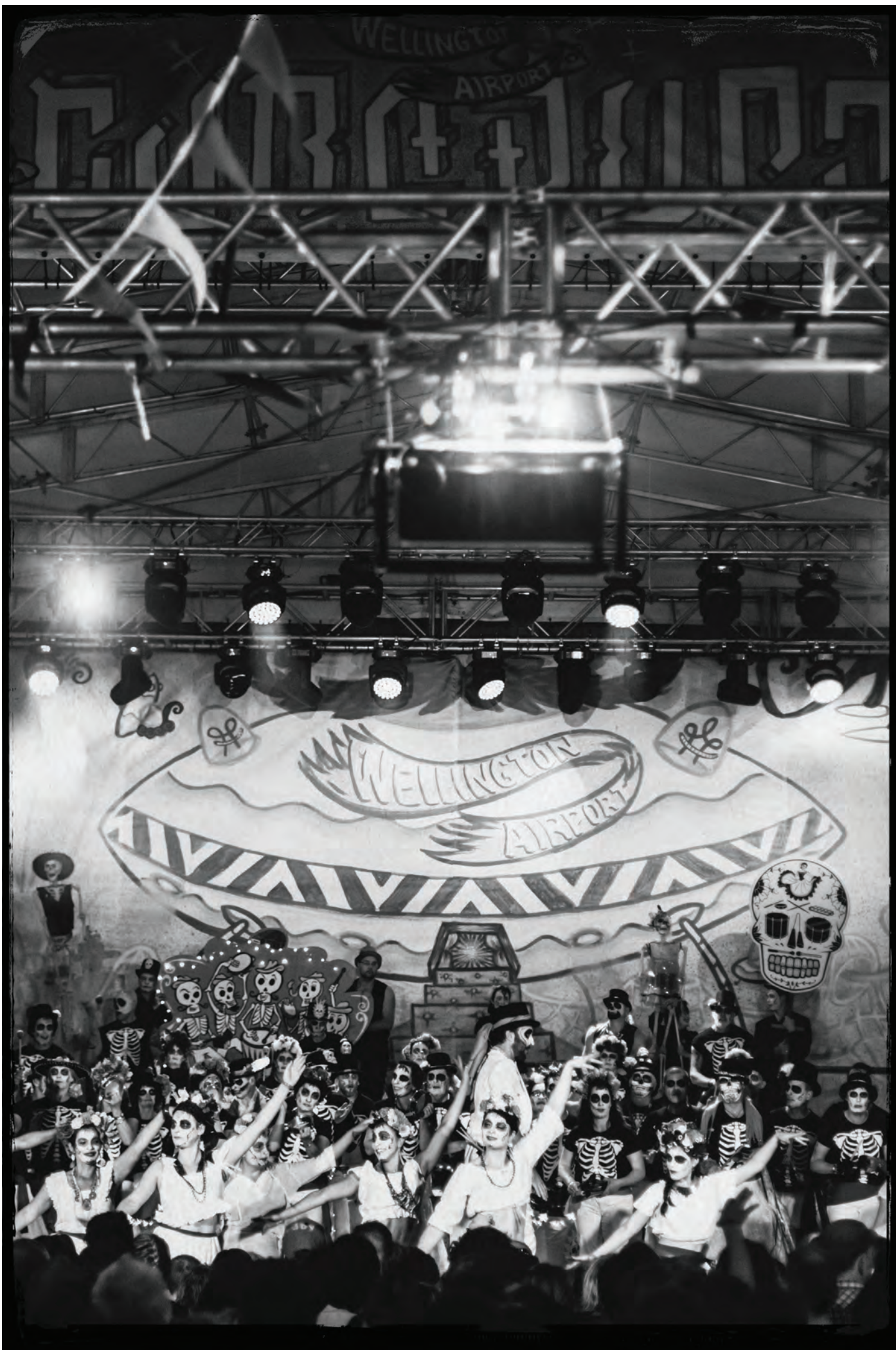


Recent technology advances offer electric vehicle transport and improved airline connectivity. In both cases realisation of the benefits requires that public and private agencies work together sharing funding and risk.













Wellington Airport is a crucial part of its region's infrastructure. It is located in a residential suburb and has homes and schools as neighbours. It pays annual dividends to the City amounting to approximately \$150 per household. It supports a wide range of community, culture, education and sporting activities.

The Airport works to build high-trust supportive relationships with its communities. While some people oppose extending the runway, the Airport will do everything possible to ensure a value creating outcome which also maintains its community relationships.

Pictures are of the finalists for the 2016 Wellington Community Trust, Wellington Airport Community Awards.



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IN THE LATE 1870s EDISON, BELL, BENZ, HUGHES  
AND PASTEUR INVENTED OR DISCOVERED ELECTRIC  
LIGHT, TELEPHONES, AN EFFICIENT INTERNAL  
COMBUSTION ENGINE, RADIO AND BACTERIA.  
BY 1920, AMERICAN HOMES WERE NETWORKED BY  
ELECTRICITY, TELEPHONES, WELL-SURFACED  
ROADS, RADIOS, AND PIPED WATER AND SEWERAGE

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Over the 40 years to 1920 American life expectancy increased almost two decades and for every 1,000 births 100 more babies survived. Wages rose 150% for the average working man and he worked 10 hours less a week. Few women were still walking 260 kilometres a year carrying 35 tonnes of water to and from their homes.

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The statistics are from a recent book, *The Rise and Fall of American Growth* by Robert Gordon, while there isn't a comparable New Zealand analysis no doubt similar improvements happened here.

New technology today is more discretionary and limited in its sphere of impact. Clean reticulated water and pasteurised milk improved a whole community's health. Now if you don't own a smart-phone or computer your life (let alone your life expectancy) could be largely unchanged aside from disappointment about the shrinking morning newspaper and regret at the disappearance of DVDs and CDs from shops.

This Update is about two current technology developments where communities can invest in adoption or can wait and see. As with buying a smartphone, there is a cost to adoption and an opportunity cost with waiting.

One of these technologies is represented by the Boeing 787 and Airbus 350. They are medium-size long-haul aircraft which are changing the economics of long-distance air travel.

Until recently central New Zealand's connection with the Northern Hemisphere meant flying to Auckland or Sydney on a 100-seat jet to re-plane to a 400-seat jumbo for Hong Kong or LA and so on. Hub and spoke. The B787 and A350 offer an alternative route. They can fly China-Wellington yet carry only slightly more passengers than the aircraft now flying Wellington-Auckland.

Each week airlines fly approximately 57,000 seats between Auckland and Wellington, occupied by about 46,000 people. For many of those people this is one leg of a longer journey and they would be delighted to fly direct to save money and time, reduce greenhouse gas emissions and generally have fewer hassles. But direct air links don't just make it more convenient and cheaper for existing travellers, they stimulate travel.

Unfortunately, to take off to Asia or the USA with a full load of passengers a B787 or A350 requires a runway longer than Wellington's.

Just as an individual doesn't have to have a smartphone, central New Zealand doesn't have to have a long-haul capable airport. For the benefit of the aircraft technology to be realised requires investment in a runway extension and the merits of this have to be assessed by comparing construction cost, opportunity cost, and benefit.

The second transport technology which is now available subject to investment are electric vehicles.

Should you wish to you could trade in your petrol-car for electric, but for a comparable vehicle you may have to pay \$20,000 more. That's such a sticking point that less than 2,000 of New Zealand's 3,100,000 private cars are electric.

For a commercial vehicle owner such as NZ Bus the cost analysis doesn't stop at the vehicle purchase, it takes into account the whole-of-life cost. Electric can make commercial sense if the higher purchase cost is balanced by lower future operating costs. NZ Bus is embarking on a project to become informed about the operating costs of electric vehicles and to transition its fleet in that direction.

