

Future Demand Summary report

November 2014



Ministry of **Transport**
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Future Demand Summary report

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November 2014

This report summarises the Ministry of Transport's Future Demand project and its findings, insights and recommendations. The project's purpose has been to confront the significant uncertainty now associated with future travel demand and car travel in particular. The guiding question for the project has been as follows: How could or should our transport system evolve in order to support mobility in the future? This question has been explored through the production of a series of resource papers in conjunction with a scenario planning exercise involving a cross section of stakeholders. This has developed four plausible but divergent scenarios for New Zealand in 2042.

This paper is presented not as policy, but with a view to inform and stimulate wider debate.

Executive summary

New Zealanders are driving nearly 30 billion kilometres each year in their cars, vans, utes and SUVs. The road network also carries 70 percent of all of our freight. As a nation we have built and continue to maintain a network of roads to allow us to make these trips.

The road network is worth more than \$60 billion and costs more than \$1 billion a year to maintain. We are planning to invest \$10 billion over the next ten years to change the shape of the network to improve its quality and capacity.

This would be relatively straightforward if we knew how demand would change. The challenge we face, however, is there have recently been changes to the patterns of demand for personal travel.

From 1980 to 2004 we saw an annual increase in demand in the order of three percent per year. This highlighted the importance of tackling congestion and improving safety and gave us assurance revenue would grow to cover the costs of a growing network. From 2005 to 2013 total demand only grew by 0.25 percent per year.

We now face an uncertain future. We cannot be certain demand will return to pre-2005 levels of growth nor can we be certain it will remain flat. This means we can no longer rely on traditional forecasting models alone to help us to decide how to invest.

The aim of this project was to explore the uncertainty around demand for personal travel, car travel in particular, which represents 77 percent of the total kilometres travelled on our roads. We did this by developing four future scenarios which explored the possible impact on travel of our use of digital technology and also the impact of energy costs on future travel demand.

The goal was not to create predictions of the future; nor was it to create a view on what our preferences were for the future transport system. Our goal was to produce a range of *plausible* futures. This would allow us to improve the likelihood the investment decisions we make today will be right for the future.

The conclusions of our work were:

1. When we think about creating a thriving New Zealand we should recognise we are trying to improve access not just mobility. This can be achieved in three different ways: with good transport systems, with good spatial planning, or by improving digital access. We need to integrate our thinking across these three areas to achieve the optimal outcome.
2. To reduce the uncertainty we face we should seek to better understand the factors affecting the changing patterns of demand and refresh our demand models accordingly. We should look both at social trends and also speed in development, take-up and impact of new technologies.
3. To ensure resilience of the access system we develop for New Zealand we should seek to build in flexibility where we can. This will allow us to respond more quickly to changing patterns of demand and reduce the likelihood we will make investments which will become unnecessary.
4. We need to recognise the investment decisions we make will shape patterns of demand and not just respond to them. We should move away from the approach of seeking to simply predict future demand and then provide for it. We should instead debate the sort of access we want and decide how to invest to support the future.

Introduction

This report concerns one of three projects the Ministry started in March 2014 to inform, challenge and stretch strategic thinking. The three projects were looking at: future travel demand; transport and economics; and future funding of the transport system. This report summarises the 'Future Demand' project.

Future Demand has focused upon the mobility of individuals as distinct from the movement of goods. We decided to focus on mobility of individuals as the Ministry completed a piece of work on future freight demand in early 2014. The project has largely considered land transport and in particular sought to explore the changing nature of car travel and its future prospects.

The project has been motivated by the recognition that something peculiar has been happening recently to the long run trend of growth in car travel, both in New Zealand and a number of other developed countries. A lack of consensus exists concerning future demand; we face a time of uncertainty unprecedented in recent years. Such uncertainty is troublesome to countries such as New Zealand, where infrastructure needs are determined and investment decisions are made based on projections of future demand. Accordingly, the Future Demand project established the following as its focal question. *How could or should our transport system evolve in order to support mobility in the future?*

To address this question, the project chose to examine a future time horizon of 2042 (aligned to the timescales being considered in other work such as the Ministry's examination of the future of freight demand; and Auckland's Integrated Transport Programme). It has considered the diversity of possibility for transport and society in 2042 New Zealand.

The report begins with a brief consideration of past changes in transport and society that informs an approach to addressing the future. It then introduces the phenomenon of 'peak car' which has come to the fore in present day transport debate. This reflects the *possibility* rather than the proposition that car travel (either per capita or in total) has reached a maximum. What follows is an explanation of the scenario planning exercise undertaken as a major part of the project. This yields depictions of four plausible yet divergent futures for New Zealand, based upon an assessment of key drivers of change pertinent to the focal question. The qualitative depictions are accompanied by modelled estimates of car travel in each scenario. The scenario planning and preceding contextual work have given rise to a number of key insights and advised responses in relation to the focal question. These are set out before the final conclusions are drawn.

This summary report is a sister document to the Future Demand Final Report which is presented in a much more visual form. Both reports draw upon a body of underlying work which is set out in a number of resource papers; these are referred to as footnotes in this report. The first of these is the scoping document for the project¹.

The purpose of this project is not to provide literal answers to the focal question. It represents important food for thought intended to be a resource and catalyst for engagement of all those individuals and organisations with a stake in shaping our transport system in a way that can support, both in the short and longer term, a thriving New Zealand.

¹ Resource paper: Future Demand Scoping paper

Learning from the past

Looking to the future involves anticipating the nature and extent of change. Change can sometimes be sudden and dramatic, as well as unexpected and disruptive. The Christchurch earthquake stands as a stark reminder. However, change is often much more gradual to the extent that from day to day or even year to year it can go almost undetected. Such change can nevertheless be powerfully cumulative over time. Looking back over a sufficient span of years reveals such change and can enlighten us as to what change is possible in the 28 years ahead to 2042. It reminds us not to be too narrow minded in our outlook by only dwelling upon the present day circumstances surrounding us.

