New Zealand’s future transport system: drivers of change

Initial report from the NZ Delphi study
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Executive summary

This report summarises the findings from three of the four stages of a Delphi study involving New Zealand transport experts. The Delphi technique is an iterative, multi-stage survey process, which brings together expert opinions on complex topics. The technique is widely used as a forecasting tool.

The aim of the study was to gain an understanding of expert views on the drivers of change to New Zealand’s transport system, and whether interventions are required to respond to trends, innovations and potential step-changes to ensure NZ continues to thrive.

This report covers initial statistical analysis of the results. A report covering more detailed analysis of these findings will be forthcoming.

Participants (see section 1)

- A total of 86 transport-related experts contributed the four round Delphi process. Seventy-five of these experts participated in Round 1, 67 participated in Round 2, 55 participated in Round 3 and 44 participated in Round 4.
- More participants worked in local and central governmental (27 of 86) than in other sectors, with NGOs second and industry third (Figure 1).
- Participants had an average of 15.1 years of experience (with a standard error of ± 1.2 years) in transport related work (figure 2).
- Across the participants, the greatest expertise was in ‘active transport’, ‘policy and planning’, ‘personal transport’ and ‘transport-related infrastructure’ (figure 3).

Delphi Round 1 (see section 2)

Trends, innovations and step-changes (freetext responses)

- The most frequently identified influential trends driving change in NZ’s transport system were technological advancements of various types.
- The most frequently identified influential innovations were IT developments, electric vehicles, smart cars, and battery technologies.
- Rising and/or volatile oil/gas prices were the 2nd most frequently identified trend and the most frequently identified step change.
- Increasing climate change issues/concerns were the 3rd most frequently identified trend and the 2nd most frequently identified step change.

Delphi Round 2 (see section 3)

Trends

- *Rising fuel prices* scored as both the most likely trend to become widespread within 10 years, and the trend most likely to transform the transport system away from BAU in the long term (figure 6).
• **Ageing population and increasing percent of population in urban areas** were the second and third most likely influential trends to become widespread within 10 years (figure 6).

• The trends that ranked second and third in their potential to transform NZ’s transport system away from BAU were **urban form that supports active transport and public transport**, and **increasing investment in public transport infrastructure** (figure 7).

**Innovations**

• **Ultrafast broadband** and **high quality videoconferencing** were identified as the most likely influential innovations to become widespread within 10 years, followed by small electric vehicles (figure 9).

• The innovation with the greatest potential to transform the transport system away from BAU was **demand management through road pricing** (figure 10).

• This was closely followed by **multi-modal integrated public transport systems** and **bicycle infrastructure** (figure 10).

**Step changes**

• The top three step changes deemed most likely to become widespread within 10 years were all oil related: **spikes in the price of liquid fossil fuels**, **political instability in oil rich countries**, and **constraints in oil supply** (figure 12). Note that there are likely to be strong interrelationships between these factors.

• A **significant breakthrough in battery/storage technologies** is fourth ranked in both likelihood and ability to transform.

• The step change deemed most likely to lead to transformation of NZ’s transport system away from BAU is **sustainability becoming a major driver of policy at all levels of NZ government and for business** (figure 13).

• This is followed by **constraints in oil supply** and **political instability in oil-rich countries**.

**Estimated timeframes**

• There is a high level of agreement that battery technologies enabling a 300km range for EVs will be readily available within 10 years (figure 15).

• The take-up of EVs in NZ’s private and commercial fleets is expected to be slow, with a median of 15-20 years to reach 20% of the fleet, and many anticipating that this will take over 20 years (figures 25 and 26).

• Almost all believe that within 15 years there will be a global price on carbon (figure 20).

**Delphi Round 3 (see section 4)**

**Trends, innovations and step changes requiring intervention:**

• The most frequently identified top priority trends requiring intervention to enable NZ to thrive, were (in order of frequency) **increasing investment in public transport infrastructure**, **rising fuel prices**, and **urban form that supports active and public transport** (figure 29x).

• The three most frequently identified trends requiring intervention, when combining first, second and third priorities, were: **Increasing investment in public transport infrastructure; urban form that supports active and public transport**, and **increasing investment in active transport infrastructure** (figure 29). These were prioritised by at least twice as many participants than any other trend.
• The most frequently identified top priority innovations requiring intervention to enable NZ to thrive, were (in order of frequency) integrated, multi modal transport; demand management through road pricing; and bicycle infrastructure (figure 30). These were also the most frequently identified innovations when combining first, second and third priorities.

• The most frequently identified top priority step changes requiring intervention were (in order of frequency) sustainability becomes a driver of policy in NZ; constraints in oil supply; spikes in the price of liquid fossil fuels, and decreasing the proportion of transport spend on roads (the latter two being equal).

• The most frequently identified step changes requiring intervention, when combining first, second and third priorities, were: sustainability becomes a driver of policy in NZ; decreasing the proportion of transport spend on roads; global price on carbon, and major investment in NZ rail system (the latter two being equal).

Features of a sustainable transport system for NZ:
• 90% or more of the participants agree or strongly agree with the following features of a sustainable transport system for NZ:
  o Integrated multi-modal transport system in urban areas over 100,000 people (figure 48).
  o Cross modal ticketing systems (figure 49).

