Te Horo Hydrogen Blending Pilot Report

New Zealand first hydrogen blending pilot

Insights from an industry led pilot integrating hydrogen into a gas distribution network

Contents

1. Introduction

New Zealand's commitment to net zero emissions by 2050 requires significant changes in the energy system.

Alongside electrification, renewable gases such as hydrogen are recognised as a potential solution for hard-to-electrify sectors, including high-temperature industrial heat and heavy transport, while maintaining energy choice for consumers.

Hydrogen has been widely identified internationally as a promising low-carbon energy carrier due to its ability to be produced from renewable electricity, stored at scale and transported using existing gas infrastructure. However, realising this potential requires robust evidence to demonstrate that hydrogen can be safely and reliably integrated into gas networks, while maintaining system integrity, appliance compatibility and public confidence.

Against this backdrop, Firstgas, working in collaboration with New Zealand's gas distribution businesses, Powerco, GasNet, Nova Energy and Vector, undertook New Zealand's first hydrogen blending pilot (the pilot) on the Te Horo gas distribution network. The pilot was designed to assess the technical, operational, safety and regulatory feasibility of introducing increasing volumes of hydrogen into an existing natural gas system under real-world conditions.

More than five years of planning, research and preparatory work informed the design and execution of the pilot. This included detailed network and appliance assessments, reviewing international experience with similar initiatives, regulatory and stakeholder engagement, and the development of comprehensive monitoring and contingency plans.

The project team worked closely with WorkSafe New Zealand, energy retailers, local authorities, emergency services and the local community to ensure the pilot was delivered safely and responsibly.

This report documents the planning, delivery, monitoring and outcomes of the Te Horo Hydrogen Blending pilot. It captures the technical findings, operational learnings, stakeholder insights and regulatory considerations that emerged through the project. The purpose of the report is to share evidence-based insights to inform future hydrogen blending activities in New Zealand, support industry and regulatory decision-making, and contribute to the broader understanding of hydrogen's role in the country's energy transition.

2. Background

a. Hydrogen feasibility study 2021

A study named "Firstgas Hydrogen Pipeline Feasibility", jointly funded by the Government through the Provincial Development Unit and Firstgas, was commissioned in 2020. This study confirmed that converting New Zealand's existing gas infrastructure to transport hydrogen is technically and economically viable, supporting the country's Net Zero 2050 target. The study identified hydrogen as a possible complement to electrification, enabling decarbonisation of hard-to-abate sectors such as high-temperature industrial heat, heavy transport and providing inter-seasonal energy storage for a fully renewable electricity system.
It highlighted that achieving this transition would require significant investment in electrolysers, renewable generation and regulatory updates, alongside collaboration across industry, government, and research bodies.

A roadmap of trials and research was proposed to validate technical performance, address regulatory gaps and build public confidence, with initial hydrogen blending trials targeted for completion by 2026. This study positioned hydrogen as a possible cornerstone of New Zealand's future energy system, offering resilience, flexibility, and deep emissions reductions across multiple sectors.

b. International experience

Many countries (including Canada, Italy, Japan, Hong Kong, Spain, Germany, France, Australia & UK) have blended hydrogen into existing natural gas systems. We consider the two most relevant jurisdictions for New Zealand are the UK and Australia due to similarities in regulations, standards and equipment.

In October 2019, a hydrogen blending trial on 100 domestic properties was undertaken at Keele University in the UK (HyDeploy). This achieved a maximum hydrogen blend of 20mol% and demonstrated that a gas distribution network similar to those in New Zealand, could be used to safely transport a hydrogen blend which could be burned in unmodified domestic gas appliances.

Much of the published learning from this trial was able to be applied to the planning and design of the New Zealand pilot at Te Horo. Although the gas systems, materials and appliances in the UK are similar to those used in New Zealand, there are also some major differences, meaning that a New Zealand pilot was essential to establish whether these differences would have a material effect on future network conversions that may be considered.

Further UK trials have been carried out in recent years at Winlaton in the UK, extending to 700 properties where similar blend concentrations have been applied and tested. Overall budget for the HyDeploy project covering Keele and Winlaton was GBP 22.5 million (approx. NZ $51.5 million at current exchange rates). The cost of Keele project was around GBP 7.26 million including the electrolyser unit (approx. NZ $16 million) and the remaining GBP 15.24 million (approx NZ $ 35 million) was for Winlaton project.

There are two Hydrogen Park blending trials in Australia. Hydrogen Park Gladstone (HyP Gladstone), blends 10% hydrogen and supplies to 700 homes. This project cost was Aus $14.5M. Hydrogen Park South Australia (HyP) is supplying 5% hydrogen to over 4,000 customers and cost Aus $14.5M. These projects are supported by grant funding from ARENA and the Queensland and South Australian Governments.

The Australian based Future Fuels CRC commenced a significant research programme in 2017 culminating in 2025, covering many aspects of hydrogen utilisation including significant testing of domestic, commercial and industrial appliances to demonstrate their suitability for use with a variety of hydrogen blends.

This research has been applied to the Te Horo hydrogen pilot to ensure that all aspects managed were well understood and any necessary mitigations in place.

Materials used in gas distribution networks and particularly appliances installed and used in Australia have a close similarity with New Zealand networks and consumer appliances, meaning that this research was very relevant to this New Zealand first pilot.

3. Project delivery

a. Project delivery mechanism a joint effort with GDBs

Firstgas and the Gas Distribution Businesses (GDBs) comprising Vector, Powerco, GasNet and Nova Energy, undertook this initial distribution blending pilot as a joint industry partnership.