While society and its transport system are in a continual state of evolution, history reveals we periodically transition from one regime or 'age' to another. Such transition occurs when technological possibility comes together with societal appetite to drive transformational change. Yet such change is not an event but a process played out over years or decades. This is revealed by looking at the history of the motor car². The motor car emerged from an era of horse-drawn transport and railways to redefine patterns of land use and social practice as more and more people were 'liberated' to transcend distance at greater speeds with a growing infrastructure provision to support this. The 'motor age' has been the incumbent regime in which we have spent our whole lives. Its stability has been assured by the power and influence exerted by public demand, vehicle manufacturers and infrastructure construction. It is easy to forget it was not always as it is now; the motor car reshaped society. Society will likely or indeed inevitably, sooner or later, be reshaped again.

In more specific terms, New Zealand has, in the last two to three decades, seen an accumulation of gradual change that is quite pronounced³. Since 1984 its population has grown by over a third. This population has been progressively ageing as well as urbanising. People's spending power has grown while the makeup of the economy has changed with a growth in the service sector. Car ownership has increased appreciably and the total distance driven on New Zealand's roads has gone up by more than half in two decades. Meanwhile the presence of the digital age has grown (by some measures) at a startling rate. For example, between 2009 and 2012 the proportion of people with internet enabled mobile phones has increased by over 300 percent. Such change invites us to contemplate the nature and extent of further change that lies ahead.

² Resource paper: The motor car and the construction of a new world

³ Resource paper: New Zealand transport and society: Trends and projections

Insights from the present

Fiction writer William Gibson has observed “the future is already here – it’s just not evenly distributed”. The present provides us with remnants of the past as well as signs of the future, the challenge being to distinguish one from the other. Conjure up in one’s mind an image of a small child staring into a tablet computer with a finger poised to sweep across the screen; one cannot help but feel this holds signs of things to come.

In terms of transport, the present or rather the recent past is providing us with clues that may lead to better understanding of what future change is to come. This relates to changes to vehicle kilometres travelled (VKT) for personal mobility on the roading network. Many developed countries, including New Zealand, have observed a recent flattening or reduction in the amount of car travel. Since its peak in 2004 vehicle kilometres travelled per person on average (VKT per capita) in New Zealand has fallen by 8 percent. This ‘interruption’ to the long-run trend of growth began before the global economic downturn and has continued since then. Expert examination of this ‘peak car’ phenomenon suggests causal factors appear multiple. Professional opinion is divided regarding the future consequences for car travel.

Research from empirical evidence in several countries reveals some common insights. Young adults are exhibiting a reduced propensity to drive and are drawn to urban living. Urban areas (while noting central and suburban differences) have observed a decline in car travel per capita while rural areas have observed growth. The link between GDP and car travel appears to have weakened. Social as well as economic factors appear to be at work. Past policy and investment decisions may have influenced present demand more than has previously been acknowledged. Such insights are not yet leading to firm conclusions and different countries have specific features. It is clear future demand will be influenced by the size, makeup and spatial distribution of New Zealand’s population. Three questions, however, remain unresolved:

- ▶ Has car travel per capita reached a level of saturation or equilibrium in urban areas?
- ▶ Does the recent decrease in per capita VKT simply reflect economic conditions with a prospect of future growth in car travel?
- ▶ Has a peak in per capita car travel in urban areas been reached such that decline will subsequently be observed (potentially offset in terms of total car travel only by a growing population)?⁴

It is important to note resolution of such questions will not be addressed by observing what happens to car travel in the immediate few years ahead.

⁴ Resource paper: Grow, peak or plateau: The outlook for car travel

Exploring the future

In times of uncertainty, the uncertainty must be embraced, not concealed. Orthodox consideration of future demand by transport authorities around the world involves demand models and forecasting tools. These produce quantitative projections based upon assumptions about factors deemed to influence demand and the relationships between such factors. Figure 1⁵ has been produced for the UK by one of the key academic commentators internationally on 'peak car'. It illustrates how projections of future demand can change over time and prove to be at odds with actual demand, raising questions regarding the level of confidence that can be applied. Such a portrayal for New Zealand might also be considered. Forecasting tools alone are insufficient for the times we face. In order to help inform and support robust decision making, diverse, *plausible* futures must be explored. An increasingly used technique to do so is scenario planning⁶. Scenario planning is a methodology that helps to recognise, consider and reflect on the uncertainties likely to be faced ahead in order, ultimately, to stimulate strategic thinking and inform decision making. The methodology involves engagement with a diversity of stakeholders and expertise to develop future scenarios, principally qualitative depictions of plausible futures. For the Future Demand project three workshops were undertaken, also informed by insights from youth focus groups⁷ and a wider set of Ministry staff. This enabled the project team to pursue the following steps: (i) identification of *key drivers* likely to influence, with varying uncertainty, future society and transport in New Zealand; (ii) selection of two *critical uncertainties* – driving forces of change pertinent to the focal question and deemed uncertain and important; (iii) development of narratives for four future scenarios – framed by the two critical uncertainties and coloured by the wider set of key drivers; (iv) consideration of the pathways from 2014 to each scenario; and (v) estimation of the VKT associated with each scenario (based on a structural demand model). The following subsections set out the substance of the scenario planning in more detail.

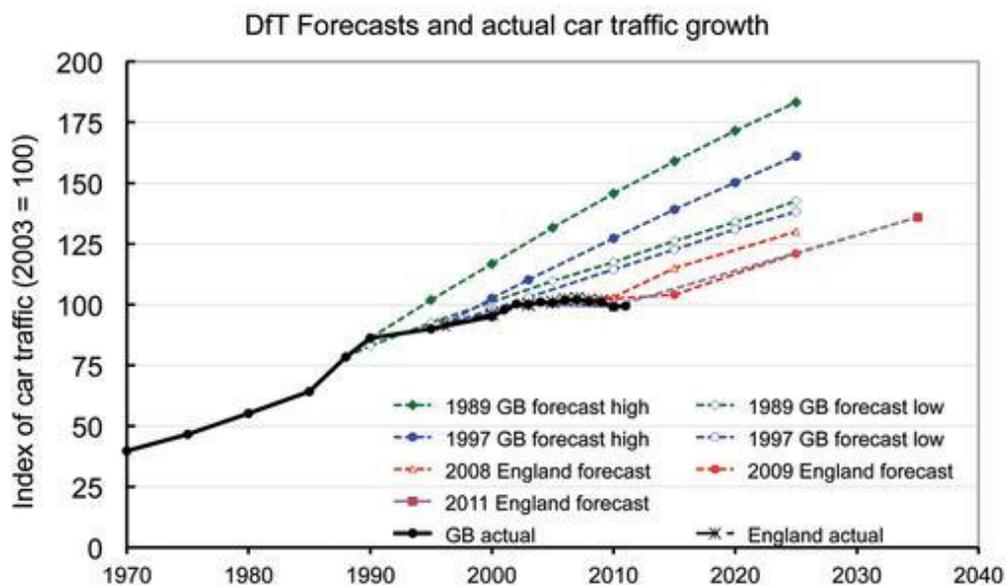


Figure 1: Comparison of forecasts and actual car traffic growth

⁵ Diagram taken, with permission, from Goodwin, P (2012). Due diligence, traffic forecasts and pensions. Local Transport Today 13 April 2012.