• 80% of more of the participants agree or strongly agree with the following features of a sustainable transport system for NZ:
  o Having different transport options for different length trips (e.g. 1-2km, 3-5km, 10-20km, 50km+) (figure 50).
  o Ensuring rural areas have access to information & communication technologies (ICT), to support travel substitution (figure 52).
  o Collective, cross-party vision of NZ’s future transport (figure 54).
  o Make the full cost of car ownership evident to the general public so that all transport modes are on a level playing field (figure 60).
  o Changing urban form and functioning to reduce need to travel (figure 61).
  o Being proactive so alternate travel modes are readily available prior to disincentivising personal vehicles (figure 62).
  o Targeting transport options to size and density of the population (figure 63).
• There were greater levels of disagreement on the following features:
  o Increasing the use of rail for inter-city travel (figure 55).
  o Biofuels for freight and long distance travel (figure 59).
  o Electrifying the entire rail system (figure 65).
  o Using electrified rail rather than roads for freight transport (figure 66).
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Introduction

This report summarises the findings from three of the four stages of a Delphi study involving New Zealand transport experts. The Delphi technique is an iterative, multi-stage survey process, which brings together expert opinions on complex topics. The technique is widely used as a forecasting tool. The aim of the study was to gain an understanding of expert views on the drivers of change to New Zealand’s transport system, and whether interventions are required to respond to trends, innovations and potential step-changes to ensure NZ continues to thrive.

Participants were recruited through direct approaches to government agencies, district and regional councils, transport consultants, transport-related businesses, and non-governmental organisations. We sought as broad a range as possible of participants with expertise in transport-related fields. The total number of participants and the rate of retention are high for a Delphi study, and give us confidence in the findings.

Round 1 of the study asked a series of open-ended questions, asking for participants’ views on trends, innovations and step-changes that are likely to lead to changes in New Zealand’s transport system.

Round 2 asked participants to nominate the likelihood of each of these trends, innovations and step-changes becoming widespread in New Zealand in the next 10 years, and their potential to transform New Zealand’s transport system away from BAU in the long term. We also asked participants to nominate timeframes within which some of these transformative influences could occur.

Round 3 asked participants to select the three trends, innovations and step changes where interventions are most urgently needed in order to achieve a transport system that enables New Zealand to thrive economically, environmentally and socially. We also asked participants to rate their level of agreement with a series of statements drawn from the free text responses in previous rounds which appeared to reflect potential areas of disagreement. Finally, we asked whether they agreed with findings from our International Delphi in 2013 in which international experts had shared their views on the possible characteristics of a sustainable transport system for New Zealand.

Round 4 (not reported here) listed the top ten most frequently selected areas for intervention (trends, innovations and step changes) and asked participants select their top 3 priority areas and to describe the interventions (e.g. changes in policy, investment, institutions, market settings) that would be needed to achieve the transport priorities identified by our Delphi panel. The results from this round are not yet fully analysed and will be reported-on separately.
A total of 86 transport-related experts contributed the four round Delphi process. Seventy-five of these experts participated in Round 1, 67 participated in Round 2, 55 participated in Round 3 and 44 participated in Round 4. The findings are catalogued in this report in order of the questions asked in Rounds 1-3. Further analysis will be forthcoming.
Section 1.0  Attributes of expert participants

Highlights:

- A total of 86 transport-related experts contributed the four round Delphi process. Seventy-five of these experts participated in Round 1, 67 participated in Round 2, 55 participated in Round 3 and 44 participated in Round 4.
- More participants worked in local and central governmental (27 of 86) than in other sectors, with NGOs second and industry third (Figure 1).
- Participants had an average of 15.1 years of experience (with a standard error of ± 1.2 years) in transport related work (figure 2).
- Across the participants, the greatest expertise was in ‘active transport’, followed closely by ‘policy and planning’, ‘personal transport’ and ‘transport-related infrastructure’ (figure 3).
- Least expertise was in ‘freight’, with only 2 panel members claiming to have excellent knowledge of freight.
- The most frequently nominated region of expertise was Auckland, followed by Wellington and Otago/Dunedin (figure 4).
- New Zealand was the most frequently nominated country by far, followed by Australia and the UK (figure 5).

1.1  Occupational background

![Occupation background of Round 1 participants](image_url)

Figure 1. Occupation background of Round 1 participants. N = 86 expert participants
1.2 Experience

Figure 2. Years’ experience in transport related work.

1.3 Transport related expertise

Participants self-assessed their degree of expertise in a number of key transport-related areas (figure 3). In addition to the predefined areas of expertise as listed in the figure, other transport-related areas of expertise nominated by participants included land use planning, modelling, aviation, fuel supply risk, logistics, public health impacts, strategy development, transport links to biodiversity, makeup of vehicle fleet, electric vehicle transport, peak oil and cost-benefit analysis.

Figure 3. Self-assessment of transport related expertise.
1.4 Regions of expertise

Participants were asked to specify the locality, region and/or countries where they felt they have in-depth knowledge. Figures 4 and 5 summarise these regions of expertise on both local (within New Zealand) and international scales.

Locally specified areas of expertise

![Bar chart showing number of expert participants in local areas of expertise.]

Figure 4. Specification of local expertise. N = 54 local specifications
Internationally specified areas of expertise:

Figure 5. Specified areas of international expertise (note some experts nominated more than one region of expertise).
Section 2.0 Round 1

2.1 Trends, Innovations and Step Changes

In Round 1, participants were asked a series of open ended questions, which asked them to describe the three most influential trends, innovations and step changes that might lead to significant change in New Zealand’s transport system within the next 20 years. The survey noted that these trends, innovations and step changes may or may not be directly related to the transport industry and could include social, economic, political or environmental factors. (Step changes were defined as ‘possible rapid or sudden shifts, shocks, or changes in context’.) Seventy five experts participated in Round 1.