Firstgas provided project management and technical input, with technical support and governance from the GDBs.

It was agreed that the following deliverables from the pilot would be shared with the GDBs in exchange for their respective contributions towards the costs of the pilot:

- Stakeholder engagement strategy, materials and findings
- Scope of work for consultant engagements
- WorkSafe exemption application
- Final hydrogen blending pilot report.

It was agreed that the GDBs will be able to use the information from the pilot (including information in the pilot report) to plan and execute further hydrogen pilots on their respective networks.

A governance group was set up which provided leadership and oversight of the pilot activities, project deliverables, providing guidance and recommendations to the project team.

b. Site selection

In order to select an appropriate site for the pilot, a number of attributes were defined and assessed against all the available gas distribution networks in New Zealand:

- Less than 50 end users
- Good data availability on distribution network
- Customers were able to be engaged in the majority
- System should be isolated with one feed and not interconnected to other systems
- Section of pre-85 polyethylene for hydrogen impact tests
- Land availability for blending unit creation
- Closeness to pilot team
- Reasonable length of polyethylene distribution pipe network.

After consideration of the conditions, three small networks were shortlisted – Te Horo, Waverley and Kapuni.

Kapuni was later eliminated due to the small number of domestic consumers and the existence of a very large process load where the hydrogen impact could have been significant for their internal compliance requirements.

Te Horo was chosen as it met the majority of the selection requirements including the pre-85 PE section.

c. GPA reports/network & appliances assessment

It was essential to assess the comparative risks between operating the network on natural gas and hydrogen while utilising overseas research as technical evidence.

GPA, a consultant based in Australia was engaged to undertake the technical and compatibility assessment of the network. GPA reviewed the network compatibility for blending up to 15% hydrogen and shared reports including:

a. Network safety report
b. Network capacity modelling
c. Consumer installation capacity review
d. Consumer installation compatibility report
e. Te Horo network compatibility report.

This process involved gathering detailed information about customer installations and appliances, which was facilitated by a team of experienced gas fitters.

d. Regulatory exemption

i. Exemption requirements

WorkSafe NZ (WorkSafe) is responsible for overseeing energy safety in New Zealand, including for gas networks. To proceed with the hydrogen blending pilot, exemptions from two key regulations - regulation 41(2) and regulation 16(1)(a) of the Gas (Safety and Measurement) Regulations 2010 - were sought.

Based on 41(2) of Gas (Safety and Measurement) Regulations 2010, the reticulated natural gas must comply with requirements of NZS 5442:2008 and the maximum Limit of H_2 was defined as 0.1 mol% only.

Firstgas applied for an exemption to regulation 16(1)(a) to add unodorised hydrogen from containers (manpacks) on the basis that the overall level of odorisation for gas within the distribution network will remain within acceptable limits. This was required because the hydrogen purchased was not odorised.

It was necessary to establish sufficient evidence to satisfy WorkSafe and obtain an exemption for a network pilot that has a defined boundary, isolated from the rest of the gas transmission or distribution system.

ii. Exemption process

In April 2023, Firstgas submitted a detailed 'exemption application' to WorkSafe outlining the exact procedures, equipment and methodologies planned to ensure the safety of the pilot. As Firstgas does not own the gas being transported in natural gas pipelines, it was essential that the exemption is also applicable to gas retailers.

A structured monitoring plan was developed in collaboration with GPA and WorkSafe to ensure the pilot was conducted safely and systematically. This plan outlined the sequence of activities and checks required at each stage of the pilot and formed the basis for the regulatory exemptions granted by WorkSafe. The monitoring plan was central to the exemption approval and the pilot's implementation, providing a clear framework for safety, compliance and reporting throughout the project.

A summary of the monitoring plan can be seen in Table 1.

Table 1. Summary of Monitoring Plan.

Stage	Required Checks	Description
Stage 1 - 0% Hydrogen Blend Baseline	All network checks, In-home testing for all appliances.	Ensure all preliminary work is completed. Complete required checks and baseline testing/findings. Check installation of space heaters to ensure they are in adequately ventilated rooms.
Stage 2 - 2% [(1)] Hydrogen Blend	All network checks, In-home testing for all appliances.	Introduce hydrogen and increase to 2% hydrogen blend. Hold for at least one week. Complete required checks.
Stage 3 - 5% Hydrogen Blend	All network checks, In-home testing for critical appliances only.	Increase to 5% hydrogen blend. Hold for at least one week. Complete required checks.
Stage 4 - 10% Hydrogen Blend	All network checks, In-home testing for all appliances.	Increase to 10% hydrogen blend. Hold for at least one week. Complete required checks.
Stage 5 - 12% [(2)] Hydrogen Blend	All network checks, In-home testing for all appliances.	Increase to 12% hydrogen blend. Hold for at least one week. Complete required checks.
Stage 6 - Post-Pilot	All network checks, In-home testing for all appliances.	Stop hydrogen injection bring network to 0% hydrogen. Complete required checks.

(1) after testing the blending setup, it was decided to increase the starting percentage to 3.5%.