⁶ Resource paper: Insights into the scenario planning methodology

⁷ Resource paper: Future Demand: A youth perspective

Critical uncertainties

Key drivers included the following: changing spatial and demographic profile of population; changing spatial nature of shopping; changing nature and extent of digital connectivity; resilience and response to environmental change; changing influence of Asia; changing resource availability for goods production and for consumption; emerging technological advances and effects on industry; changing nature of and response to inequalities; systems of decision making; changing values, community and identity; fundamentalism; security; and control of the internet.

There were a number of candidate critical uncertainties from the examination of key drivers. Selection of the preferred candidates was strongly guided by a need to reflect uncertainty regarding two dimensions: what people will *want* to do in 2042; and what people will be *able* to (afford to) do in 2042. The critical uncertainties selected were as follows:

Accessibility preference (physical/virtual)

This reflects how society will want to access people, goods, services and opportunities. There has been a historical trend of physical travel dominating provision of access. This remains highly significant and growing strongly, in the form of motorisation in some countries and emerging economies. Research shows on average, across countries, cultures and time, people like to travel for around an hour a day. This has been unaffected by technology, which to date has simply changed how far we travel and our means of travel. Alongside physical travel, internet traffic growth has been dramatic globally. Cisco has estimated the data traffic carried by mobile networks in 2013 was 18 times higher than the total traffic across the internet in 2000⁸. Alongside this, a dramatic penetration of internet use across populations globally has been taking place in both the developed and developing world. Across world regions, online retail sales are showing strong and continued growth. It is clear that for a growing proportion of society the *choice* between physical and virtual access exists. What remains uncertain is the future balance of *preference*.

Relative cost of energy (high/low)

This affects what people will be able to do. A series of short term forecasts for future oil prices from different sources shows a combined *range* of projection from a 10 percent decrease to a 30 percent increase over six years⁹. The World Energy Council in its 2014 reflection of global energy leaders' opinions has marked out energy prices as a critical uncertainty¹⁰. The world's population is growing. Much of this population is in non-OECD countries. As their economies grow, so too will their energy demands which could drive energy prices upwards. Energy prices could fall if economic growth can be achieved without comparable increases in energy use and as new sources of energy are exploited. The energy intensity of economic activity in New Zealand has been reducing since the 1990s reflecting in part the changing makeup of the economy.

⁸ Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2013–2018.

⁹ See www.businessforscotland.co.uk/wp-content/uploads/2013/12/oil-prices.png

¹⁰ See www.worldenergy.org/publications/2014/world-energy-issues-monitor-2014/

The two critical uncertainties should not be taken as the only assumed drivers that will shape society and transport in 2042. They represent the ‘canvas’ upon which to paint four future scenarios. The wider set of key drivers identified by the project then comes into play as the palette from which to add colour to the narratives describing the four futures for New Zealand.

The goal was not to create predicted futures nor preferred futures; rather, we sought to produce plausible futures. As you read these scenarios the key question to ask yourself is whether each of these scenarios is plausible. If they are, we need to look afresh at how we invest in access for the future of New Zealand.

2042 scenarios

Figure 2 depicts an overview of the 2042 scenarios. Full versions are provided separately¹¹ and these offer better opportunity for readers to immerse themselves in the nature of the plausible futures described. However, *summaries* are provided next as well as an illustration of how New Zealand moved from 2014 to each of the four 2042 futures.