Highlights

- The most frequently identified influential trends were technological advancements of various types.
- Rising and/or volatile oil/gas prices were the 2nd most frequently identified trend and the most frequently identified step change.
- Increasing climate change issues/concerns were the 3rd most frequently identified trend and the 2nd most frequently identified step change.
- The most frequently identified influential innovations were IT developments, electric vehicles, smart cars, and battery technologies.
- Uptake of active transport also received significant mention, as the 4th most commonly mentioned trend, the 3rd most commonly mentioned step change; and bicycles and cycle infrastructure being the 6th most commonly mentioned innovation.

2.1.1 Trends

Survey question: “Trends (things that you know are already changing): What are the most influential trends that might lead to significant change in New Zealand’s transport system within the next 20 years? Please note that these trends may or may not be directly related to the transport industry and could include social, economic, political or environmental factors. Please base your responses on the aspects of the transport system in which you have expertise.”

This was a free-text question. Answers were analysed and grouped into common categories. Below we list the most frequently identified trends, and the percentage of participants who identified each trend.

Note: Participants were each asked to describe three trends, which is why combining all percentages add up to more than 100%.

1. Various technological advancements including Intelligent transport systems (ITS), vehicle safety technology, significant uptake of electric vehicles (EVs), improvement of battery technology, self-driving cars, improvement in communications technology (travel substitution) (Identified by 56%)
2. Rising fuel prices / peak oil / resource peaks leading to greater transport costs (33%)
3. Growing climate change concerns (and other environmental concerns relating to fossil fuel use including air quality) (25%)
4. Uptake of active transport. (17%)
5. Younger people becoming less likely to get licenses resulting in less private-car travel among youth. (14%)
6. Demographic changes, especially aging population leading to a shift in transport demands (14%)
7. Changes in national/global economy (10%)
8. Public transport improvements / investments (7%)
9. Urbanisation – rising population and density in major centres (7%)
10. Rising congestion in major centres (7%)
11. Emergence of alternative fuels (6%)
12. Trends in spatial planning supporting lower car use (including polycentric cities; complete streets planning; integrated land-use; localisation of products and services) (6%)
13. Infrastructure: Infrastructure constraints leading to private vehicle reliance / Infrastructure changes to allow for efficient transport (6%)
14. Shipping / freight improvements (4%)
15. Changing governance (including lobbyist influence; government investment) (4%)
16. Multi-modal, integrated transport systems (3%)
17. Road pricing / tax (3%)
18. Safety targets (3%)

2.1.2 Innovations

Survey question: “Innovations: Novel technological, behavioural and policy developments. What are the three most influential innovations that might lead to significant change in New Zealand’s transport system within the next 20 years? Please note that these innovations may or may not be directly related to the transport industry and could include social, economic, political or environmental factors. Please base your responses on the aspects of the transport system in which you have expertise.”

This was a free-text question. Answers were analysed and grouped into common categories. Below we list the most frequently identified innovations, and the percentage of participants who identified each innovation.

Note: Participants were asked to describe three different innovations, which is why combining all percentages adds up to more than 100%.

1. Information technology innovations (48%) including:
   - Integrated transport platforms supporting online one-stop-shop for all transport/travel information
   - Developments in social media
   - Faster broadband supporting easier video conferencing
   - Advances in GPS
   - Intelligent transport systems – integrated IT within infrastructure
2. Electric Vehicles: greater use / affordability; advances in EV technology – range increase; induction charging may replace cable charging in the mid-term; Electric buses (38%)
3. Smart cars (26%)
- Cars communicating with other cars and transport infrastructure to reduce congestion and improve safety
- Driver behaviour real-time monitoring and feedback
- Semi-autonomous vehicles; driverless vehicles

4. Battery technology improvements (better/more storage, cheaper, longer life) (20%)
5. Renewable energy for transport (including biofuel and utilising solar / wave/ wind energy for electricity) (19%)
6. Bicycles: Electric bicycle becoming more commonplace; bicycle hire schemes; bicycle sharing schemes; protected bike lanes and infrastructure (13%)
7. Urbanisation / densification – resulting in different urban design (10%)
8. Government spending / investment (7%)
9. Driver behaviour monitoring (6%)
10. Tax; congestion tax; road pricing; carbon tax (6%)
11. Implementation of automated personal rapid transit in city centres (1%)
12. Reduced parking requirements (1%)

2.1.3 Step changes

Survey question: “Step changes - possible rapid or sudden shifts, shocks, or changes in context. What are the three most influential step changes that might lead to significant change in New Zealand’s transport system within the next 20 years? Please note that these step changes may or may not be directly related to the transport industry and could include social, economic, political or environmental factors. Please base your responses on the aspects of the transport system in which you have expertise.”

This was a free-text question. Answers were analysed and grouped into common categories. Below we list the most frequently identified step changes, and the percentage of participants who identified each step change.

Note: Participants were asked to describe three different step changes, which is why combining all percentages adds up to more than 100%.