(2) To stay within lower Wobbe limit (i.e., > 46), H_2 percentage was reduced to 12% (instead of 13% at Stage-5) and 15% stage was deleted.

iii. WorkSafe exemptions

In July 2024 the following two regulatory exemptions were granted by WorkSafe New Zealand to Firstgas for the Te Horo gas distribution network pilot:

- Odorisation Exemption (EX25-07)
- Gas Quality Exemption (EX25-08)

The main conditions of the exemptions included:

- Ensuring gas supplied downstream of the blend point was odorised in accordance with regulation 16(1) at all times.
- Gas supplied had to meet NZS 5442:2008, except for the hydrogen limit.
- Ongoing compliance with a monitoring plan, including appliance testing for ignition, combustion and emissions.
- Compliance with a monitoring plan and regular reporting to WorkSafe at each stage of the pilot.
- Submission of a comprehensive report on the pilot within 90 days of completion.
- Immediate notification to WorkSafe of any safety incidents or issues.
- Providing consumers the right to opt out and be offered alternative supply arrangements.
- Notifying WorkSafe at least five days before the pilot commenced.
- The exemption did not affect other regulatory obligations and expired on 31 December 2025.

e. Blending set up at delivery point (DP)

In addition to the assessments carried out by GPA, Worley was engaged to carry out the design of the overall hydrogen blending system at the DP and associated controls for quality and safety. Design overview of the key features included:

- A hydrogen dosing package, supplied by Welker, using solenoid injection control and hydrogen injection flow rate ratio controller, see Figure 1.
- Hydrogen bottle 'manpack' for supply of gas for blending, see Figure 2.
- Pressure reduction and relief equipment panel on hydrogen line considering its storage pressure of > 150barg.
- Coriolis mass flow sensors and transmitters for measuring natural gas and hydrogen.
- Measured quantity of hydrogen coming from hydrogen dosing package was injected into the gas piping via an injection quill, followed by restriction orifice (RO) and mixing tank.
- A continuous on-line process gas chromatograph (GC) analyser with hydrogen measurement and gas analysis installed at the downstream of gas injection.
- Various supporting items such as piping, solar power setup, programmable logic controller (PLC) and remote telemetry units (RTU).

The completed system was designed to control, monitor and record the blended gas composition accurately, over a variable range of hydrogen concentrations. Blending mol% mix was adjustable for increasing incrementally over the course of the pilot.

The dosing package controller had an independent PLC, controlling in a closed loop fashion using both the metered mass flow of hydrogen and the composition fed back from the site GC.

The hydrogen dosing package measured the hydrogen flow rate via an on-skid flow meter and used natural gas flow rate to ensure the blended hydrogen volume is meeting the user input set point.

Design of the site piping layout incorporated a mixing header to allow the injected H_2 to be thoroughly blended with the incoming pipeline natural gas. The GC installed downstream of this header and at the end of the station piping, measured H_2 concentration and blended gas Wobbe to ensure these are kept within acceptable limits.

The safety trips were configured to cease H_2 dosing in the event of any of the following:

- Wobbe number > 52 MJ/m^3
- Wobbe number < 46 MJ/m^3
- H_2 concentration > 1mol% above required concentration
- Actual H_2 flow exceed allowable limits
- Gas flow < minimum. safe value to operate i.e., <0.35kg/hr.

The system was designed to be fail safe, i.e. in the event of any H_2 trips, natural gas (unblended gas) continued flowing through the network, therefore avoiding any nuisance to customers on the network.

Apart from some piping and hydrogen supply, all the new equipment was packaged into two portable containers for ease during installation and removal post-pilot.

f. Hydrogen supply & storage

Proposals were sought for the supply of hydrogen at the pilot site via portable equipment. Following a detailed evaluation, BOC was selected as the recommended supplier including their commitment on supply assurance during the pilot. BOC had offered two supply configurations: portable manpacks (each having 15 bottle single skid mounting) or large H_2 mobile vessels. Given the small site layout, the manpack option was selected and these packs were easy to install via Hiab trucks. Each manpack contained approximately nine kilograms of certified green hydrogen. During the pilot, two manpacks were used to support the operations. The hydrogen was supplied from an electrolyser at BOC's Glenbrook production plant.

To store H_2 at site, a Location Compliance Certificate (LCC) was required under the Health and Safety at Work (Hazardous Substances) Regulations 2017. A WorkSafe approved compliance inspector was engaged for documentation review and issuance of the certificate. The certificate was issued (12 months validity) after a site visit and review of the Emergency Response Plan (ERP), Safety Data Sheets (SDS), site layout and signage.

Figure 1. Welker unit set up at the DP

Figure 2. Portable H_2 manpack at the DP

g. Gas reconciliation

For the duration of the pilot, Te Horo remained an unmetered gas gate with no transmission revenue meter installed. The "Allocation Agent" continued to determine each shipper's delivery quantities for Te Horo using monthly consumption data provided by retailers.

To ensure retailers could accurately bill customers energy during the pilot, Firstgas created a new "Te Horo Network" gas type, which was published on OATIS and determined by an onsite chromatograph.

Throughout the pilot, consumers were expected to use the same amount of energy if there had been no hydrogen in the gas, with the hydrogen simply displacing natural gas. With no meter at the delivery point, shippers' volumetric transmission charges were based on total volume inclusive of the hydrogen, meaning retailers would knowingly be paying for the transmission of the hydrogen content. However, the total amount of energy injected as hydrogen during the pilot was minor, so the impact on transmission throughput charges and balancing and peaking pool costs was minimal and accepted by all trading retailers. Further supporting this acceptance was the advantage provided to retailers, where the value of the hydrogen supplied at no charge by Firstgas more than offset the volume cost of transmission throughput charges.

The hydrogen volume injected into the distribution network was treated as positive unaccounted-for gas (UFG) for reconciliation purposes. This approach was supported by the Gas Industry Company and trading retailers as the pilot involved only small energy volumes and was only a short duration.

h. Resource consent

Following resource consents (RC) were required from the Kapiti Coast District Council under the Resource Management Act 1991 (RMA):

- Land use consent (LUC) for new aboveground structures in a ponding area.
- LUC for aboveground piping modifications, pressure exceeding 2000 kPa.