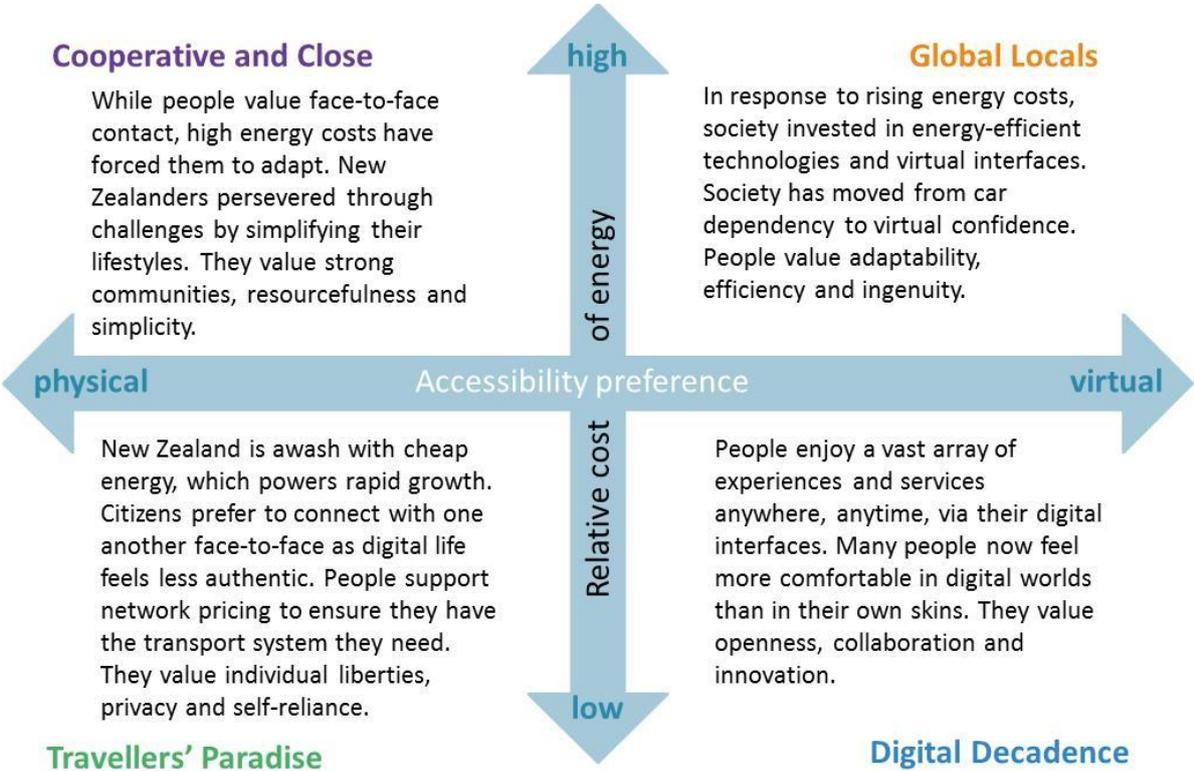


Figure 2: Overview of the 2042 scenarios for New Zealand

Travellers' Paradise

New Zealand is a bustling South Pacific powerhouse in this scenario, awash with cheap energy. Substantial oil and gas discoveries have enabled New Zealand to be a net oil exporter. Living costs are low thanks to a high New Zealand dollar that skyrocketed in value when exports flourished.

¹¹ Resource paper: New Zealand transport and society: Scenarios to 2042

Abundant energy has powered economic growth and rapid expansion of New Zealand's sprawling major cities. Rural regions initially struggled with the high New Zealand dollar but they have found new ways to thrive. Both urban and rural citizens prefer to connect with one another face-to-face as digital life feels less authentic. Digital technologies are still widely used, but people are highly discerning about how they use them. People value individual liberties, privacy and self-reliance. Domestic tourism has soared as city slickers seek to escape the hustle and bustle of loud, crowded city streets.

Compared to 2014, people are travelling more often. They want to get to places quickly, easily and on their own terms. Individual privacy and choice are paramount. While a significant programme of investment in transport infrastructure has continued, it has not been possible to physically out-build congestion on popular travel routes. Demand management initiatives have been introduced on these routes to better utilise transport infrastructure. In major cities, mass transit rail and rapid bus systems are also popular to move people around quickly. Cycling is often dangerous in fast-moving traffic. Climate emissions from transport have stabilised and New Zealand is meeting its international climate obligations.

Getting from 2014 to Travellers' Paradise

Investments in offshore oil and gas prospecting paid off when substantial oil reserves were discovered in the North Island's East Coast Basin and other previously unexplored basins in the early 2020s. International energy companies developed the reserves and began exporting. Oil royalties were invested in health, education and superannuation. Government also invested heavily in New Zealand's transport infrastructure, bringing many road projects forward and investing in greatly-expanded mass transit rail and rapid bus systems to keep Auckland, Wellington and Christchurch moving.

A growing global appetite for energy meant New Zealand's oil exports were in hot demand. This pushed the value of New Zealand's dollar up to record levels, requiring other industries to innovate and develop niche markets to stay competitive. The main market for high volume, low cost food became domestic due to the high value of the dollar.

Fossil fuel prices reduced globally thanks to new oil discoveries, while low electricity costs (thanks to renewable energies) saw the gradual uptake of more electric vehicles in New Zealand. The strong New Zealand dollar raised national incomes and went some way to dampen rises in other living costs such as housing and food; however, these costs gradually increased from 2014 levels.

The social media bonanza of the early 20th century began to fall out of favour for most New Zealanders from the mid-2020s. People were suspicious of how their personal data was being used. Digital technologies kept evolving, but people grew more interested in authentic personal experiences and less interested in the latest technological trends.

Cooperative and Close

Although people value face-to-face contact, high energy costs have forced people to adapt. New Zealanders have persevered through challenges by simplifying their lifestyles and working together. They value strong communities, resourcefulness and simplicity. Local community life is flourishing but some tensions exist between communities.

Travelling by large private vehicle is expensive so most people prefer to stay close to their local communities and workplaces. Adapting has been strenuous and often painful for low-income families who live on the outer edges of settlements. They commute long distances to work by carpooling or using public transport (where it exists).

Compared to 2014, people are travelling less by motorised means. They are travelling more by foot and on bikes, and co-share transport. Many people are healthier because they lead more active lifestyles. Climate emissions from transport have decreased dramatically.

Getting from 2014 to Cooperative and Close

Global energy prices soared in the 2020s because of high demand from thriving economies in Asia and South America that clashed with oil supply constraints. Political turbulence and conflicts in the Middle East led to unstable oil prices and occasional oil shocks. Strong public pressure for political and business action on climate change also led to rising international carbon charges.

In combination, these pressures forced most countries to seek safer and more secure alternatives to fossil fuels. As these fuels became more expensive, renewable energy research and developments boomed from the 2020s onwards.

High energy costs rippled throughout economies, making the vast majority of goods more expensive. These cost increases included digital technologies, which started to become more costly from the 2030s onwards after decades of price declines. Manufactured goods are expensive, so people appreciate products that are durable, reliable and upgradable.

New Zealand still exports many primary products because of the high global demand for food to serve a growing world population. However, major exporters were hit hard by the rising costs of energy and fossil-fuel based inputs such as fertilisers. Incomes in New Zealand have not kept pace with rising global energy prices.

Fortunately, New Zealand was initially well-positioned to face these challenges with abundant renewable energy sources. New Zealanders are supportive of their country becoming totally self-sufficient for energy.

As industries and householders transitioned from fossil fuel dependency to using energy from renewable sources, electricity demand climbed. Despite abundant renewable energy resources, investments in electricity generation struggled to keep up with demand. Hydro developments were limited by competing demands for fresh water from farmers. Many wind developments were opposed by local communities, making remote wind farms the only option. Therefore, electricity prices increased along with fossil fuel prices. Advances in solar technologies have enabled most upper- and middle-income households to generate enough electricity to meet their household needs, but not enough to power a large private car.

Digital technologies are still readily available. However, high profile security breaches in the late 2010s and 2020s eroded public trust in many of these technologies. Digital technologies are only embraced as a complement to local/physical interactions. When people began relying more on their local communities and supporting one another they formed stronger social bonds.