1. Fossil fuel price/availability (51%)
   - Oil / gas supply constraints
   - Step change in fuel price – oil / gas price shock
2. Climate change issues (30%), including:
   - Climate change issues becoming seen as more urgent, consequently taken more seriously by government, businesses, public
   - Change in policy to tackle GHG emissions
   - Chinese take concerted action to reduce air pollution, changing demand patterns globally
   - Shift in public opinion regarding climate change – toward concern
   - International binding agreement for action on climate change is reached
   - Alternative view expressed by one participant: “Slow realisation that global warming / climate change is not a real threat despite the scaremongering. Discover that other forms of pollution are a threat”
3. Step investment in active transport infrastructure / societal shift toward active transport (19%)
4. Greater investment in public transport and public transport infrastructure (12%)
5. Breakthrough in battery technology (10%)
6. New Zealand government adopts a more sustainable agenda: (10%), e.g.
   - Sustainability and particularly greenhouse gas emissions reduction become major driver of policy at all levels for government and business
   - Cross party agreement where the purpose of the transport system is to enhance quality of life through access to wellbeing, promoting employment, education, goods and services – rather than drive economic growth
7. Natural disasters / disease (earthquakes, volcanic eruptions, resistant viruses) (10%)
8. Global financial crisis: significant and rapid economic contraction – triggered by one of many possible unrelated events (9%)
9. Mass production of low-cost electric vehicles - rapid drop in electric vehicle cost (9%)
10. Sustainable alternative fuel innovations (7%)
11. Political instability / war overseas affecting fossil fuel supply and cost (6%)
12. Congestion tax to alleviate rising congestion in major NZ centres (6%)
13. Political shift away from road-related investment (4%)
14. Urbanisation: Increasing population density in urban areas, forcing a restructure of transport demands / infrastructure (4%)
15. Major investment in New Zealand rail (3%)
16. Automation of traditional work/occupations etc.), could displace large proportions of the workforce leading to major changes in travel demand (1%)
17. Consolidation of ports – restricted to major centres (1%)
18. Rise in airline air fares (1%)
Section 3.0  Round 2

3.1  Trends, innovations and step changes

In Round 2 all trends, innovations and step changes which had received more than one independent mention were listed. Participants were asked to nominate 1) the likelihood of these trends, innovations and step changes becoming widespread in New Zealand within 10 years, and 2) their potential to transform New Zealand’s transport sector away from business as usual (BAU) in the long term. BAU was defined as ‘the continuation of transport systems and practices that rely on finite resources and support automobile dependence’. A 5-point scale was used, with 1 being a low likelihood, and 5 being a high likelihood.

Sixty seven experts participated in Round 2.

3.1.1  Trends:

Highlights:

- Rising fuel prices scored as both the most likely trend to become widespread within 10 years, and the trend most likely to transform the transport system away from BAU in the long term (figure 6).
- Ageing population and increasing percent of population in urban areas were the second and third most likely influential trends to become widespread within 10 years (figure 6).
- The trends that ranked second and third in their potential to transform NZ’s transport system away from BAU were urban form that supports active transport and public transport, and increasing investment in public transport infrastructure (figure 7).
- Twelve trends scored more than mid-point in both their potential to transform away from BAU and likelihood of becoming widespread within 10 years. These were rising fuel prices; increasing percent of population in urban areas; increasing public concern about climate change; increasing investment in PT infrastructure; use of travel substitution technologies; aging population; decreasing car ownership among youth; uptake of PT; increasing investment in active transport infrastructure; uptake of active transport; decreasing drivers licensing among youth, and uptake of electric vehicles (figure 8).
Figure 6. Likelihood of trend becoming widespread in 10 years (1 = low likelihood, 5 = high likelihood). N = 62 participants. Error bars denote standard error of the means. Differences between the items are statistically significant (one-way ANOVA test $F_{19} = 10.447$, $p < 0.001$).
Figure 7. Potential for trend to transform transport system away from BAU in the long term (1 = low potential, 5 = high potential). N = 62 participants. Errors bars denote standard error of the means. Differences between the items are statistically significant (one-way ANOVA test, $F_{19} = 9.172, P < 0.01$).
**Trend quadrant**

Here we map the means from the previous two figures against each other.

Note: PT = public transport, AT = active transport (e.g. walking, cycling)

**Figure 8.** The likelihood of each trend becoming widespread mapped against its potential to transform the transport system away from BAU (1 = low, 5 = high). N = 62 participants.
3.1.2 Innovations:

**Highlights**

- *Ultrafast broadband* and *high quality videoconferencing* were identified as the most likely influential innovations to become widespread within 10 years, followed by small electric vehicles (figure 9).
- The innovation with the greatest potential to transform the transport system away from BAU was *demand management through road pricing* (figure 10).
- This was closely followed by *multi-modal integrated public transport systems* and *bicycle infrastructure* (figure 10).
- Large-scale biofuel production scored very low in both likelihood of becoming widespread and potential to transform away from BAU (figure 11).
- Six innovations scored more than mid-point in both their potential to transform away from BAU and likelihood of becoming widespread within 10 years (figure 11). These were: *bicycle infrastructure; multi-modal, integrated public transport; improvements in battery technologies for electric vehicles; small electrified vehicles; measures that reduce parking availability in city centres; and intelligent transport systems.*
Figure 9. Likelihood on each innovation to become widespread in next 10 years (1 = low likelihood, 5 = high likelihood). N = 62 participants. Error bars denote standard error of the means. Differences between the items are statistically significant (one-way ANOVA test, $F_{13} = 17.120$, $p < 0.01$)
Potential for innovation to transform NZ’s transport system away from BAU in the long term

Figure 10. Potential for each innovation to transform the transport system away from BAU in the long term (1 = low potential, 5 = high potential). N = 62 participants. Error bars denote standard error of the means. Differences between the items are statistically significant (one-way ANOVA test, $F_{13} = 8.455$, $p < 0.01$).
Innovations quadrant

Here we map the means from the previous two figures against each other.