#### **Taking the Long Term View**

The project to extend Wellington Airport's runway started in earnest in 2013 and has an earliest possible commissioning date in 2021.

When NZ Bus buys a new bus it anticipates 20 years of operation from the vehicle.

Extending the runway and electrifying the bus fleet are long-term goals based on practical logic. Both initiatives require collaboration and partnership between Infratil and civic and government agencies.



## BETTER CONNECTIONS BETWEEN CENTRAL NEW ZEALAND AND THE WORLD WILL GROW TRAFFIC

Drawing water from a well and carrying it into your home versus turning on a tap in your kitchen. Looking at your iPhone for the latest news versus waiting for the newspaper delivery. Flying to Auckland, walking to the international terminal and sitting about for a few hours versus flying direct Wellington-Hong Kong.

It's easy to appreciate why piped water is "must have" while iPhones and direct air services are "nice to have". But there are substantial economic and social costs to not owning a smartphone or having efficient air services. Also, today's choices could become tomorrow's "must have". It's quite probable that news will eventually cease to be available on paper and possibly in the future there will be more burdensome costs to leaving or arriving in New Zealand via Auckland.

The opportunity cost of central New Zealand not having direct links with the northern hemisphere was illustrated by what happened when Wellington recently got new services with Melbourne, Queensland and Fiji. In each case the extra airline capacity resulted in an equivalent number of additional travellers.

Direct long-haul services between central New Zealand and the northern hemisphere offers additional growth potential. They would not just be adding capacity to existing routes, but would be opening channels to a whole new sector of demand.

Some appreciation of why new services attract new travellers can be gained from observing the Singaporean travel agents now selling seats on the new Singapore Airlines services linking Singapore-Canberra-Wellington.

- Singapore travel agents sell Singaporeans destinations serviced by Singapore Airways which are convenient and have suitable accommodation and activities.
- Until recently the "New Zealand offer" to a Singaporeans has been a flight to Auckland or Christchurch to visit surrounding attractions.
- However, both Auckland and Queenstown (where many people who fly into Christchurch head) have capacity constraints. At times they are congested and affordable hotel rooms are not always available.
- Problems with squeezing more people into Auckland and Queenstown are a good first reason to market central New Zealand, although of course the region's draw to visitors are its food, wine, and experiences. Nelson seafood, Wellington restaurants, Marlborough and Wairarapa wine, and plenty of coast, mountains and farms.

Travel agent and airline marketing focusses on specific destinations and surrounding attractions. Singaporeans are now being offered central New Zealand as a convenient and affordable destination, but it is apparent from Singaporean travel brochures that central New Zealand does not yet have the curated activities of the north and the south.

There is a virtuous cycle of improved air services, visitor growth, and investment in attractions. Not surprisingly central

New Zealand businesses and tourism organisations support Wellington Airport's initiatives to enhance the region's air links.

Observing the Singaporean travel agents highlights that when an airline operates a service, it sells it to both residents and visitors. Just as Singaporeans are made familiar with Singapore Airlines' destinations so too are New Zealanders made aware that Singapore Airlines is a great way to fly to the world. Of course New Zealanders will be even more aware of Air New Zealand's brand, service quality, destinations and probably even airfares as many people receive regular emails pointing out that tickets are now available to Ho Chi Minh City \$539, Singapore \$549, Shanghai \$549, Hong Kong \$549, Tokyo \$629 and so on.

Last year Air New Zealand spent \$303 million on sales and marketing. Spend of this magnitude reflects the effectiveness of marketing and is undertaken by all airlines seeking to attract customers. When an airline opens a service between central New Zealand and Singapore or Hong Kong or Guangzhou or Shanghai or LA or Abu Dhabi the airline will sell the destinations; to the 1 million people who live in central New Zealand and the 7,400 million who do not.

Air travel is growing and thanks to the technology of new aircraft much of that growth is on new routes. In 2015 Boeing reported that its B787 aircraft was then operating on 430 routes, of which over 100 were new. Airbus forecasts that 30% of air traffic growth over the next two decades will be on new routes. To take advantage of this, central New Zealand requires a suitable airfield.



A Singaporean travel brochure's listing of New Zealand's attractions highlights the availability of curated activities around the existing north and south entry airports.

Island	Adventurous Experience	Sightseeing Experience
North	Auckland Bridge Climb	Hobbiton movie set and farm tour
	Rotorua Agroventures	Waitomo Caves Glowworm tour
	Bay of Islands dolphin cruise	Napier Gannet safari
South	Cromwell jet boat	Milford Sound cruise
	Queenstown kayaking	Mt Cook Big Sky tour
	Walter Peak horse trek	Queenstown Gondola ride

As visitor numbers rise, central New Zealand's outstanding environs will be augmented by investment in attractive experiences.

*Left: Wairarapa  
Below: Photographer - Ian Trafford.  
Abel Tasman Kayaks.*





## Consents

To reclaim 11 hectares of land on Wellington's south coast requires resource consents. The process to get such consents is designed to ensure the availability of reliable information about the environmental effects of construction and the resulting structure and its uses. It is also intended to enable those with an interest in the project to interrogate and comment on the information and to have their concerns about potential adverse effects appropriately addressed. The objective is an overall assessment of the project which determines whether granting resource consents will achieve the sustainable management of natural and physical resources.

If you wanted to make a modest change to your house which was inconsistent with your council's district plan, you may be able to get a consent from your council without it being "notified", i.e. without informing your neighbours. If your house change was likely to give rise to significant effects the council would be more likely to require that the consent request be notified so that neighbours had an opportunity to have their opinions taken into consideration when a decision is made.

Ideally the process is proportional to the nature and scale of the environmental effects. Reclaiming 11 hectares of seabed to form an extension to Wellington Airport's runway involves the City Council, the Regional Council, considerable public input and the Environment Court.



### September 2013

Wellington City Council and Wellington Airport agreed to jointly fund a viability study of the runway extension. Would airlines provide long-haul services to Wellington and attract additional passengers and freight? How much would the extension cost? Did Wellington businesses, institutions, community and cultural groups see benefits? Were consent hurdles likely to be surmountable? What length of runway was required to accommodate air services to Beijing or San Francisco? Would the intended use of the extended runway be approved by the Civil Aviation Authority? The study took a year and cost \$2 million.

### September 2014

Based on the findings of the viability study, Wellington City Council and the Airport decided to seek consents for the extension. Forecast cost \$4 million.

This process started with determining what information would be required by the decision making entity (which at that time was expected to be either the Environment Court or a Board of Inquiry). Ultimately this resulted in the preparation of 28 expert reports. The reports covered construction (dust, noise, road use, etc.), sea and coast (marine and bird life, surfing, swimming, aesthetics, amenities), cultural and archaeological considerations, and economic benefits.

Once these reports were drafted they were made available to the public and the Airport hosted meetings, open days and presentations at which report authors could be quizzed by the public and receive feedback. In-depth consultation was undertaken with affected parties. The objective was to encourage interest and feedback with the aim of ensuring that the final reports were accurate, comprehensive and recognised a diversity of opinions. It also allowed the experts and Airport to identify and consider ways to improve the outcome for people who faced adverse effects.





While the Airport believes it has made a strong case to have consents granted, it is the role of the Environment Court to decide. Some of the issues that will be relevant to the final decision are summarised in this Update.

*Photo: Wellington Airport's submission*

#### April 2016

After making changes to the application based on the public consultation it was submitted to the Wellington City Council and the Wellington Regional Council along with the updated technical reports. Two councils were involved because the effects of the project are both on land (purview of City Council) and sea (Regional Council). At this time the Airport also requested that its application be heard by the Environment Court once the public submission process was concluded. This request was accepted by the councils.