Consent was granted after a year with some conditions. One of the conditions was to design a restraint system for the temporary containers against a modelled flood level of 1.9 meters above the site ground level. Therefore, the containers and hydrogen manpacks were tethered using concrete blocks and hold down straps.

In parallel to the RC, additional land was leased from the landowner due to requirement for an increased footprint.

Figure-3: Site without the hydrogen pilot setup

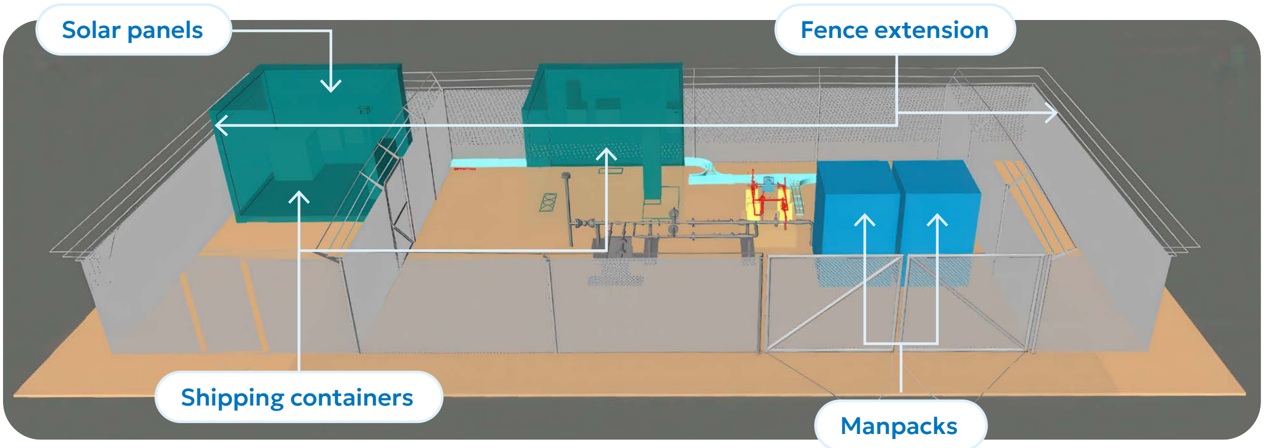


Figure-4: 3D model of the proposed site

i. Hydrogen blending display home

During customer engagement for the pilot, we identified that one of the houses on the network was undergoing renovations. This provided the opportunity to establish an on-site display home for the duration of the pilot. The display home became a central feature of the pilot, serving several important functions.

Firstly, it acted as a demonstration site for testing appliances under various hydrogen blend conditions, allowing our project team and stakeholders to observe appliance performance and safety measures first-hand. Secondly, the display home was used to engage industry representatives and other interested parties, offering a practical showcase of hydrogen blending technology in a real-world setting. Finally, maintaining active gas flow through the display home helped to mitigate the risk of low network flow, which had been identified as a potential challenge for the pilot.

Overall, the display home contributed significantly to the success of the pilot by facilitating appliance testing, stakeholder engagement and operational stability within the network.

j. Project cost details

The total actual project cost was less than NZD $3million. We believe that delivering this project within $3million represents good value for money. While the scope and scale of the pilot was relatively small, many of the design and engagement activities that are essential to a project of this nature do not vary with scale. As highlighted above, similar (albeit larger) pilot projects overseas cost considerably more.

k. Project schedule

Task Name	Start	Finish
Te Horo DP Hydrogen Pilot	**Mon 2/08/21**	**Fri 29/05/26**
Scope	Mon 2/08/21	Thu 11/11/21
FEED	Tue 5/10/21	Thu 28/07/22
WorkSafe Exemption	Thu 16/12/21	Fri 26/07/24
Detail Design – DD	Fri 15/07/22	Mon 20/05/24
Materials	Tue 20/09/22	Mon 16/12/24
Execution	Tue 19/03/24	Fri 13/06/25
Pilot Operations	Tue 17/06/25	Fri 14/11/25
Closeouts	Wed 3/12/25	Fri 29/05/26

Task Name	Start	Finish
Pilot Operation	**Tue 17/06/25**	**Fri 14/11/25**
3.5% H_2 blend	Tue 17/06/25	Fri 18/07/25
5% H_2 blend	Mon 21/07/25	Thu 07/08/25
10% H_2 blend	Mon 11/08/25	Thu 11/09/25
12% H_2 blend	Mon 15/09/25	Mon 06/10/25
0% H_2, Post blending monitoring works	Tue 07/10/25	Fri 14/11/25

A further break down showing the pilot activities from starting at a 3.5% blend to the post blending monitoring works and dismantling works for the temporary setup installed at the DP.

4. Stakeholder engagement

As a first-of-its-kind pilot and an unfamiliar energy type for many consumers, early and transparent stakeholder engagement was critical to build consumer confidence, address any safety concerns and establish commercial frameworks for the pilot.

The project team adopted a collaborative approach, engaging homeowners, regulators and industry partners from an early stage to ensure the purpose of the pilot was understood and stakeholders felt comfortable being involved.

a. WorkSafe

WorkSafe engagement involved submitting a comprehensive, evidence-based package, conducting regular consultations and hosting site audits to demonstrate compliance with safety objectives. WorkSafe approval and oversight was critical to enabling the pilot but also validated our processes and built confidence among wider stakeholder groups.

b. Trading retailers

Across the 15 consumers, four energy retailers were identified as trading on the distribution network. Under normal circumstances, a retailer retains ownership of the gas throughout the distribution process and is responsible for ensuring that the gas supplied to its consumers meets specification in accordance with NZS 5442.