Figure 11. The likelihood of each innovation becoming widespread graphed against its potential to transform the transport system away from BAU (1 = low, 5 = high). N = 62 participants.
3.1.3 Step changes

Highlights:

- The top three step changes deemed most likely to become widespread within 10 years were all oil related: *spikes in the price of liquid fossil fuels, political instability in oil rich countries*, and *constraints in oil supply* (figure 12). Note that there are likely to be strong interrelationships between these factors.
- A *significant breakthrough in battery/storage technologies* is fourth ranked in both likelihood and ability to transform.
- Of the 9 top step-changes that are deemed most likely to become widespread within ten years, 8 originate internationally. NZ could thus be at the receiving end of some potentially highly influential changes which are well outside of NZ’s control.
- The step change deemed most likely to lead to transformation of NZ’s transport system away from BAU is *sustainability becoming a major driver of policy at all levels of NZ government and for business* (figure 13).
- This is followed by *constraints in oil supply* and *political instability in oil-rich countries*.
- Five step-changes scored more than mid-point in both their potential to transform away from BAU and likelihood of becoming widespread within 10 years (figure 14). These were *spikes in the price of liquid fossil fuels; political instability in oil rich countries; constraints in oil supply; significant breakthrough in cheap battery / storage technology; and mass production of low cost electric vehicles*. 
Likelihood of step change becoming widespread in NZ in next 10 years

Note most step changes identified were external to NZ but with the potential to influence transport in NZ.

Figure 12. Likelihood of step change becoming widespread in 10 years (1 = low likelihood, 5 = high likelihood). N = 62 participants. Error bars denote standard error of the means. Differences between the items are statistically significant (one-way ANOVA test, F_{12} = 17.120, p < 0.01).

* = Denotes step changes specific to New Zealand.
Potential for step change to transform NZ’s transport system away from BAU in the long term

Note most step changes identified were external to NZ but with the potential to influence transport in NZ.

Potential for STEP CHANGE to transform the transport system away from BAU in the long term (1 = Low, 5 = High)

* = Step changes specific to New Zealand

**Figure 13.** Potential for step change to transform the transport system away from BAU in the long term (1 = low potential, 5 = high potential). N = 62 participants. Error bars denote standard error of the means. Differences between the items are statistically significant (one-way ANOVA test, $F_{12} = 4.345$, $p < 0.001$).
Step changes quadrant

Here we map the means from the previous two figures against each other.

Note: blue letters on graph indicate step changes specific to New Zealand.

Figure 14. The likelihood of each step change becoming widespread graphed against its potential to transform the transport system away from BAU (1 = low, 5 = high). N = 62 participants
3.2 Time Frames

Participants were asked to nominate the timeframe within which they considered that the stated changes were likely to occur. N = 63 participants per graph. Timeframe categories were pre-set.

Note: The median is presented below each graph. The ‘Don’t know’ category was removed for median calculation.

Highlights:

- We found no correlation between participants’ estimations of timeframes and the sector in which they worked.
- There is a high level of agreement that battery technologies enabling a 300km range for EVs will be readily available within 10 years (figure 15).
- The take-up of EVs in NZ’s private and commercial fleets is expected to be slow, with a median of 15-20 years to comprise 20% of the fleet, and many anticipating that this will take over 20 years (figures 25 and 26).
- Almost all believe that within 15 years there will be a global price on carbon (figure 20) and that international aviation will be included in post-Kyoto negotiations on GHG emissions (figure 16).
- Participants are fairly evenly spread on when oil prices might reach $US200 a barrel, although none chose ‘never’ (figure 21).
- The median expectation for biofuels or biofuel mix being available in over 50% of NZ fuel stations is 10-15 years (figure 22).
- Almost all the participants consider that there will be a 20% improvement in freight efficiency within 15 years (figure 17).
- Within 10-15 years, the majority see a 15% decrease in VKT in the private vehicle fleet, and a 30% increase in uptake of public transport (figures 18 and 19).
- Induction charging and autonomous vehicles are well into the future (figure 27 and 28).
Results in more detail

**Fig. 15:** Readily available battery technologies enabling a 300km range for personal electric vehicles

- Number of respondents
- Median = 5-10 years

**Fig. 16:** Inclusion of international aviation in post-Kyoto negotiations on global greenhouse gas emissions

- Number of respondents
- Median = 5-10 years

**Fig. 17:** A 20% increase in energy efficiency of freight movements in New Zealand

- Number of respondents
- Median = 5-10 years

**Fig. 18:** 15% decrease in vehicle kilometers travelled in the private vehicle fleet in New Zealand

- Number of respondents
- Median = 10-15 years
Fig 19: 30% increase in the Uptake of public transport in New Zealand

Fig 20: Global price on carbon

Fig 21: Oil prices average $200/barrel

Fig 22: Biofuels or biofuel mix is available in over 50% of fuel stations in New Zealand
Fig. 23: 3D printing reduces New Zealand freight mileage by 5%

Fig. 24: Fully integrated, mixed modal transport systems available in all New Zealand cities with a population over 100,000

Fig. 25: Electric vehicles make up 20% of New Zealand’s commercial vehicle fleet

Fig. 26: Electric vehicles make up 20% of New Zealand’s private vehicle fleet

Median = 15-20 years
**Fig. 27: Widespread availability of wireless induction charging for electric vehicles throughout New Zealand**

- 0-5 years: 2
- 5-10 years: 5
- 10-15 years: 10
- 15-20 years: 15
- Beyond 20 years: 20
- Never: 15
- Don't know: 10

Median = 15-20 years

**Fig. 28: Autonomous vehicles make up 20% of New Zealand’s private vehicle fleet**

- 0-5 years: 2
- 5-10 years: 5
- 10-15 years: 10
- 15-20 years: 15
- Beyond 20 years: 20
- Never: 15
- Don't know: 10

Median = Beyond 20 years
4.0 Round 3

Round 3 consisted of three sections. Fifty five experts participated in Round 3.