Although Wellington City Council has an interest in the project it also has a regulatory responsibility under the Resource Management Act. This type of situation is common for councils and they are set up to ensure both roles are performed independently.

The submission was over 5,000 pages, filled eight folders, weighed 22 kilograms and had effectively cost more than \$2 million to prepare. The Airport is offering hard copies for \$1,500. They are also available free on the website or by asking for a copy on a USB. So far no one has purchased a copy, but there have been plenty of downloads.

The two councils reviewed the information to ensure it was complete for the purpose of public notification and sufficient to allow an informed consideration of the consent application. As a part of this review the council sought and received additional information from the Airport. The application was publicly notified on 25 June 2016 and drew 775 submissions on a wide range of effects and other matters.

#### August 2016

Once submissions were closed on 12th August they, and the Airport's application, were assessed by the Regional and City Councils and their advisers.

The councils have a responsibility to prepare reports for the Environment Court that provide a summary of submissions and issues relevant to the application. They may also suggest conditions on the consents that could be imposed if the Environment Court grants the Airport's application.

#### September 2016 to Mid 2017

As the councils have approved the Airport's request that its consent application is directly referred to the Environment Court this will occur following lodgement of a notice by the Airport with the Court.

The Court will then set down the procedures for the preparation of expert evidence, for witnesses on all sides of the case to conference in the hope that issues and concerns can be addressed or narrowed, and for the parties to be ready for the Court hearing which is likely to be in about March 2017.



## Effects on the Neighbourhood

This has two main aspects, the effect during construction and the ongoing impact of an 11 hectare reclamation on views, sea and coastline. Some examples of the research and consultation which has gone into the consent application are listed below:

- Construction will require trucking material to the site. To manage the effect on traffic it is proposed that heavy haulage tip-trucks be limited to transporting materials on public roads only between 9.30am to 2.30pm and 10pm to 6am, but not after 2.30pm on Fridays or over the weekend.
- One group of nearby residents who are particularly affected by the uncertainty associated with the multi-year consenting process, and in due course by the construction and existence of the runway extension are the 21 households on the adjacent coast at Moa Point. In consideration the Airport has offered each of these households a number of mitigations and alternatives::
  - \$10,000 on a no strings attached basis.
  - A commitment to buy the properties at fair value should the extension be consented and owners wish to sell (over the two decades since a Court decision in 1997 a similar arrangement for noise affected properties around the Airport has resulted in the purchase of 49 houses). A number of Moa Point residents have subsequently approached the Airport requesting that they be bought out sooner and the Airport has agreed.
  - Noise insulation and for residents to be relocated during construction.

- Lyall Bay hosts many recreational activities; visiting a cafe, sight-seeing, dog walking, picnics and water sports. Two groups particularly interested in the project were swimmers and surfers. To identify possible effects and to help impacted parties understand the changes and suggest mitigations the Airport engaged experts to forecast how the surf could change and to work with surfers who wished to understand the analysis.

Using records of wave direction, speed and dimensions the experts concluded that the extension would not cause a noticeable reduction in wave height or surfability at the main surfing area, 'The Corner'. The extension is however likely to result in a modest decrease in the number of surfable waves in the middle and west of the bay. To offset this and to potentially improve the surf in the middle of the bay a wave focussing structure is proposed. This would be made of rock and emulate the wave generating effect of many natural rock structures at surf locations around the world.

If the changes occur some individuals will feel they could lose something, but there should be more surfing and less surfer congestion which has caused arguments and injuries.

This is an example of the consenting process working as it should. Research has delivered an understanding of effects and potential offsets. This, and consultation, has allowed individual surfers to identify how they may be impacted and what remedies they may like.

- The seabed that is to be reclaimed comprises sand and rocky reef which is swept by strong currents and occasionally large seas. It is home to seaweeds, shrimps, worms, kina, paua, reef-fish such as red moki, marblefish, and butterflyfish, and is visited by other fish such as spotties, blue cod, goatfish, leather jacket, and terakihi as well as crayfish and seabirds.

Expert advice is that the construction and final structure will have little enduring impact on most of this sea and bird life. To deal with the displacement caused by the reclamation the experts suggested that the new seawall include cavities for crayfish and that there may be a need to restock kina and paua which could otherwise take time to migrate back.

Fishing at the site will be interrupted during construction, but foreshore landscaping and beach enhancement at Moa Point will improve the amenity value of the area after construction finishes.

Given that the project involves reclaiming 11 hectares with 1.4 million cubic metres of fill the impact on the immediate sea area is relatively muted. The sea at the south end of Wellington's runway is intimidating on a good day and some days are far from good. Consequently, the reclamation and seawall protection will be expensive, but it isn't exactly a delicate environment. The Airport is also aware of the risk of sea level rises and earthquakes and the extension will be built to withstand a once every 100 year wave and a once every 2,500 year earthquake. A construction engineer joked that if Wellington is ever hit by a sizable earthquake at least the 355 metres of new runway will continue to be available.



At present most surfers congregate in an area known as The Corner. A new surf feature will be created in the middle of the Bay by a wave focusing structure. It would allow surfers to spread out and reduce congestion.

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*Photo: Lyall Bay surfers*





## Effects on the Economy

Someone following coverage of the consenting process via the Dominion Post or RNZ could easily infer that resource consents were all about economic impacts. Perhaps the economic case is genuinely uncertain, or economists like to debate, or opponents of the extension don't feel that the environmental effects are sufficient to stop consents being granted so have looked elsewhere for points to make.

To ensure that the economic analysis was comprehensive, accurate and reliable the City Council and Airport between them used four separate advisers with the final modelling being based on the work of the New Zealand Treasury and Ministry of Business, Innovation and Employment, using Statistics New Zealand data. The findings are:

*"We conclude that the real economic value added by the runway would substantially exceed its economic cost. Extending the runway would produce a net economic benefit for the country of around \$2.3 billion in today's dollars. Almost \$8 of economic benefit would be added for each dollar spent on lengthening the runway. These are national benefits. The major results are broadly in line with Cost Benefit Analysis of runway extensions elsewhere and compare favourably to other infrastructure investments in New Zealand."*

About 30% of the benefits will be captured by travellers and 70% by the wider community.

The analysis captures many costs and benefits, but not all of them; for instance the improved resilience of New Zealand's transport system. Also not counted is the benefit of choice and the democratising effect of cheaper fares. At the bottom of a page is a table included in a submission to the Commerce Commission.

The two itineraries show the co-existence of travel choices starting on Wellington's Lambton Quay at the same time on the same day and finishing less than an hour apart on Queen Street Auckland.

One traveller was able to pay for comfort and convenience. Another traveller was able to travel because of its low cost. The benefits of choice to each individual are real, but not captured by economic analysis.

The economic analysis aggregates benefits rather than incorporating the specific inputs of individuals, businesses and institutions. It is therefore telling that the following parties all made positive submissions on the extension consent application because they anticipate economic or commercial benefits; Destination Wairarapa, Hawkes Bay Tourism, Destination Great Lake Taupo, Marlborough Tours, Napier City Council, Porirua City Council, Upper Hutt City Council, Wellington Chamber of Commerce, Hutt Valley Chamber of Commerce & Industry, Wellington Regional Economic Development Agency, Nelson Regional Development Agency, Miramar Business District Improvement,

Wellington Regional Stadium Trust, Wellington Trails Trust, City Gallery, New Zealand Festival, Wellington Culinary Events Trust, Wellington Phoenix, Hurricanes, Weltec & Whitirea, Victoria University of Wellington, Massey University, Intern NZ, Scots College, Samuel Marsden Collegiate, West Plaza Hotel, Rydges Hotel, Bay Plaza Hotel, Willis Hotel, Ibis Hotel, Travel Agents Ass of NZ, Roxy Cinema, Weta Workshop, Te Papa Tongarewa, Chameleon Events, Fletcher Building, Hawkins Construction, Fulton Hogan, Hexagon Safety, Property Council of NZ, Willis Bond, Ian Cassels, Mark Dunajtschik, Colliers International, Shock, Helfen, Paua Industry Council, Neil Bramley, Momentum Consulting, Business and Economic Research, Chorus, Kiwibank, Ernst & Young, CentrePort, Nelson Airport, Tourism Industry Aotearoa.