For the pilot, Firstgas took ownership of the gas at the delivery point from retailers. Firstgas managed the blending process and subsequently transferred ownership back to the retailers when the gas entered the distribution network. This meant that Firstgas effectively acted as a default gas wholesaler to enable blending. The arrangement was facilitated through individual sale and purchase agreements with each retailer. Firstgas supplied the hydrogen to retailers at no cost.

Key considerations for retailers included liability exposure, reputational risk and customer advocacy. The sale and purchase agreements provided strong protections from Firstgas, supported by an assurance of regulatory compliance. Advocacy on behalf of their customers centred around ensuring consumers were treated fairly throughout the engagement process. Customers weren't exposed to any additional liabilities and were also able to opt out of participation in the pilot should they wish to. Retailers were given visibility and opportunities to input into Firstgas' consumer engagement process, demonstrating each of these concerns were met. Successful collaboration and securing retailer participation was critical to enabling the pilot to proceed.

c. Gas Industry Company

The GIC's role was primarily regulatory and procedural, rather than operational. They were kept informed and consulted on matters affecting industry compliance and reconciliation processes. GIC received regulatory and commercial consultation papers alongside gas retailers to ensure transparency and alignment with industry rules.

d. Consumers

All consumers connected to the Te Horo network were identified as key stakeholders with their participation being crucial to the success of the pilot. With only 15 consumers on the network, achieving close to full participation and having ongoing participation throughout the pilot was critical.

Hydrogen was unfamiliar to most participants and initial perceptions ranged from neutral to cautious. Early direct engagement helped to address safety concerns and build confidence in the pilot. We aimed to develop a positive and collaborative approach encouraging consumer participation in the pilot by leaning on a pioneering theme.

Of the 15 consumers on the network, only one consumer chose not to participate in the pilot, citing concerns about the suitability of the hydrogen blend for their ageing heating appliance. After an in-house inspection, Firstgas confirmed there were no compatibility issues with the appliance. However, to accommodate the consumer's concerns, Firstgas agreed to temporarily disconnect them at the network boundary and provide an alternative heating source for the duration of the pilot. At the conclusion of the pilot, this consumer elected to permanently disconnect from the network and expressed appreciation for the engagement and support provided throughout the process.

Figure: 5 Picture of final enrolment pack.

All remaining consumers agreed to individual terms and conditions that set obligations across both parties, allowing for the practical completion of the pilot. The terms and conditions set clear expectations around access to properties, data collection, liabilities and compensation. Financial acknowledgement was deemed an appropriate means to recognise the commitment made by participants for their participation. Being respectful of the time commitments around regular in-home appliance inspections was an important theme of the relationship, while the financial acknowledgement also offset any consumer concerns around the blend having led to higher energy costs during the pilot. At the completion of the pilot all participants completed a 15-question online survey (the results of this survey can be found in Section 7).

e. Local authorities and emergency services

Local councils and emergency services were engaged with pre-pilot and kept informed about site works, commissioning activities and emergency protocols.

f. Metering asset owner

As the sole metering asset owner, Bluecurrent was engaged in the lead up to the pilot to ensure they were comfortable with the compatibility of the blended gas with their assets. Bluecurrent agreed to pause any metering upgrades during the pilot to maintain consistency and keep a range of meter types present across the network to enable broader testing to occur.

g. Local gasfitting community

All registered gasfitters in the Kapiti region were notified before introducing the blend into the network. While Firstgas maintained regular communication with consumers and managed in-home appliance inspections, we recognised there was a small possibility that a gasfitter might attend a property to carry out work. To ensure safety and awareness, we wanted to make certain they were informed about the blend in such circumstances.

h. Iwi

Firstgas engaged with Ngā Hapu o Otaki who are considered mana whenua for the region of which Te Horo falls in. Mana whenua met online with Firstgas to learn about the organisation and upcoming project. As requested by mana whenua, we provided updates on relevant milestones throughout the project.

i. Te Horo community

Sponsorship of the Te Horo Community Hall earthquake strengthening project played a role in building goodwill and trust within the wider community and pilot participants. The Hall is an important focal point for the community, hosting over 200 events per year. By supporting the preservation of a space important to the Te Horo community, our aim was to reinforce the communities confidence in our intentions which helped foster trust and created a positive foundation for collaboration.

Figure 6: Picture of Te Horo Community Hall.

j. Media

Media engagement the for the pilot was phased to support transparency, public understanding and confidence in New Zealand's first hydrogen blending project. Communications were designed to be factual and neutral, with a clear focus on explaining the purpose of the pilot, its boundaries and the evidence it was intended to generate. Initial media engagement occurred in 2024, with the announcement of the pilot and WorkSafe granting two exemptions. This early communication established the safety-led approach to the pilot and set expectations that the project was a controlled, time-bound pilot rather than a commitment to widespread hydrogen rollout.

A second key phase of media engagement occurred in 2025, when the pilot reached the 10% hydrogen blend milestone. This milestone provided an opportunity to demonstrate hydrogen blending in both the pipeline and household appliances under real-world conditions. Media coverage at this stage focused on progress, learnings and the practical operation of the pilot, supported by site visits and the hydrogen blend display home.