Firstly we asked participants to select the three trends, innovations and step changes for which they believe interventions are most urgently needed in order to achieve a transport system that enables New Zealand to thrive economically, environmentally and socially (reported in 4.1).

The next section investigated some potentially contentious topics which had emerged in the freetext responses in the previous rounds, and explored participants’ levels of agreement on those topics (reported in 4.2).

The third section assessed levels of agreement on characteristics of a sustainable transport system that had been nominated by participants in the International Delphi in 2013 (reported in 4.3).

4.1 Trends, innovations and step-changes requiring intervention

Highlights:

- The most frequently identified top priority trends requiring intervention to enable NZ to thrive, were (in order of frequency) increasing investment in public transport infrastructure, rising fuel prices, and urban form that supports active and public transport (figure 29).
- The three most frequently identified trends requiring intervention, when combining first, second and third priorities, were: Increasing investment in public transport infrastructure; urban form that supports active and public transport, and increasing investment in active transport infrastructure (figure 29). These were prioritised by at least twice as many participants than any other trend.
- The most frequently identified top priority innovations requiring intervention to enable NZ to thrive, were (in order of frequency) integrated, multi modal transport; demand management through road pricing; and bicycle infrastructure (figure 30). These were also the most frequently identified innovations when combining first, second and third priorities.
- The most frequently identified top priority step changes requiring intervention were (in order of frequency) sustainability becomes a driver of policy in NZ; constraints in oil supply; spikes in the price of liquid fossil fuels, and decreasing the proportion of transport spend on roads (the latter two being equal).
- The most frequently identified step changes requiring intervention, when combining first, second and third priorities, were: sustainability becomes a driver of policy in NZ; decreasing the proportion of transport spend on roads; global price on carbon, and major investment in the NZ rail system (the latter two being equal).
- We superimposed the highest priority areas for intervention over the quadrants from sections 3.1.1, 3.1.2 and 3.1.3 (Round 2). Interventions are consistently those which have the highest potential to transform the transport system away from BAU in the long term (see Appendix A).
**Trends requiring intervention**

From the list (from Round 2) of identified trends, participants were asked to prioritise three trends where they considered interventions (e.g. changes in NZ's policy and/or market settings) are most urgently needed in order to achieve a transport system that enables NZ to thrive (economically, socially, environmentally).

Clarification: Some of the listed ‘trends’ below may also appear to be ‘interventions’. The reason for this is that in Round 1 we asked participants to nominate trends (things they thought were already happening that could change the transport system away from BAU). Some of the nominated trends were things like increasing investment in public transport, or the emergence of urban forms that supported active transport, i.e. trends that were already being driven by policy. In asking participants, in Round 3, to nominate priorities for intervention to enable NZ to thrive, we opened the possibility that some participants might propose interventions (in Round 4) that would slow or turn around such policy initiatives.
Figure 29. Trends for which participants considered interventions are most urgently needed in order to achieve a transport system that enables NZ to thrive (economically, socially, environmentally). N = 55 participants.
Innovations requiring intervention

From the list (from Round 2) of identified innovations, participants were asked to prioritise three innovations where they considered interventions (e.g. changes in NZ’s policy and/or market settings) are most urgently needed in order to achieve a transport system that enables NZ to thrive (economically, socially, environmentally).

Figure 30. Innovations where participants considered interventions are most urgently needed in order to achieve a transport system that enables NZ to thrive (economically, socially, environmentally). N = 55 participants.
Step changes requiring intervention

From the list (from Round 2) of identified step changes, participants were asked to prioritise three step changes where they considered interventions (e.g. changes in NZ's policy and/or market settings) are most urgently needed in order to achieve a transport system that enables NZ to thrive (economically, socially, environmentally).

![Diagram showing prioritization of step changes](image)

**Figure 31.** Step changes where participants considered interventions are most urgently needed in order to achieve a transport system that enables NZ to thrive (economically, socially, environmentally). N = 55 participants.
4.2 Areas of Contention