## CO-EXISTING TRAVEL ITINERARIES (Lambton Quay to Queens St)

Willing to Pay Traveller			Low Cost Traveller
Taxi to Wellington Airport	\$29.00	\$3.63	Bus to near Wellington Airport
Snack in Koru Lounge*	\$20.00	\$4.00	Coffee in terminal
Airfare	\$200.00	\$100.00	Airfare
Auckland taxi	\$80.00	\$16.00	Airport bus to Auckland city
<b>Total</b>	<b>\$329.00</b>	<b>\$123.63</b>	<b>Total</b>

\* Reflecting Koru Club membership cost



## NO ONE WANTS TO INVEST IN A RUNWAY EXTENSION THAT DOESN'T RESULT IN MORE TRAFFIC.

### Criticism

After the economic analysis was made public it drew comment from independent economists and from the Board of Airline Representatives (BARNZ) and their advisers. Some of the submissions were critical of the Airport's case, with the criticism largely falling into three areas:

1. That the analysis was flawed.
2. That forecasts of traffic growth were too optimistic.
3. That the funding of the construction was inappropriate.

Each of these points is summarised in the following sections of this Update.

### Calculating the benefit of tourism

In the Update it isn't practical to cover the full economic analysis (all submissions are available online), but the following summarises one of the key points; the calculation of the benefit to New Zealand of additional tourist spend.

- Calculation of tourism benefits starts with estimates of tourist numbers and their spending.
- The second step is to estimate the net benefit resulting from each \$1 visitors spend, which is contentious. To explain, take a simple example:
  - Someone rents a hotel room for \$100 + GST.
  - The net benefit to the hotel will depend on the costs it incurs as a result of renting the room.

If the hotel has few added costs most of the \$100 will be retained as net benefit. On the other hand, if incremental costs are high (perhaps extra staff had to be taken on) the net benefit of renting the room will be low.

- And what if the hotel owners are encouraged by the extra room demand to invest in building a new wing?
- And does it matter if hotel management spend the \$100 on staff, or imported goods, or put it in the bank?
- And what about the \$15 of GST received by government?

Assessing net benefit even for a hotel room involves a number of variables and judgements. Fortunately, the Ministry of Business, Innovation and Employment (MBIE) has undertaken the necessary national benefit calculation and has estimated that on average each \$1.00 tourists spend creates about \$0.75 of net benefit for New Zealand. This was based on the Statistics New Zealand National Accounts data which showed that in 2015 total domestic and international tourist spend in New Zealand contributed \$18.5 billion to the Country's Gross Domestic Product as well as increasing Government's GST income by \$2.5 billion.

The Airport's economic advisors recommended using MBIE's \$0.75 of benefit of \$1.00 of spend. However NZIER working for BARNZ criticised this and recommended using \$0.13 per \$1.00.

In effect NZIER suggest that the country as a whole incurs 87 cents of costs for every \$1.00 spent by a visitor. This seems intuitively wrong as well as being inconsistent with government statistics. In due course it will be up to the Court to assess the merits of the relevant conflicting figures.

### Traffic Growth

The most important variable in the economic analysis is the forecast of the traffic growth which is expected to arise from the runway extension allowing:

- Aircraft to fly directly between Wellington and northern hemisphere cities.
- Larger aircraft with greater passenger and freight loads and lower costs per passenger and kilogram of freight.
- Increased airline competition.

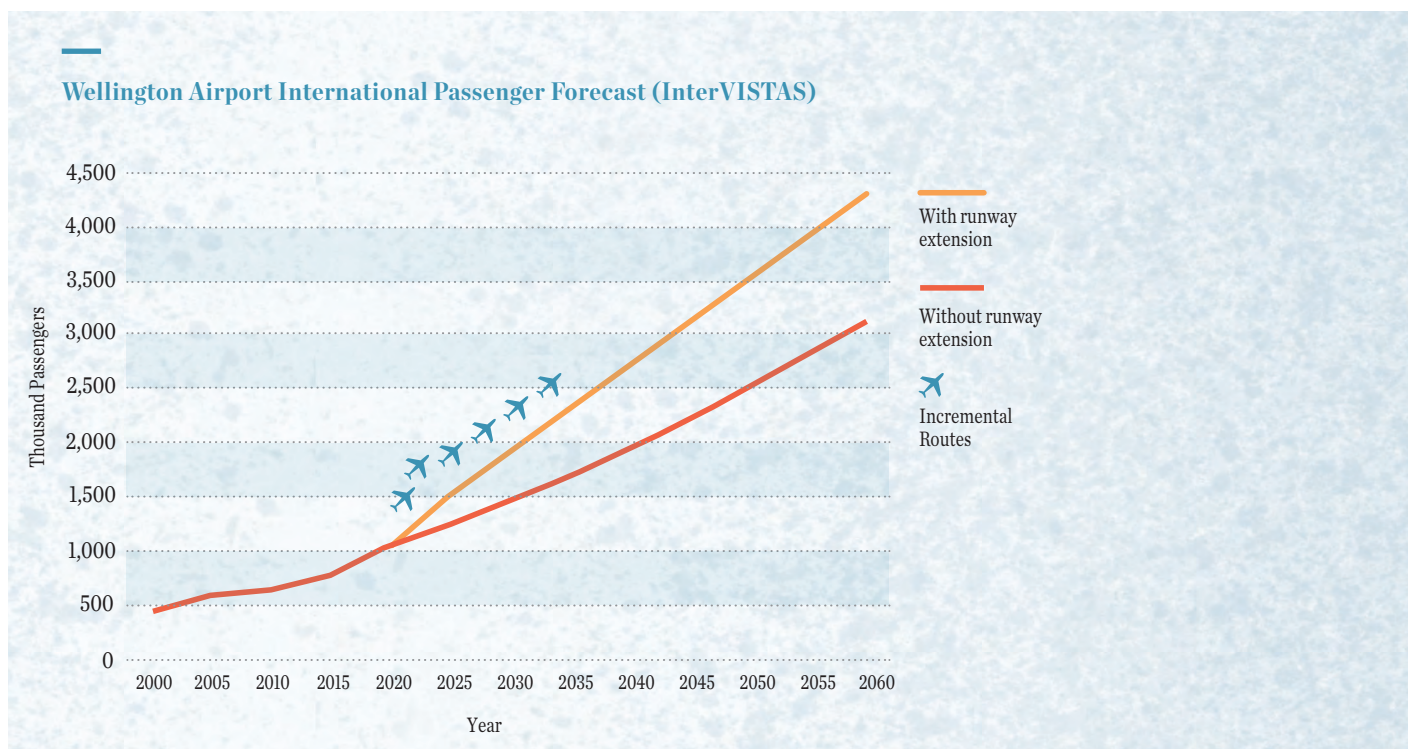
Lower airline operating costs, more direct services and cheaper travel are forecast to result in Wellington Airport having an additional 1.1 million international passengers (4.3 million with the runway extension and 3.2 million without) by 2060, albeit with fewer domestic passengers as some of the travellers flying direct will be avoiding having to catch a domestic flight to start or finish their journey.