By 2042, most people prefer connecting face-to-face with one another rather than via digital media. They also support local businesses because this strengthens their cherished local communities.

Global Locals

New Zealanders pride themselves on their 'can do' attitude in this scenario. Government, business and community leaders could see escalating challenges on the horizon and they navigated their way through them before big changes were forced upon them. New Zealand rapidly responded to spiralling energy costs by embracing smart technologies and virtual interfaces to do business and stay connected. New Zealanders value adaptability, efficiency and ingenuity. They love living in their digital worlds, which offer greater security than the physical world.

New Zealand is embedded in a global matrix of digital highways and byways. Highly educated people can work anywhere in the world from the comfort of their armchairs. People have traded off concerns about being monitored or tracked by corporations and government for the security and utility the digital world offers. Communities are largely based on talents and interests, rather than proximity to other people. Less technologically literate people continue to do manual jobs that keep society functioning.

Compared to 2014, people are using all motorised forms of transport far less. People prefer exploring the digital world to travelling outside. Obesity and diabetes rates have increased because of a lack of physical exercise. People regularly try to manage their health by walking and cycling for recreation. Climate emissions from transport have fallen dramatically.

Getting from 2014 to Global Locals

Global energy prices climbed steadily from the late 2010s onwards. This was initially because of high global demand for oil and gas from growing economies in Asia, India, Eastern Europe and South America.

In the early 2020s, a severe oil shock sparked by major conflicts in the Middle East caused oil prices to spike for over a year. New Zealand was ill-prepared for the scale of this event. New Zealand struggled to compete with larger countries to source affordable oil. Public turmoil around surging petrol and food prices led government, business and community leaders to establish an Emergency Energy Commission to re-evaluate New Zealand's reliance on fossil fuels.

The outcome of this Commission was the Re-energise Aotearoa New Zealand Accord in the late 2020s, which advocated a shift towards a super high-tech energy-efficient economy that embraced digital technologies to keep New Zealand connected with the rest of the world. The Accord received strong backing from many industries and communities across the country.

Government and businesses invested heavily in digital literacy, intelligent infrastructure and smart technologies to closely connect people and businesses. Those generations already immersed in digital technologies found the transition easy and welcomed it. This meant New Zealand was well placed in the early 2030s when a binding international climate stabilisation agreement raised the price of polluting fuels. This agreement was signed after a series of severe hurricanes and storm surges inflicted major damage in the United States, Australia and the coastline of South East Asia. High profile public protests

against deep sea prospecting, coal mines and ‘fracking’ for natural gas pushed governments and businesses to accelerate the transition from fossil fuels to alternative sources of energy.

By 2042, New Zealand has made a shift away from its historical export industries of tourism and farming. High-value food and fibre products are still produced and sold in Australia and the Asia–Pacific region, but in lower quantities than in 2014. New Zealand’s Intellectual Property (IP) and online service industries are well regarded, as workers can fill a distinct service gap when much of the world is sleeping.

Digital Decadence

The true measure of success for most New Zealanders in this scenario is not how many possessions they own but how rich their digital experiences are. Most experiences are mediated through immersive and sometimes addictive digital technologies. People carefully groom their digital lives to express their individuality. The sense of power and enjoyment they get from creating their digital selves has spilled into the material world. People actively participate in online forums and readily share their likes and dislikes. New Zealanders value openness, collaboration and innovation.

New Zealand is a magnet for digital entrepreneurs, ‘enhanced reality’ designers and social innovators. Traditional industries have also had a new lease of life. Food and fibre exports from automated farms and factories are booming. Energy costs have reduced globally and energy is widely affordable in New Zealand thanks to high exports, super-efficient technologies and access to abundant renewable energy sources.

Compared to 2014, people are travelling less on all forms of motorised transport because they can enjoy a vast array of experiences and services — anytime and anywhere — by activating their digital interfaces. When people need to travel it is cheap for them to do so. They prefer to travel in self-driving cars so they can remain connected. Doctors regularly prescribe walking and cycling to people who are not physically active. Climate emissions from transport have fallen dramatically as most vehicles run on renewably-sourced electricity.

Getting from 2014 to Digital Decadence

Digital technologies kept evolving exponentially during the 2010s and 2020s. New Zealanders heartily embraced these technologies because of the convenience and open access they offered. The boundaries between ‘online’ and ‘offline’ life blurred with wearable devices and intelligent nanosensors that could be embedded in almost anything. The prices of these technologies kept falling. Everyone and everything became ‘digitally enmeshed’.

Digital technologies enabled sweeping changes in how people organised their lives. For the vast majority of New Zealanders, living without digital technologies became totally unthinkable. Digital citizens became increasingly concerned about the threats to their digital connections. Rather than retreating from the digital worlds, government and service providers collaborated to produce a Digital Rights Act in the early 2030s, which aimed to ensure wholesale access to digital connectivity across the population. Digital connectivity became a basic human right.

Fossil fuels gradually became more expensive globally as governments and businesses responded to social pressures for climate action. New Zealand was initially insulated from rising prices because of the high New Zealand dollar. Farm exports kept booming thanks to strong demand for high protein food — from Asia in particular.

By the late 2030s, it was cheaper to access most energy from renewable sources because of the increasing costs of fossil fuels and advances in renewable energy technologies.

Quantification of demand in each scenario

A spreadsheet-based structural model was developed as part of the Future Demand project to enable simple approximations of demand for car travel to be estimated for each of the scenarios¹². The model draws upon data from the NZ Household Travel Survey, key assumptions from Treasury, and Statistics NZ projections and forecasts. A subset of key quantifiable drivers is adjustable in the model to allow each scenario to be examined: population (growth, structure and urbanisation), energy prices, fuel efficiency and the impact of digital connectivity. The resulting estimates of car travel are shown in Table 1.

Table 1: Estimates of private VKT for the 2042 scenarios

2042 Scenario	Change from 2014	
	VKT/capita	total VKT
Travellers’ Paradise (Low/Physical)	+10%	+35%
Cooperative and Close (High/Physical)	-21%	-3%
Global Locals (High/Virtual)	-62%	-53%
Digital Decadence (Low/Virtual)	-44%	-25%

This indicates an estimation that VKT and VKT/capita goes down in three of the four scenarios with an estimated span of possible change from 2014 across the 2042 scenario set of 72 percent variance for VKT/capita and 88 percent for total VKT. These spans especially reflect the uncertainty over society’s balance of preference in terms of what people will want to do in 2042 combined with the uncertainty over what it will be affordable to do.