Highlights:
- We found no correlation between participants’ positions on the statements and the sector in which they worked.
- At least 80% of all participants disagree or strongly disagree with the following statements:
  - “Our transport system doesn’t need to reduce its level of reliance on fossil fuels” – (figure 32).
  - “We don’t need interventions because current trends and new technologies will naturally lead to a resilient transport system” – participants overwhelmingly disagree and strongly disagree (figure 33).
- At least 80% of participants agree or strongly agree with the following statements:
  - We should markedly increase investment in active transport and public transport” (figure 45).
  - “We need leadership in anticipation of the impacts of future climate change and fuel price variability” (figure 46).
  - “In rural and provincial NZ, the car will remain the primary mode of travel” (figure 47).
- Around two-thirds of the participants agree or strongly agree with the following statements:
  - “A much higher proportion of NZ’s freight should be carried by rail than is currently the case” (figure 37).
  - “With its large supply of renewables, NZ is the perfect country to lead the way in accelerating the uptake of electric vehicles” (figure 38).
  - “We should not be undertaking a massive motorway building program” (figure 41).
- Around two-thirds of the participants disagree or strongly disagree with the following statement:
  - “Decreasing travel times through investment in new and improved roads should be high priority” (figure 42).
- The highest number of ‘don’t know’ responses were to the statements:
  - “Increasing use of natural gas [globally] will offset overall demand for oil, potentially leading to lower oil prices” (figure 36), and
  - “Hydrogen fuel cells will play an important role especially in the heavy vehicle fleet” (figure 44).
- The most contentious statements (i.e. ones which resulted in the most even range of responses between strongly agree to strongly disagree) were:
  - “We need to stimulate the development of biofuels as they will play a major role in road transport in time to come” (figure 34).
  - “Stimulating a shift to electric and hybrid vehicles is not the solution; driving less is the key thing to achieve” (figure 35).
  - “Accelerating smart technologies that reduce traffic congestion is the most efficient way to improve the NZ transport system” (figure 39).
o “Road congestion will continue to be a problem regardless of current trends and new technologies” (figure 40).

o “It is far more important to focus on efficiency within our ICE [internal combustion engine] fleet than expecting lots of NZers to adopt electric vehicles, hybrids and PHEVs [plug-in hybrid electric vehicle]” (figure 43).

Results in more detail

The following statements about New Zealand’s future transport were drawn from the free-text responses in Rounds 1 and 2 of the Delphi. They were chosen to represent particular views on topics which appeared to be subject to a range of views. Participants were asked to indicate their level of agreement with each statement.
Fig. 32: Our transport system doesn't need to reduce its level of reliance on fossil fuels

Fig. 33: We don't need interventions because current trends and new technologies will naturally lead to a resilient transport system

Fig. 34: We need to stimulate the development of biofuels as they will play a major role in road transport in time to come

Fig. 35: Stimulating a shift to electric and hybrid vehicles is not the solution; driving less is the key thing to achieve
Fig. 36: Increasing use of natural gas [globally] will offset overall demand for oil, potentially leading to lower oil prices

Fig. 37: A much higher proportion of NZ’s freight should be carried by rail than is currently the case

Fig. 38: With its large supply of renewables, NZ is the perfect country to lead the way in accelerating the uptake of electric vehicles

Fig. 39: Accelerating smart technologies that reduce traffic congestion is the most efficient way to improve the NZ transport system
Fig. 40: Road congestion will continue to be a problem regardless of current trends and new technologies.

Fig. 41: We should not be undertaking a massive motorway building program.

Fig. 42: Decreasing travel times through investment in new and improved roads should be high priority.

Fig. 43: It is far more important to focus on efficiency within our ICE [internal combustion engine] fleet than expecting lots of NZers to adopt electric vehicles, hybrids and PHEVs [plug-in hybrid electric vehicle].
Fig. 44: Hydrogen fuel cells will play an important role especially in the heavy vehicle fleet

Fig. 45: We should markedly increase investment in active transport and public transport

Fig. 46: We need leadership in anticipation of the impacts of future climate change and fuel price variability

Fig. 47: In rural and provincial NZ, the car will remain the primary mode of travel
4.3 Features of a sustainable transport system

In this part of the survey we asked about the level of agreement that participants had with findings from the International Delphi (2013) in which international experts had identified what they considered should be features of a sustainable transport system for a country with New Zealand’s characteristics.

Highlights

- We found no correlation between participants’ positions on the statements and the sector in which they worked.
- 90% or more of the participants agree or strongly agree with the following features of a sustainable transport system for NZ:
  - Integrated multi-modal transport system in urban areas over 100,000 people (figure 48).
  - Cross modal ticketing systems (figure 49).
- 80% of more of the participants agree or strongly agree with the following features of a sustainable transport system for NZ:
  - Having different transport options for different length trips (e.g. 1-2km, 3-5km, 10-20km, 50km+) (figure 50).
  - Ensuring rural areas have access to information & communication technologies (ICT), to support travel substitution (figure 52).
  - Collective, cross-party vision of NZ’s future transport (figure 54).
  - Make the full cost of car ownership evident to the general public so that all transport modes are on a level playing field (figure 60).
  - Changing urban form and functioning to reduce need to travel to work/shopping/school (figure 61).
  - Being proactive so alternate travel modes are readily available prior to disincentivising personal vehicles (figure 62).
  - Targeting transport options to size and density of the population (e.g. public transport for cities, car sharing for towns) (figure 63).
- Two-thirds or more agree or strongly agree with the following features:
  - Time of use variable pricing for roads (figure 53).
  - Exploit renewables through uptake and incentivisation of electric vehicles (figure 56).
  - Technologies (apps) to support modal choice (figure 57).
  - Car sharing schemes (both businesses and community based) (figure 58).
  - Improving environmental credentials of imported cars (figure 64).
- There were greater levels of disagreement on the following features:
  - Targeted design of transport for the needs of different segments of the population (e.g. disabled, non-English speakers etc.) (figure 51).
  - Increasing the use of rail for inter-city travel (figure 55).
Biofuels for freight and long distance travel (figure 59).
Electrifying the entire rail system (figure 65).
Using electrified rail rather than roads for freight transport, thereby decreasing road traffic and exploiting renewable energy availability (figure 66).