This is the "Mid Case" forecast derived by international airline route consultants InterVISTAS and Wellington Airport.

The forecasts required by the economic analysis go out to 2060, but to be conservative no new routes are assumed to arise after the initial fifteen years.

To indicate the reasonableness of the forecasts, it can be noted that over the 16 years since 2000 Wellington's international passenger numbers have risen 4.5%pa. If no extension is built international passenger numbers for the next 16 years are forecast to increase 3.5%pa. (on average 41,000 more passengers a year), while a longer runway is forecast to result in 5.3%pa. growth (on average over the 16 years that is 73,000 more passengers a year which roughly equates to one additional international air service every two years).





### Traffic Growth Critique

Forecast demand for the runway extension has been criticised by BARNZ which has submitted analysis prepared by consultants Ailevon Pacific. Perhaps not surprisingly (given BARNZ represents many of the airlines now serving New Zealand) the basic message is that people looking to fly between central New Zealand and the northern hemisphere\* will continue to prefer to do so on existing services operating via Auckland or Australia so the longer runway will not attract use.

Essentially the BARNZ opposition case is that:

- The central New Zealand air travel market is small, low growth and mainly involves people flying to and from Australia and the South Pacific.
- For long-haul destination central New Zealand is well served by existing links through Auckland and Australia.
- Spending a lot of money extending the runway would be pointless because of A and B.

For example, BARNZ's figures show that in 2015 approximately 9,000 Chinese residents flew in and out of Wellington (presumably 4,500 each way) in a year when approximately 400,000 Chinese residents visited New Zealand. The BARNZ hypothesis is that this shows that Chinese tourists don't wish to visit central New Zealand.

The Wellington Airport hypothesis is that Chinese tourists don't fly to central New Zealand because it's not convenient, is relatively expensive and is not marketed to them.

### Small, low-growth, mainly short-haul

Each of the key BARNZ claims is addressed below.

#### 1. Identifying Passengers?

InterVISTAS have identified that on average over 1,150 people a day fly between Wellington and the northern hemisphere (Using different data sources Statistics New Zealand figures show that over 1,500 people a day travel between central New Zealand and long-haul destinations, but not all of those people use Wellington Airport). BARNZ claims that the figure is closer to 950 people. Both the InterVISTAS and BARNZ figures start with the IATA BSP data (Billing and Settlement Plan) which gives detailed information about the worldwide booking activities of travel agencies and airlines. However, there are a number of areas where the BSP figures can over and under count traffic. Users of the data correct for the shortcomings by cross-checking with information from other sources such as Statistics New Zealand departure cards and Wellington Airport's own arrival and departure traffic figures.

There can be differences of opinion about such corrections, especially as there is a tendency for the BSP data to under-count the long-haul passengers of airports such as Wellington and Christchurch while over-estimating the numbers travelling through hubs like Auckland or Sydney. Some of the corrections and hence why Wellington Airport and BARNZ have different numbers about the existing market size are explained below:

- Someone who books with one airline to fly Wellington-Auckland-Singapore will tend to be identified by BSP as Wellington-Singapore. But if the traveller buys the

domestic and international tickets separately; called "two ticketing"; BSP will tend to show one passenger flying Wellington-Auckland, and another passenger travelling Auckland-Singapore.

In recording origin-destination traffic this will over-count Auckland-Singapore and under-count Wellington-Singapore.

This can be corrected using information from the departure card left at Auckland Airport which will show that a Wellington resident has flown to Singapore. Wellington Airport's adviser InterVISTAS used the departure card information to adjust the BSP data. The BARNZ adviser did not make this adjustment.

- Another shortcoming with the data relates to broken trips. If someone flies Wellington-Sydney-Singapore and only briefly transits in Sydney the data shows them as flying Wellington-Singapore, but otherwise BSP will show one passenger flying Wellington-Sydney and another passenger flying Sydney-Singapore. As with the example given above, the raw data under-counts Wellington' long-haul traffic and can be corrected using departure card information.

Reliable route analysis takes the BSP data and using other information corrects it to arrive at a "best" estimate. This is the standard industry approach and has been followed by InterVISTAS, but not by BARNZ.

\* In this Update "northern hemisphere" is a proxy for long-haul, it includes some traffic with Africa and South America.



**Figures provided by BARNZ  
showing international  
passenger growth 2011-2015**

	Auckland	Wellington	New Zealand
Kiwi travellers	4.0%pa.	3.1%pa.	3.6%pa.
Short haul Visitors	11.7%pa.	7.8%pa.	7.2%pa.
Long haul Visitors	10.2%pa.	4.6%pa.	5.8%pa.

**Most up to date reliable  
data for all international  
passenger 5 year growth**

Total International	5.3%pa.	6.5%pa.	4.9%pa.
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Another market size dispute relates to the percent of people from regions adjacent to Wellington who use Wellington Airport. For instance, BARNZ found that 17% of the people from Manawatu-Whanganui who start an international journey with a flight from Palmerston North airport leave New Zealand via Wellington Airport. They inferred that Wellington's share of that region's international flights is therefore 17%.

InterVISTAS however has used international departure card data and found that actually 60% of Manawatu-Whanganui residents' international flights are via Wellington. The discrepancy with BARNZ's 17% is because most of the travellers from this region start and finish their trip with a drive to and from Wellington and these people have been entirely missed in BARNZ's calculation.

Departure cards also show that of the people from Hawkes Bay, Taranaki, Nelson, Tasman and Marlborough between 10% and 20% use Wellington Airport for trips to Australia.

For its traffic forecasts, InterVISTAS have assumed that only 5% of the people from these regions who undertake a long-haul trip will do so through Wellington. This conservatism is based on recognition that Auckland will always offer more options for long-haul destinations than Wellington. But at least the analysis indicates that Wellington does have potential to attract traffic from the whole of central New Zealand and not just from areas within two hours' drive.

## 2. Market Growth?

In its submission BARNZ provided figures showing international passenger growth 2011-2015 for Auckland, Wellington and New Zealand (see the table above).

However, figures from Statistics New Zealand and Auckland and Wellington airports tell a different story for the most recent five-year periods for which each provides data.

- Wellington's international traffic to 31 March 2016 rose 6.5%pa.
- New Zealand's international traffic to 30 June 2016 rose 4.9%pa.
- Auckland's international traffic to 31 July 2016 rose 5.3%pa. But excluding the 23%pa. increase in Chinese traffic, the rest of Auckland's growth amounted to 4.3%pa.

A detail of the BARNZ case about Wellington's 'low growth' is interesting. According to BARNZ, over the period 2011-2015 Auckland's traffic with China rose 22%pa. while Wellington suffered a 3%pa. decline in the number of people flying to and from that destination (travelling via another airport). In other words, over a period when Auckland's Chinese-resident inbound passengers went from 130,157 a year to 364,816 a year, Wellington's total NZ-China passengers (flying both ways) apparently fell from about 20,400 to 18,075.

Wellington's own figures for NZ-China traffic are not materially different to those of BARNZ. Both Wellington Airport and BARNZ agree that Wellington's China traffic is less than 3% of the total New Zealand-China travel market; a substantial shortcoming as that market is approaching 9% of New Zealand's total international air-passenger movements.

But even without the Chinese traffic, Wellington has achieved good growth.

## 3. Central New Zealand. Few Long-Haul Travellers and Visitors?

According to BARNZ, Wellington had 1,088,000 international passenger movements in calendar 2015 (including about 200,000 passengers who started or finished in Wellington but took their international flights via another international New Zealand airport).