It is important to note more than four possible futures exist; the future is uncertain. However, the diversity of this set of four plausible futures offers a tangible range of possibility with which to test thinking and examine the robustness and flexibility of policy and investment decisions.

¹² Resource paper: Future Demand Model overview and user guide

Insights and recommended responses

The resource papers, the scenario planning process and the scenarios themselves provide a richness of examination of change and possibility in terms of what the future may have in store for New Zealand society, its transport system and people's travel. The project drew upon all of this to reflect back on its focal question: 'how could or should our transport system evolve in order to support mobility in the future?' This gave rise to a series of key insights and associated recommendations for how to respond. These are set out below and cover six themes:

- ▶ **Change** — we face an uncertain future as we see change in patterns of demand
- ▶ **Flexibility** — we need to build flexibility into our transport system to accommodate change
- ▶ **Accessibility** — we need to invest in accessibility recognising this can be achieved through a good transport system, good planning of our physical environment or through good digital connection
- ▶ **Technology** — we need a better understanding of emerging technology and its speed of adoption
- ▶ **People** — we need a better understanding of what is shaping the changes in people's behaviour
- ▶ **Responsibility** — we need to recognise the decisions we make will shape future demand. We should accept responsibility for that and start a discussion on what sort of transport system is appropriate.

Change — respecting uncertainty and our limited grasp of cause and effect

The traffic intensity of the economy has been reducing for over a decade

Historically there has been an observed association between economic output (GDP) and levels of road traffic. This is known as 'coupling'. Accepted wisdom was that one could not have one without the other (the same has been true of GDP and energy demand). Demand models used to produce forecasts of future demand are based upon assumptions related to this coupling. The prospect of 'decoupling' is recognised, a *weakening* of the relationship between resource consumption and economic output. Evidence in recent years for New Zealand shows a reducing traffic intensity of the economy: between 2001 and 2013 while GDP grew by 34 percent, total VKT has increased by only 12 percent and light passenger VKT by only 8 percent. Economic prosperity is not as seemingly dependent upon people travelling by car as it once was. Goods and materials movement shows a more modest change in intensity but a degree of decoupling nevertheless; instead of growing with GDP it is now growing more slowly. Changing traffic intensity of economic activity raises questions about how demand models can account for *future* change in the production of demand forecasts. It also raises a question about whether we need to grow our transport system capacity (as much as we might previously have thought) to ensure we do not constrain economic growth. The roading network remains important for a thriving New Zealand but it is not unique in supporting economic activity. Other factors must be at work. These are not fully understood but are likely to include the changing makeup of the economy and also changing preferences for alternative forms of access to people, goods, services and opportunities besides that provided by the car. Of course it must not be forgotten a thriving New Zealand amounts to more than being economically prosperous.

Further investigation is encouraged to better understand the changing traffic intensity of economic activity that has been observed in the recent past and to begin considering how that intensity may change in the future. It is also important to review the appropriateness of parameters and assumptions in our transport models. This is not a matter unique to New Zealand so a collaborative international approach should be considered, perhaps through the International Transport Forum of the OECD.

The matter about which one can have greatest confidence of outcome is that a projection about the future will be wrong

It is a widely held acknowledgement that the matter about which one can have greatest confidence of outcome is that a projection about the future will be wrong. Single point projections are commonly produced. This typically involves more than a single projection such that a set of projections can then reflect bounds of possibility (for example a 'high', 'mid-range' and 'low' projection). Whether dealing with prediction or plausibility, we are, at best, producing estimates of change to a complex system based on limited understanding of cause and effect. Such estimates involve assumptions, both implicit and explicit. This project has produced estimates for four plausible futures. These will be at odds with other estimates of future demand. One can liken the upper and lower bounds of future projections to the jaws of a crocodile. They can widen or close; they can tilt up or down compared to the waterline of present or baseline demand. Either way, they are still the jaws of a crocodile and should be treated with the caution they deserve.

It is recommended any production of estimates of future demand possibility should seek to be as transparent as possible about the underlying assumptions and limitations that are involved. The Future Demand project makes available its spreadsheet-based structural model of demand alongside the detail behind the process and outputs of its scenario planning exercise. Differences between estimates from different sources should be constructively examined rather than applying premature judgements over credibility. Important lessons are to be learnt from assessing and better understanding past estimates of future demand that have been made over time.

We should not dismiss the plausibility of seeing little change in future

Uncertainty implies change and indeed suggests substantial change, to society and transport. While this can indeed be the case in a number of respects, it is important to recognise uncertainty also encompasses the plausibility of little fundamental change or change that takes much longer than anticipated to come about. Geological time marks change at another extreme to that represented by Moore's Law and its reflection of the rapidity of increase in computer processing power. Social change in terms of values and practices can be slower than technological change. Change to regimes of governance may be yet slower than social change. Both can be subject to significant inertia. Change arises both from opportunity but also from motivations and actions of the actors in the system. As noted earlier, in relation to the history of the car, regimes and particular practices can be subject to 'lock-in' effects of the various behaviours and interests of the actors involved.

At one extreme, our transport system may be subject to a state of stable equilibrium in which stability and balance prevail, allied to forces of inertia resisting all but small perturbations of (temporary) change.

At the other extreme, our transport system may be subject to a state of unstable equilibrium in which changes to the underlying drivers and the relationships between them could precipitate a rather rapid process of destabilisation and change. It will be important to be mindful of such extremes in considering future demand while at the same time being alert to the preconceptions at play (see below).

Flexibility — designing our systems to accommodate uncertainty

We need to be willing to be flexible in our thinking

The future is uncertain. This is a given. However, the challenge this represents is amplified by the range of different preconceptions held by the actors involved in the process of examining the future and informing and making decisions that help shape it. Individuals and organisations may align with one or more of the following outlooks: *predicted* — an extrapolated outlook for the future giving a (misguided) sense of confidence; *plausible* — an outlook for one or more future possibilities whose potential emergence cannot be denied based on current knowledge; *presumed* — an outlook for the future on a basis of probability and instinct but without proof; *preferred* — an outlook for the future that is desirable (so therefore value laden); and *practical* — an outlook for the future that aligns best with immediate interests and imperatives.