Results in more detail

In the last round of the International Delphi study, we outlined key demographic, geographic, economic and infrastructural characteristics relevant to NZ's transport system1, and asked them "Given the global trends and prospects, what should be the key features of a sustainable transport system for a small isolated country like New Zealand?"

Participants from the New Zealand Delphi rated their level of agreement with the most frequently occurring features mentioned by the international panel of experts.

N = 50 participants for each graph.

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1 The information provided to the International Delphi panel was as follows: New Zealand is a small, geographically isolated country in the South Pacific Ocean consisting of two main islands, and many small ones, 2. NZ’s population is 4.4 million. The land area of 269,000 km² is comparable to the area of Italy or the United Kingdom, but the population density is far lower and is very unevenly spread, 3. Around 85% of the population lives in urban areas. The biggest concentration is the Greater Auckland metropolitan area where 1.4 million people live. High rise and high density housing is unusual, 4. NZ’s transport infrastructure consists of 11,000km of state highways, 80,000km of local roads, 7 international airports, 28 regional airports, 4,000km of rail track, and 14 exporting sea ports, 5. New Zealanders are heavily reliant on personal cars for their travel. There are close to 700 light fleet vehicles per 1000 people. This is higher than Australia, but lower than the USA, 6. All new vehicles are imported, and over half of new cars registered are second-hand, imported mainly from Japan. The average vehicle age is 13 years, 7. In most regions there is very limited public transport infrastructure. However there is a drive to improve public transport in the urban regions of Auckland and Wellington, 8. Eight out of ten New Zealanders drive to work, only 5% use public transport, 9. Virtually all transport relies on imported oil products. Electric vehicles, CNG and LPG vehicles accounted for just 0.04% of the national fleet in 2008. The rail system is partially electrified, 10. All petrol and diesel is imported. NZ does produce some oil and gas but all of the oil is exported. There is no appreciable commercial biofuel production. New Zealand’s electricity supply is approximately 75% renewable, 11. The economy is heavily reliant on exports of primary products (by shipping and air), and international tourists (involving long haul air flights), 12. Within NZ, around 70% of freight tonne-kilometres are by road transport, followed by coastal shipping (14.9%), rail (14.6%) and air (0.4%).
Fig. 48: Integrated multi-modal transport system in urban areas over 100,000 people

Fig. 49: Cross modal ticketing systems

Fig. 50: Having different transport options for different length trips (e.g. 1-2km, 3-5km, 10-20km, 50km+)

Fig. 51: Targeted design of transport for the needs of different segments of the population (e.g. disabled, non english speakers etc)
Fig. 52: Ensuring rural areas have access to information & communication technologies (ICT), to support travel substitution

Fig. 53: Time of use variable pricing for roads

Fig. 54: Collective, cross-party vision of NZ’s future transport

Fig. 55: Increasing the use of rail for inter-city travel
Fig. 56: Exploit renewables through uptake and incentivisation of electric vehicles

Fig. 57: Technologies (Apps) to support modal choice

Fig. 58: Car sharing schemes (both businesses and community based)

Fig. 59: Biofuels for freight and long distance travel
Fig. 60: Make the full cost of car ownership evident to the general public so that all transport modes are on a level playing field.

Fig. 61: Changing urban form and functioning to reduce need to travel to work / shopping / school.

Fig. 62: Being proactive so alternate travel modes are readily available prior to dis-incentivising personal vehicles.

Fig. 63: Targeting transport options to size and density of the population (e.g. public transport for cities, car sharing for towns).
Fig. 64: Improving environmental credentials of imported cars

Fig. 65: Electrifying the entire rail system

Fig. 66: Using electrified rail rather than roads for freight transport, thereby decreasing road traffic and exploiting renewable energy availability
Appendix A

The quadrants from sections 3.1.1, 3.1.2 and 3.1.3 are superimposed with the topics identified as being highest priority for intervention in section 4.1 (red circles).
Likelihood of INNOVATION becoming widespread in 10 years

Potential for INNOVATION to transform transport system away from BAU in the long term

- A - Bicycle infrastructure
- B - Multi-modal, integrated public transport
- C - Improvements in battery technologies for electric vehicles
- D - Small electrified vehicles
- E - Reduce parking availability in city centres
- F - Intelligent transport systems
- G - Demand management through road pricing
- H - Ultra fast broadband
- I - High quality video conferencing
- J - Electric vehicle charging infrastructure
- K - Real-time driver feedback software
- L - Autonomously guided vehicles
- M - Wireless induction charging for electric vehicles
- N - Large scale biofuel production

LOW likelihood
LOW potential

HIGH likelihood
HIGH potential

Potential for INNOVATION to transform transport system away from BAU in the long term
Likelihood of STEP CHANGE becoming widespread in 10 years

Potential for STEP CHANGE to transform transport system away from BAU in the long term

- A - Spikes in the price of liquid fossil fuels
- B - Political instability in oil rich countries
- C - Constraints in oil supply
- D - Significant breakthrough in cheap battery / storage technology
- E - Mass production of low cost electric vehicles
- F - Sustainability becomes driver of policy in NZ
- G - Global price on carbon
- H - Decreasing the proportion of transport spend on roads in NZ
- I - Significant global economic decline
- J - Major investment in NZ rail system
- K - Substantial increase in cost of air travel (NZ domestic)
- L - Catastrophic natural disaster or disease outbreak
- M - Radical societal shift to healthier lifestyles in NZ