BARNZ figures indicate that 68% of these passengers' ultimate destination/origin was Australia or the South Pacific with only 32% travelling long-haul. Wellington Airport's figures show a traffic split of 57/43 (the difference reflects the adjustments outlined previously).

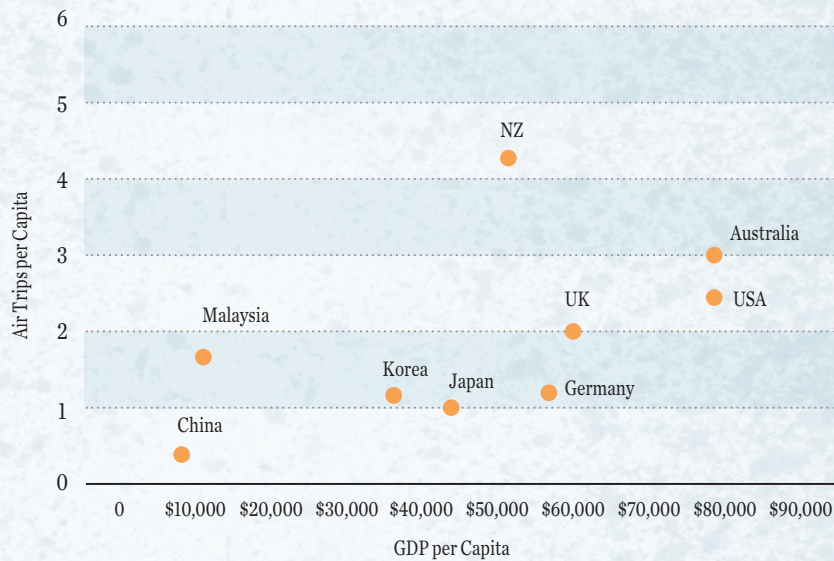
However, the low proportion of international passengers travelling long-haul is not as important as which long-haul passengers are missing. **Central New Zealand isn't just missing out on people travelling to and from the northern hemisphere, it is missing out on visitors.**

- Between New Zealand and the USA the Statistics New Zealand figures for the latest year show that 61% of all travellers were Americans and 39% were New Zealand residents. The BARNZ's figures for 2015 show that for Wellington-USA air travel only 38% of the passengers were Americans with 62% being New Zealand residents.

This means that of the 80,125 Wellington-USA passenger movements BARNZ recorded, 30,448 were Americans. Yet had the Wellington-USA traffic mix been the same as that of the rest of the country, 77,701 Americans would have flow in and out. (at that number Americans would have made up 61% of the total number of passengers on this route).



### Per Capita Air Travel and GDP



### China's 20 Most Populous Cities (million people)

Chongqin 30.17m	Wuhan 10.61m
Shanghai 24.15m	Baoding 10.35m
Beijing 21.71m	Linyi 10.32m
Tianjin 15.47m	Nanyang 10.06m
Chengdu 14.66m	Zhengzhou 9.57m
Guangzhou 13.50m	Tanfang 9.25m
Shenzhen 11.38m	Qingdao 9.10m
Shijiazhuang 10.70m	Hangzhou 9.02m
Herbing 10.67m	Zhoukou 8.81m
Suzhou 10.62m	Xi'an 8.71m

*New Zealand has direct air services with three of these 20 cities. By the end of the year Australia will have services with 10 plus 5 more not on this list.*

#### What happened to the missing Americans?

- Wellington Airport's hypothesis is that they didn't come because of inconvenient, expensive, un-marketed air services.
- BARNZ's hypothesis is that they have no interest in coming and because of that lack of interest, the air services haven't been provided (the existential reason services are not provided is because they cannot be provided because of the runway length).

This difference of opinion about horse and cart is the basis of the parties' different views about the consequence of the runway extension. Wellington Airport believes that there is suppressed passenger demand which would result in traffic growth if good air services were available. BARNZ believes that the existing air links work fine and those who want to come are coming.

- With China 81% of the travellers to/from New Zealand are Chinese-residents, at Wellington it's 50%.
- With the rest of Asia 59% of the travellers to/from New Zealand are foreign-resident, at Wellington it's 25%.
- With the rest of the world 65% of the travellers to/from New Zealand are foreign-resident, at Wellington it's 35%.

BARNZ has calculated that in 2015 112,995 northern hemisphere residents flew into or out from Wellington making up 32% of the total long-haul market. Statistics NZ figures for all travel between New Zealand and the northern hemisphere have 63% of passengers being foreign-residents.

If it had been consistent with the rest of New Zealand's long-haul traffic, Wellington would have had 288,610 northern hemisphere resident passengers rather than the 112,995 identified.

175,615 "missing" passenger movements is a lot. Were they missing because they didn't want to come or because of the cost and inconvenience of the air services and because no one marketed the destination to them?

Singapore Airlines services linking Singapore-Canberra-Wellington will be a test of the stimulation hypothesis. Will it bring visitors to New Zealand who would not otherwise have come, especially visitors from Asia? Will there be an increase in tourist spend across central New Zealand? It will also be interesting to see how central New Zealand is marketed to visitors and how the region's attractions are developed.

Ministry figures for 2015 show that 491,000 people live in the Wellington region (11% of New Zealand's total) generating 13% of national GDP. Central New Zealand's population is 1,141,000 (25% of the total) producing 29% of national GDP. It's a big part of New Zealand to not have direct air links with the northern hemisphere.

On the flip side, the opportunity for growing visitation to New Zealand is graphically illustrated by the graph and table above. The graph shows the relationship between per-capita GDP and air travel. As Asia gets wealthier its people will travel more. The table on the right lists the populations of the 20 largest Chinese cities.

In the last decade Chinese international air travel has risen 243% to over 120 million trips and it is forecast to treble over the next decade.



Financial year 2015	Airport Operating Costs per Passenger	Airport Charges per Passenger
Auckland	\$5.91	\$16.11
Wellington	\$3.14	\$11.09
Christchurch	\$6.38	\$11.52
Queenstown	\$4.71	\$11.56

*All figures from Airport disclosure accounts*

### Paying For Construction & Benefiting From Growth

The stated intention of the Wellington City Council and the Wellington Airport Company to share the cost of constructing the runway extension has been a lightning rod for criticism. It has created concerns about socialising costs and privatising benefits, and about forcing airport users to pay for something from which they get no benefit. The concerns are premature.

Before committing to sharing the cost and effort of seeking consents each party needed the other to express their intentions with regards to the construction cost. But until consents are available and a detailed business case prepared no one can develop a proposal for the funding.

When a funding proposal is developed it will be public, transparent and thoroughly analysed. Infratil is a public listed company subject to rigorous disclosure requirements. It has over 35,000 New Zealand share and bond holders and its activities and prospects are reviewed and publically reported by five highly regarded broker analysts, along with the in-depth private analysis undertaken by institutional investors.

With regards to the concern about cost allocation; Wellington Airport has a proud record as New Zealand's most efficient and lowest cost major international airport (measured by operating costs and aeronautical charges per passenger). The desire to maintain this record is a key reason the runway extension project has been ring-fenced from the Airport's other activities. The efficiency claims are backed by comparing the information disclosures of Wellington, Auckland, Christchurch and Queenstown airports.

For those philosophically averse to public-private partnerships, the bad news is that Wellington Airport is a joint venture between Wellington City Council and Infratil which by any possible measure has been highly successful for almost two decades. The success of this partnership is a key reason the parties are working together now on the extension project. Both parties are also incentivised to ensure that the extension project doesn't dent the success of their partnership.