Across all media activity, messaging consistently reinforced what the pilot was - a carefully monitored pilot designed to test technical, safety and operational feasibility, and what it wasn't - a decision to introduce hydrogen into every household or a commitment to immediate network conversion. This approach ensured accurate reporting, supported by informed discussion and helped build balanced public understanding of hydrogen's potential role in New Zealand's energy transition.

k. Stakeholder visits

Reaching a 10% hydrogen blend marked an important milestone in the pilot and provided a tangible moment to begin sharing the story more widely. From late August 2025 through September 2025, the hydrogen blend display home played a central role in hosting a range of stakeholder visits to the pilot site. These visits included representatives from Rinnai, MBIE, the Commerce Commission, the Gas Industry Company, Master Plumbers, energy retailers, government officials, GasNZ, WorkSafe, and members of the Clarus Board, as well as local MP, Tim Costley and Hon. Megan Woods.

The display home enabled visitors to see appliances operating on a hydrogen and natural gas blend in a real world setting, supporting informed discussion and building confidence in the pilot. These engagements also provided valuable opportunities to capture content for Firstgas and gas distribution business partner communication channels, helping to raise awareness of the pilot and clearly communicate its purpose, progress and learnings.

Figure 7. The Rinnai gas heater running on a hydrogen blend in the display home

Figure 8. Cooking on the gas hob at the 10% hydrogen blend stage

5. Pilot and key findings

5.1 Monitoring activities

Gas composition and flow at the injection point were continuously tracked using a gas chromatograph (GC). Sample sites distributed across the network also measured gas composition and odorant levels, see Figure 9. During the pilot, each stage involved monitoring the gas composition, odorant content, leakage and in-home appliances.

Monitoring activities were executed as per Table 4 on page 24.

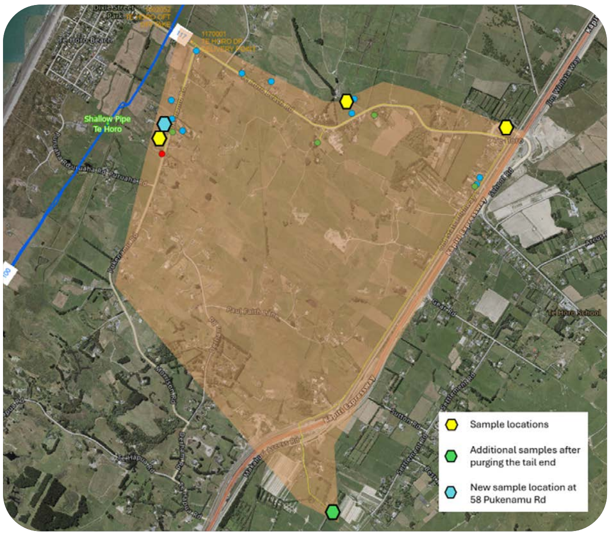


Figure 9. Sample locations for gas composition and odour testing

a. Gas composition

The hydrogen blend was monitored using the gas chromatograph at the delivery point (DP), and samples were taken from the network sampling locations for subsequent laboratory testing by IPL, see Appendix A Table A1 for test results. The hydrogen blend percentage monitored by the GC can be seen in Figure 10.

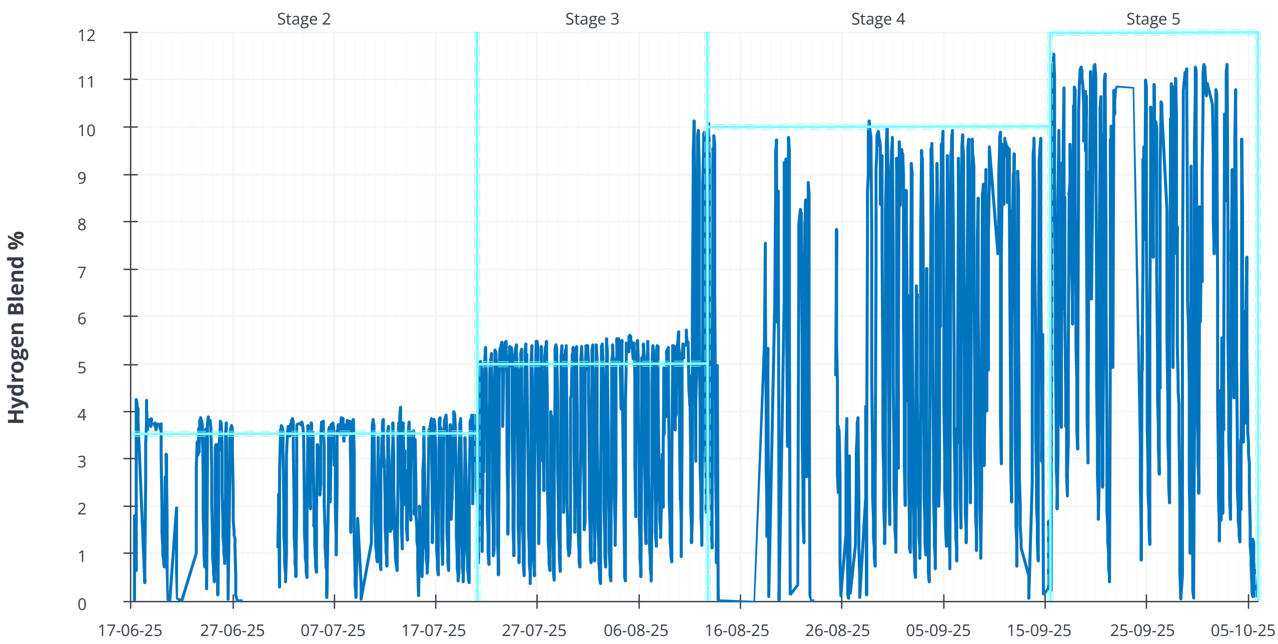


Figure 10. Average percentage of hydrogen blend recorded each hour during the pilot.