It is advised that as analysts, experts and decision makers we would be wise to acknowledge to ourselves, and perhaps to others, the standpoint(s) from which we contribute. What becomes apparent from and underlined by the project is that a wider range of possibility for future mobility should be entertained than has traditionally been the case. It is not enough to only consider predicted outlooks; *plausible* outlooks should also be considered. Once this is done then the need for (greater) flexibility and resilience being accounted for in policy, transport measures and investment decisions becomes apparent. In particular this points to the importance of a *real options approach*¹³ in the appraisal of investment options.

We need to future-proof the development of our built environment

It is apparent the development of our built environment, including transport infrastructure, can give rise to a number of consequences: it can constrain society's changing needs by limiting growth or being built in the wrong places; legacy infrastructure can become underutilised or even abandoned while also constraining adaptation of the environment; and infrastructure planning and implementation can fail to anticipate future conditions. Building upon the previous insight, our land use and transport systems need to be future-proofed to maximise opportunities for their use as society adapts in terms of its future demand. This means balancing the need for a good return on infrastructure investment with the high degree of uncertainty about the future.

¹³ The real options approach supplements cost benefit analysis in situations of uncertainty, which is usually on the demand side. Traditional analysis is dependent on whatever information is available upfront and cannot incorporate new information that emerges later. Real options based decision making sees each stage of a project (for example, concept/design, land acquisition, approvals, site preparation, construction) as buying the option to proceed to the next stage or to delay/modify/cancel in the light of new information emerging from the preceding phase and of new external information. This preserves the option of constructing a worthwhile project while also preserving the option of avoiding a white elephant. See www.bitre.gov.au/publications/2014/files/overview-project-appraisal.pdf for further insight.

Investment decisions face the challenge of how to address present demands for infrastructure and those in the immediate future while avoiding unanticipated consequences of ‘lock in’ that will limit the ability of future generations to meet their needs. It is recommended examples of existing urban and rural development should be reviewed in terms of built-in flexibility as should methodologies to inform investment decisions (taking account of a real options approach as referred to above).

Accessibility — ensuring society can reach people, goods, services and opportunities

We must recognise it is about access not transport

Accessibility concerns our ability to be able to connect with people, goods, services and opportunities. There has been a tendency for physical (motorised) mobility to be construed as broadly synonymous with accessibility. While it is certainly the case that the motor age has created a strong dependency on mobility for connecting, three different underpinnings to what might be called New Zealand’s ‘triple-access system’ need to be recognised, namely motorised vehicles for access, physical proximity for access and digital communications for access. Transport, land-use and telecommunications systems are all evolving and interacting to provide access. All three are relevant to policymaking and investment.

It is strongly recommended this project’s focal question be recognised as a subsidiary question to the following: *How could or should our system of access evolve in order to support a thriving future New Zealand?* Transport policy and investment decisions cannot be isolated from developments in land use and digital communications. Consideration should be given to establishing an overarching body or function that considers how transport, land use and communications co-create, and can improve, provision of access for a thriving New Zealand. This triple-access system needs to evolve to ensure resilience and flexibility in the face of uncertainty.

Technology — tracking developments and critically examining future prospects

We need a better understanding of emerging technologies and their likely impact on transport and travel demand

Building upon the previous key insight and turning to a technology focus, it is important the transport sector does not ignore the rapid changes of the digital age, especially those that do not appear to fall within the immediate remit of ‘Intelligent Transport Systems’. Since Henry Ford’s Model T of a century ago, the technology of the motor age has continued to advance in terms of vehicle design, energy efficiency of propulsion, fuel sources and systems of communications and control, within the vehicle, between vehicles and with the transport infrastructure. Yet over an even shorter time span, modern computing has gone from monolithic valve-based devices for relatively simple calculations to miniaturised, multi-functional, mobile and massively connected devices that would have belonged to the realms of science fiction not many decades ago. Unless the digital age is poised to reach the top of its development curve any time soon then further dramatic change in technological possibility is yet to come. In our present day consideration of transport’s future we are bearing witness to a ‘collision’ of the digital age and the motor age¹⁴. This project’s scenarios play out the collision for different contexts of

¹⁴ Resource paper: Transport’s digital age transition

energy affordability, accounting also for land use change. The landscape of access possibility in and against which our transport system plays its part has been changed forever and is continuing to change, notwithstanding path dependencies that will be at work.

National work is needed to assemble a more detailed picture of take-up of digital technology and its use for economic and social ends than we have at present. Such work needs to continue over time. This should be allied to a 'technology watch' undertaking that charts the emergence of new technologies and services that have the possibility for widespread influence on access and behaviour in New Zealand. Whether digital technology use is augmenting or replacing access gained through using the transport system needs to be gauged.

We need to treat the impact of emerging technologies on access with caution

A range of technological possibilities of change or advance exist in any age. Some are simply ideas while others are inventions or proofs of concept. Others besides are moving from invention into the space of innovation as they begin to be adopted and diffused into social practice with the possibility of eventual widespread use and transformative effect. Present day examples include wearable technology, augmented reality technologies, 3D printing and driverless cars. With the globalisation of connectivity and communications and the power of social media, news and images of leading edge technology travel fast. It can be easy to be drawn into plausible, presumed or preferred outlooks that treat the possibilities from technology in a distorted or inflated way. Ideas and inventions reflect human capacity for creativity and ingenuity. They provide glimpses of future possibility for New Zealand's society. However, they only become important once they translate into innovation and adoption, and this takes time, if it happens. History tells us today's hype has every prospect of becoming tomorrow's disillusionment, with uncertainty over whether enlightenment will follow. New Zealand is in an interesting position as a country known both for its capacity to be a test-bed for new technologies (and perhaps in turn an early adopter) as well as for being a technology take-up laggard, following the lead in other countries.

It is recommended exercises should be undertaken to critically examine 'hyped' technologies as they arise. This should involve a number of perspectives to develop informed and robust understandings of the possibilities that lie ahead beyond the initially inflated expectations.