### Will Adding 355 Metres Make It Long Enough? Will It Be Safe?

"Why 355 metres?". Wellington Airport engaged aircraft experts to determine the runway length required for the intended routes and the aircraft most likely to be used for such services. The expert advice was tested with aircraft manufacturers.

After the extension is in place, not every commercial aircraft will be able to fly from Wellington to far off destinations with a full complement of passengers. That was never the objective. There is almost no chance that any airline would ever want to provide (say) a Wellington-Beijing service with a massive aircraft like an A380. The goal is to cater for the prevalent smaller wide-body aircraft which will dominate airline fleets over the next 30 years (the Boeing 787 and Airbus 350).

Is Wellington's runway long enough to be safe, and will it continue to be so in future? As with every aviation safety issue this matters a lot to many parties. The Airport management and board have safety as their number one priority. Every airline which flies into Wellington undertakes its own safety checks. In addition to this self-policing, the Airport is reviewed and licensed by the Civil Aviation Authority which is guided in its decisions by the safety standards promulgated by the International Civil Aviation Organisation.

When Wellington Airport began consideration of the runway extension the CAA reviewed and confirmed that the existing runway safety rules would remain in force if the runway were extended. Subsequently the pilot's union challenged this in court claiming that CAA was wrong in its interpretation of the relevant safety requirements and hadn't consulted with the union in reaching its decision. The court endorsed the CAA position. The union is appealing this decision.

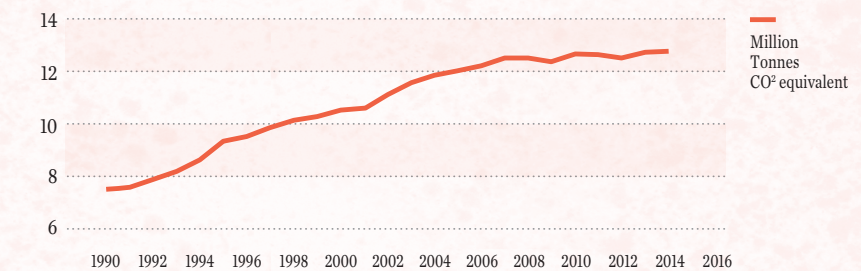
With the extension the Airport's goal is a runway which is 2,436 metres long of which 2,170 metres will be operational (89% of the total length) and the rest safety and starting areas. The union is seeking additional safety areas which would drop the operational length to 75-79% of the total.



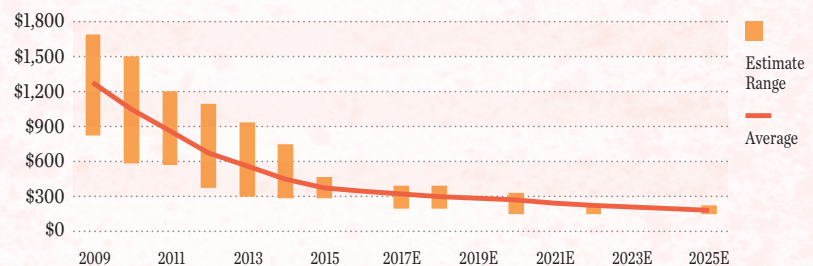




### NZ Transport Sector Greenhouse Gas Emissions



### Battery Costs per kWh of Electricity Stored



## Electric Buses

NZ Bus provides 60 million public transport rides a year (about half of New Zealand's total). To deliver these services it owns 1,000 buses of which 95% are diesel and 5% are electric, but NZ Bus has decided that the future is electric and it is seeking to invest accordingly.

This strategy has two aspects. Electric buses provide significant environmental benefits relative to diesels and they are on the cusp of having a similar whole-of-life cost. It only requires small relative changes to the cost of diesel, electricity, CO<sub>2</sub> emissions, or road taxes to make electric buses the preferred public transport vehicle in New Zealand.

It is also commercially sensible to now invest in electric rather than diesel buses which could be redundant well before the end of their economic lives.

### A Plausible Vision

Let's say that every one of the approximately 1,000 households in Auckland's Herne Bay places 3 kilowatts of photovoltaic panels on their roof. On a sunny day over the two and a half hours from noon the panels generate 6,000 kWh more than the homes use.

Coincidentally at that time of day many NZ Bus vehicles are not in use and could be recharged by the surplus household generation. The transaction avoids grid charges and could be orchestrated by the lines company Vector on terms that benefit the households and NZ Bus (Vector is trialing peer-to-peer electricity trading).

All the pieces of that vision will soon be viable; physically and commercially. It will be initiatives such as this which lower the cost of electric buses and allow them to overtake diesels as the preferred public transport vehicle in New Zealand.

### Coinciding Forces

The graphs above show New Zealand's transport sector greenhouse gas emissions on the one hand and the cost of battery energy storage on the other. One obvious way for New Zealand to reduce its transport sector emissions is to shift from petrol and diesel powered vehicles to electric ones, and fortunately the cost of battery storage of electricity is falling.

New Zealand's greenhouse gas emission record is poor and not on track to meet goals

- Net emissions in 1990 were 36.9 million tonnes of CO<sub>2</sub> equivalent. Net emissions in 2014 were 56.7 million tonnes. +54%.
- The Government target for 2020 is 35.0 million tonnes. The target for 2030 is 38.6 million tonnes.

Road transport's 12.8 million tonnes of emissions in 2014 were 5.3 million tonnes more than the level of 1990. This is the largest single contributor to the national increase over the 24 years since records began. In response Government is now developing targeted subsidies and incentives to encourage a switch to electric vehicles.

Public transport buses are a good place for Government to start the transition. Public transport contracts allow regional transport agencies to specify the vehicles an operator can use (size, colour, age, engine, source of power).

While private motorists are discouraged from buying electric cars because of the purchase cost (and range uncertainty), a commercial decision about which bus to purchase will reflect both the acquisition cost and projected operating costs and depreciation. Today, assessing the whole-of-life cost for an electric bus is challenging, but this uncertainty can be surmounted by the right partnering approach by government (central and local) and operators.

### Where The World's Largest Vehicle Market is Heading

Last year Chinese motorists purchased over 20 million cars. Coincidentally the Chinese government implemented aggressive policies to restrict vehicles with internal combustion engines and to accelerate the manufacture and uptake of electric vehicles. The following table shows Chinese purchases of electric vehicles in 2015 and its government 2020 targets.

		Vehicles		Battery Storage kWh average	
		2015	2020	2015	2020
Cars	PHEV	63,617	276,822	13	18
	EV	181,147	518,400	25	36
Trucks	EV	20,241	100,000	35	43
Buses	PHEV	24,466	69,960	27	34
	EV	100,247	137,759	90	156

PHEV are plug-in hybrids. EV are fully electric powered



### Fuel Energy Density and Cost

(recognising that the diesel is consumed while the battery is not)

1 kilogram of	Energy available	Energy used for propulsion*	Cost per kilogram	Cost per kWh of propulsion*
Diesel	11.1kWh	3.0kWh	\$1.15	38 cents
Lithium-ion battery	0.28kWh	0.27kWh	\$110.00	\$400
Lead-acid battery	0.03kWh	0.028kWh	\$6.00	\$5,000

\* In an internal combustion engine about 75% of the energy contained in diesel is lost as heat, etc. Electric engines are much more efficient in converting energy into propulsion.

The Chinese government intends that by 2020 at least 90% of China's new city buses will be electric. This scale of investment and production will drive efficiencies and innovation and improve the viability of New Zealand's shift in the same direction.

#### Bus Propulsion

There are three ways to power a bus; each has commercial and environmental characteristics.

1. Diesel. Since about 1930, diesel buses have been the world's main source of urban public transport except in areas of very high population density (in London buses provide twice as many trips as trains. It takes population densities of cities like New York for trains to beat buses 2 to 1 and only Tokyo has a ratio of over 10 to 1).