The Wobbe Index was monitored to ensure it met NZS 5442 standards which sets an upper limit of 52 MJ/m³ and a lower limit of 46 MJ/m³. The baseline for the incoming natural gas prior to hydrogen injection was ~48 MJ/m³, which is towards the lower end of the Wobbe limits. Figure 11 shows the Wobbe Index throughout the pilot. The lowest Wobbe Index observed was 46.38 MJ/m³ during the 12% hydrogen blend.

During routine maintenance, the tail end of the Te Horo distribution network was purged at the 5% hydrogen blend. Samples collected at this time were consistent with those obtained from the three primary sampling locations.

Moreover, upon completion of the pilot and during post-pilot monitoring checks, purging was undertaken at both tail ends, i.e. 84 Pukenamu Rd and 672 Old SH1. Gas composition sampling and odour testing were completed to ensure thorough removal of residual hydrogen from the network.

Minimum Wobbe Index

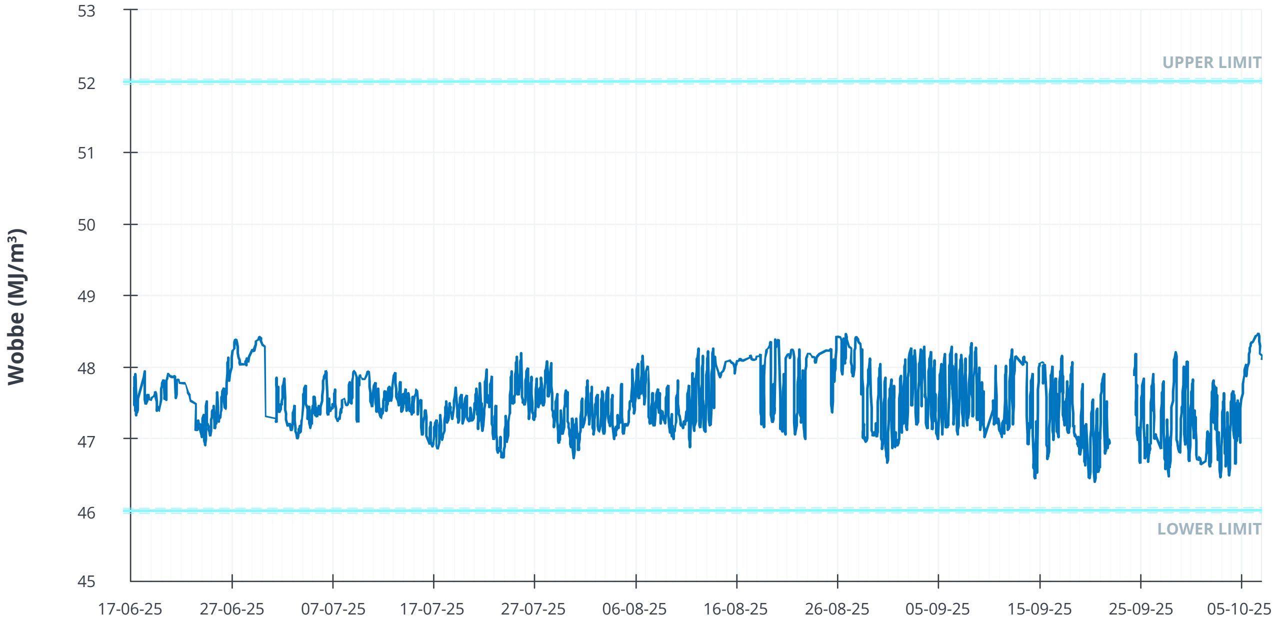


Figure 11. Minimum Wobbe Index at half-hour intervals during the pilot

b. Odorant testing

Odorant levels were measured at the three main sampling locations at each stage of the pilot. Odorant was measured using odour level (Heath Odorator) and odour concentration tests (Gastec Tubes 75L). All results were within the acceptable limits of NZS 5263, see Table 2 below.

Table 2

Odorant levels throughout the pilot

Stage	Test Notes	Test Details	Acceptable Limit	58/84 Pukenamu Rd	120 TH Beach Rd	Opp 3 TH Beach Rd SH1
Stage 1 Baseline	**Prior to trial**	Odor Level	≤ 0.9% (v/v)	0.25	0.28	0.22
		Odor Conc.	3–25 mg/m³	12	16	14
Stage 2 3.5%	**Test #1** (19/06/25)	Odor Level	≤ 0.9% (v/v)	0.25	0.35	0.30
		Odor Conc.	3–25 mg/m³	12	8	8
	Test #2 (08/07/25)	Odor Level	≤ 0.9% (v/v)	0.25	0.38	0.48
		Odor Conc.	3–25 mg/m³	8	8	10
Stage 3 5%	**Test #1** (24/07/25)	Odor Level	≤ 0.9% (v/v)	0.32	0.34	0.26
		Odor Conc.	3–25 mg/m³	10	14	13
	Test #2 (31/07/25)	Odor Level	≤ 0.9% (v/v)	0.32	0.30	0.29
		Odor Conc.	3–25 mg/m³	12	12	12
Stage 4 10%	**Test #1** (14/08/25)	Odor Level	≤ 0.9% (v/v)	0.33	0.31	0.35
		Odor Conc.	3–25 mg/m³	12	14	12
	Test #2 (02/09/25)	Odor Level	≤ 0.9% (v/v)	0.44	0.60	0.55
		Odor Conc.	3–25 mg/m³	12	12	12
Stage 5 12%	**Test #1** (18/09/25)	Odor Level	≤ 0.9% (v/v)	0.11	0.25	0.23
		Odor Conc.	3–25 mg/m³	10	11	12
	Test #2 (30/09/25)	Odor Level	≤ 0.9% (v/v)	0.35	0.27	0.28
		Odor Conc.	3–25 mg/m³	10	16	10
Stage 6 Post trial	**Test** (28/10/25)	Odor Level	≤ 0.9% (v/v)	0.77	0.54	0.48
		Odor Conc.	3–25 mg/m³	16	16	16