People — understanding behaviour for different people in different locations

We need to understand what is shaping travel behaviour change

Travel demand, especially relating to the roading network, is commonly measured in terms of total travel or average travel per person. Units of measurement are vehicle kilometres travelled (VKT) or VKT/capita. Trends in total (car) travel inform us of demands upon our transport system (dependent on time and place). These combine changing population size with changing behaviour. It gives a sense of *what* people are doing. Changing behaviour itself is more apparent in trends in (car) travel per person which will also embody and reflect signals of social and lifestyle change; it better reflects whether or not *why* people are travelling might be changing. However, figures either at national, regional or local level for VKT/capita reflect observation and only begin to scratch at the surface of understanding.

Future uncertainty could be reduced if we better understood the travel behaviour dynamics of the present and how these are changing and have been changing over time. We need to review the adequacy of available national data and determine whether more needs to be done in terms of data collection and/or further analysis to improve understanding. In short, we need to move beyond asking people what they are doing to asking them why they are doing it (beyond simply recording the purpose of travel). Indeed, to understand behaviour in terms of future demand, we need to examine people's reasons for not travelling as well as for travelling, to better ascertain how travel is experienced and to what extent virtual access is accompanying or substituting for physical access.

We need to recognise different types of people will change in different ways

Ultimately our transport system must evolve to support New Zealand's future population of travellers. International research examining the 'peak car' phenomenon including that in New Zealand has recognised the significance for overall travel of understanding the following: how many people will comprise the travelling population; the socio-demographic composition of this population; and where the population is located spatially. By only examining average figures even at regional levels we risk overlooking important divergent trends and divergent needs that lie underneath. An ageing population is to be considered and questions asked about *where* older people will live and *how* they will live and the associated travel demands concerning both older people and those with whom they interact. We need to understand how older people of 2042 may differ from older people of today as our young and middle-aged cohorts move through their own life courses. Declining car travel per capita is recognised as being associated with a national trend of urbanisation while in rural areas the reverse may be true; where people are living will matter greatly to future demand.

It is suggested all regions engage in a strategic exercise to examine and compare their present populations and their lifestyles. Such an exercise if undertaken should then examine the uncertainty over how these could change in future. Evolution of the triple-access system of transport, land-use and telecommunications should be informed by the outcomes of such an exercise. This would be a substantial undertaking and call upon a co-ordinated approach across regions with careful planning and sufficient resourcing and timescales. However, the eventual rate of return on investing in such an exercise could be considerable.

Responsibility — making decisions today to enable adaptation for a thriving future

While we face many uncertainties we need to realise we can make choices that will shape our future

How people will want to connect in future and where the balance between physical and virtual access will lie is uncertain. How much people will be able to afford to connect in the way(s) they might wish is uncertain. People's *adaptability* is key to reconciling connection need and affordability. By providing a balanced and flexibly designed triple-access system, it is possible to support people by maintaining choice between transport, telecommunications and proximity, ensuring society's adaptability and capacity to thrive.

Policymaking should recognise the human capacity to adapt. Such capacity is exhibited in times of sudden and disruptive change and can also be revealed through more measured and intended approaches such as demand management surrounding major events like the Olympic Games.

Policymaking should give greater priority to *leading* developments that can assure people's *future* needs (and the needs of future people) can be met. This should be alongside if not instead of *following* people's expressed demands (and resistance to change) based on how they currently fulfil their needs (and wants). *Feasibility* of how we seek to evolve our transport system must nevertheless be acknowledged. Policy intentions and rationale must be clearly communicated.

Should we move from 'predict and provide' to 'debate and decide'?

"A self-fulfilling prophecy is an assumption or prediction that, purely as a result of having been made, causes the expected or predicted event to occur and thus confirms its own 'accuracy'" (Paul Watzlawick). Assuming how people will behave and then providing for that behaviour can overlook that the behaviour can occur because of the provision. Without that provision or with different provision people will behave differently. It is now established, for example, building new roading capacity can cause the generation of (some) new traffic. Likewise it has been shown when roading capacity is removed, traffic can disappear (and not simply be displaced). It should be no surprise that improving the service quality of public transport can be the key to increasing patronage or that improving the quality of the public realm in urban areas can cause people to spend time and money there. Evolution of our transport system is not merely serving society; it is shaping it, including the demand for travel. It is not then perhaps a question of predicting future demand but *deciding* upon the demand that is appropriate and investing in ways to provide for this and ensure it is supported.

Given uncertainty over future demand, it is legitimate to acknowledge the need to shape future demand in terms of access provision. Consideration should be given to establishing compatible 2042 targets for transport, land-use *and* telecommunications access at national and regional levels and determining suitable investment trajectories. Such an approach would also require a review of hypothecation in terms of implications for revenue generation and use.

Conclusions

How could or should our transport system evolve in order to support mobility in the future? This is a challenging question to answer given the unknowns we face. 'How *could* it evolve?' has more than one answer, reflective of both policy and investment decisions that are made and of the uncertainties ahead. 'How *should* it evolve?' also has more than one answer reflecting diversity of public, professional and political opinion.

However, three important principles that emerge from this project can help us. Firstly, it is *access* not mobility per se that is key to a thriving New Zealand. What makeup of access will be desirable and affordable in future is uncertain.

Therefore, secondly, we must ensure a resilient provision of access options that allows for adaptability of behaviour over time. This means a combined and co-ordinated effort to evolve and improve roading *and* proximity *and* digital communications.

Our transport system's nature and scale partly determine the demand placed upon it. Therefore, thirdly, when evolving our transport system we should consider providing for the demand we believe is *appropriate* (and feasible) rather than providing for the demand we may be tempted to predict. We need to move from seeking to predict and providing for demand to debating and deciding what level and type of access we should seek to deliver.

The question posed by this project is not confined in its jurisdiction only to transport and neither is it only pertinent to New Zealand. National and international dialogue is important for us to foster and engage in.

New Zealand's land transport programme has a current expenditure target for the next 10 years of \$38.7 billion. Such a scale of investment will not only shape our transport system's evolution but that of New Zealand society for generations to come. We must invest wisely and those with the responsibility to influence expenditure decisions are encouraged to give serious attention to the issues set out in this report.