A century of refinement has resulted in a reliable, efficient engine, but one which produces 50 tonnes of CO<sub>2</sub> emission a year (in travelling 45,000 kilometres, approximately the NZ average).

2. Diesel-Hybrid. Globally there are now almost 4 million Toyota-Prius and about 8 million other petrol-hybrid cars. But hybrid diesel buses are heavy, expensive, and don't necessarily save fuel (something of a trifecta of problems). A Prius weighs about 200kg more than a Corolla. Adding 3 to 5 tonnes to the weight of a bus makes a substantial difference, especially on hills. The problem is due to hybrid vehicles needing both electric and diesel engines.
3. Electric. 1900 to 1930 was the era of the electric trolley bus, but its higher cost and inflexibility saw it replaced by diesels. Wellington stayed with trolleys for a mixture of nostalgic and environmental reasons, but even that Regional Council has decided they will be withdrawn from June 2017. Thereafter, if you want to see a

trolley bus in the southern hemisphere you will need to visit Chile, Argentina or Brazil.

But as buses attached to wires vanish, buses powered by batteries are arriving.

#### Batteries

In 1903 US inventor Thomas Edison announced that he had perfected a nickel-graphite battery which he intended to manufacture in bulk to power cars. It was to be lighter than the lead-acid battery, more durable, and not prone to releasing deadly chlorine gas. It was a real contender to the then unreliable and expensive internal combustion engine and a number of car companies quickly built vehicles to use it.

Unfortunately, Edison's battery actually turned out to be unreliable, expensive and prone to exploding; and while he worked on solving those problems Henry Ford's Model T arrived and a century of internal combustion ensued.

The "battery problem" is simple. The amount of energy it will store per kilogram of battery is a fraction of the energy in a kilogram of diesel. Also each kilogram, and hence unit of energy, costs a lot more. The table at the top of the page assumes diesel costs \$1/litre and a lithium battery \$400/kWh of storage capacity.

Fortunately for batteries, the table gives only part of the commercial story. It illustrates why electric buses are expensive to buy (batteries are expensive), but a more comprehensive comparison of the cost of fuel for a diesel bus and an electric bus is given below.

It's also fortunate that battery costs are forecast to halve over the next five years (from about \$400 per kWh of storage capacity now to about \$200 in 2021). This forecast is for a lithium battery. By 2021 fuel cells are expected to be becoming available with still lower costs for providing electricity to electric vehicles.

#### Comparing Costs: Batteries Vs Diesel

(The following figures are averaged and rounded. Also, a route with hills and many stops/starts will have a quite different energy profile to one on the flat with steady speeds.)

- A public transport bus travelling 150 kilometres in a normal day will consume 55 kilograms of diesel (62 litres) to provide 160kWh of propulsion energy.
- If it were not recharged during the day, a electric bus would require about 600 kilograms of lithium-ion batteries (and about the same weight of casing) costing about \$80,000.
- To travel 150 kilometres the diesel bus burns 62 litres of fuel that costs \$62. (62 litres provides 680kWh of energy, of which 160kWh will be actually delivered by the engine to create motive power).
- To travel 150 kilometres the electric bus battery must be charged with about 200kWh of electricity at a cost of \$20 (200kWh goes into the battery to allow 180kWh to come out for the efficient electric motor to produce the required 160kWh of motive power).

In this cost-comparison with diesel at \$1/litre and electricity at 10c/kWh the electric bus has a third of the fuel cost of a diesel. But of course the electric bus also has an expensive battery.

The whole-of-life cost analysis for an electric bus will require information about electricity usage and price; battery size, weight and price; maintenance and depreciation; government policies such as road user charges; and individual route topography and timetables.



Electric Bus Morning Schedule  
( 3 hours of operation,  
45 kilometres of travel requiring 51 kWh of electricity)

Time	Location	Distance	Battery Charge run start	Turbine Charge during run	Grid Charge while waiting
6am	Kilbirnie	0	42kWh	0	0
6.25am	Station	8km	33kWh	0	3kWh
7.30am	Seatoun	12km	20kWh	0	0
8.10am	Station	12km	10kWh	3kWh	0
9am	Island Bay	13km	6kWh	9kWh	

To illustrate that analysis:

1. The Base Case is a bus with \$80,000 of lithium-ion batteries capable of storing 168kWh of electricity. It requires 200kWh of electricity from the grid to deliver 160kWh of motive power so the bus can travel 150 kilometres.
  - \$20 a day in electricity.
  - \$35 a day in battery depreciation and funding cost.

The \$55 daily fuel cost is about the same as that for a diesel bus, at the prices used in this example.

2. Let's say we trial a bus with \$20,000 of batteries capable of storing 42kWh (weighing 150 kilograms).
  - This bus will run out of charge after 38 kilometres, which may be sufficient for its services if the battery can be recharged between runs.
  - \$20 a day in electricity. \$9 a day in battery costs.

This is a significant drop in the battery capital cost but it may be offset by additional costs for installing recharging stations for the bus to use between runs.

In an ideal world, a light cheap battery would be available to power a bus for a full day. In the real world of today with expensive heavy batteries its necessary to either pay an uneconomic sum for a large battery or to recharge the battery during the day. Some recharging is plausible as usually buses have time during the day when they are not in operation and they could be plugged in and recharged. But the smaller (and cheaper) the battery, the greater will be the during-the-day recharging required. In most cases it will be problematic whether this recharging is sufficient to keep the bus moving.

However with an on-board generator it is possible to recharge even without plugging-in, which is the solution offered to NZ Bus by WrightSpeed. This Californian company, led by New Zealander Ian Wright, has integrated battery-electric motor-turbine so that the battery can be recharged if plugging in isn't practical.

The turbine can be fueled with diesel, natural gas or anything similar. Because it is a turbine it is extremely clean burning.

3. For a third case study let's assume we have a bus with a battery capable of storing 42kWh which also has a turbine. The economics of this bus will depend a lot on its route and schedule.

In the hypothetical schedule shown above, the bus starts from the Kilbirnie depot and covers 45 kilometers over the first three hours of operation. It had enough parked time to recharge 3kWh from the grid, and it uses the turbine to generate 12kWh while running.

Public transport buses usually operate between 100 kilometres and 250 kilometres a day. Some have short trips and breaks with plug-in recharging opportunities. Some undertake long runs with little recharging opportunity at the turn around.

It will take time to trial buses around the Auckland and Wellington networks to build up an understanding of individual route energy profiles and hence economics. In due course every route will be tested and a recharging profile developed for each. Also opportunities to reduce costs, such as the Herne Bay example mentioned on page 15, will be identified and developed.

In Due Course

Bus motive power is at a pivotal point. The scale of Chinese commitment, and that of car makers Tesla, Renault-Nissan, GM, Ford, etc. and battery manufacturers Bosch, NEC, Matsushita, LG, etc. makes it inevitable that batteries will become cheaper and lighter (ie. more energy per kilogram and per dollar).

Many public transport authorities have responded by setting targets for full electrification of their bus fleets (Paris 2025, Central London 2020, Shenzhen 2017).

The challenge faced by NZ Bus is to manage the transition. A new diesel bus would historically have been expected to still be in service in 2036, that now seems unlikely.

WrightSpeed is a technological solution to the current shortcomings in battery technology. As that shortcoming is remedied the WrightSpeed buses can have their batteries switched over and their turbines switched off.

Today, New Zealand's total national fleet of diesel public transport buses are emitting about 100,000 tonnes of CO<sup>2</sup> a year. Within a decade they could be emission free.