Odorant tests were completed at the tail end of the distribution network (672 Old State Highway 1) at 5% hydrogen blend and post-pilot. The results of these tests were within the limits of NZS 5263.

c. Leakage surveys

Hydrogen, being the smallest molecule, can leak through joints, seals and micro-cracks more easily than natural gas, raising safety concerns. The Te Horo distribution network includes pre-1985 PE sections, see Figure 12. These sections were closely monitored during the pilot due to their age and material properties, which may have been more prone to leakage or integrity issues when exposed to hydrogen blends.

The baseline survey was completed using a SELMA (Street Evaluating Laser Methane Assessment) driving survey and handheld detector and no leaks were observed with the network transporting 100% natural gas. At each increasing blend stage further leakage surveys were undertaken by walking and utilising handheld IBRID MX6 hydrogen gas detection equipment and GMI (Gas Measurement Instrument) detectors for natural gas detection (Figure 13-15). Throughout the course of the pilot, no leaks were identified within the network, see Table 3.

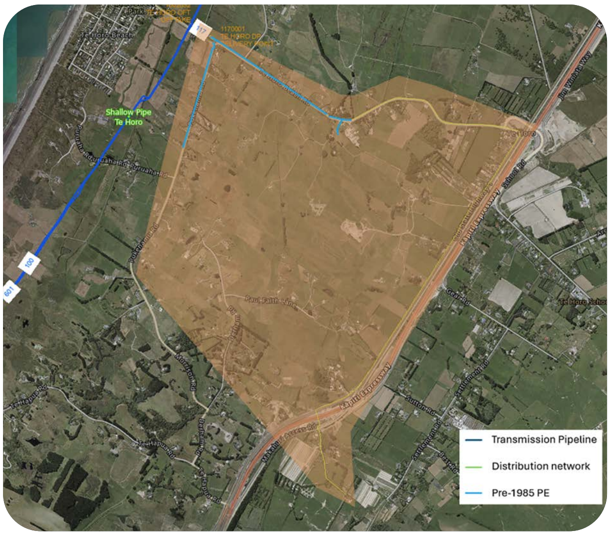


Figure 12. Network details with pre-1985 PE piping highlighted in blue.

Table 3

Leakage survey results

Pilot Stage	Test Date	Results
Stage 1 Baseline	13/02/2025	No leaks
Stage 2 3.5%	27/06/2025	No leaks
Stage 3 5%	29/07/2025	No leaks
Stage 4 10%	19/08/2025	No leaks
Stage 5 12%	25/09/2025	No leaks
Stage 6 Post-Pilot	31/10/2025	No leaks

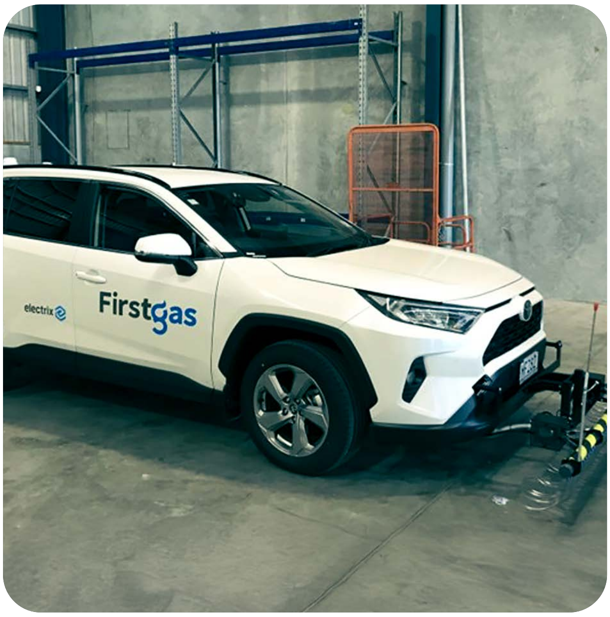


Figure 13. SELMA (Steet Evaluating Laser Methane Assessment) vehicle.

Figure 14. IBRID MX6 Hydrogen Detector.

Figure 15. GMI (Gas Measurement Instrument).

d. In-home appliance testing

It was necessary to identify appliances that would need additional checks throughout the pilot due to concerns with existing certification or appliance age or maintenance. The following criteria was used for classification of 'critical appliance' in the monitoring plan:

- Foreign-made appliances which have no confirmation of certification testing with a hydrogen blend
- Closed glass-fronted flame effect heaters
- Any appliances of customers which are identified during customer engagement requesting in-home monitoring
- Any appliances identified as a concern due to observed installation or condition during baseline appliance inspections in Stage 1, and/or
- Any appliances identified as a concern during in-home testing at any stage in the pilot.

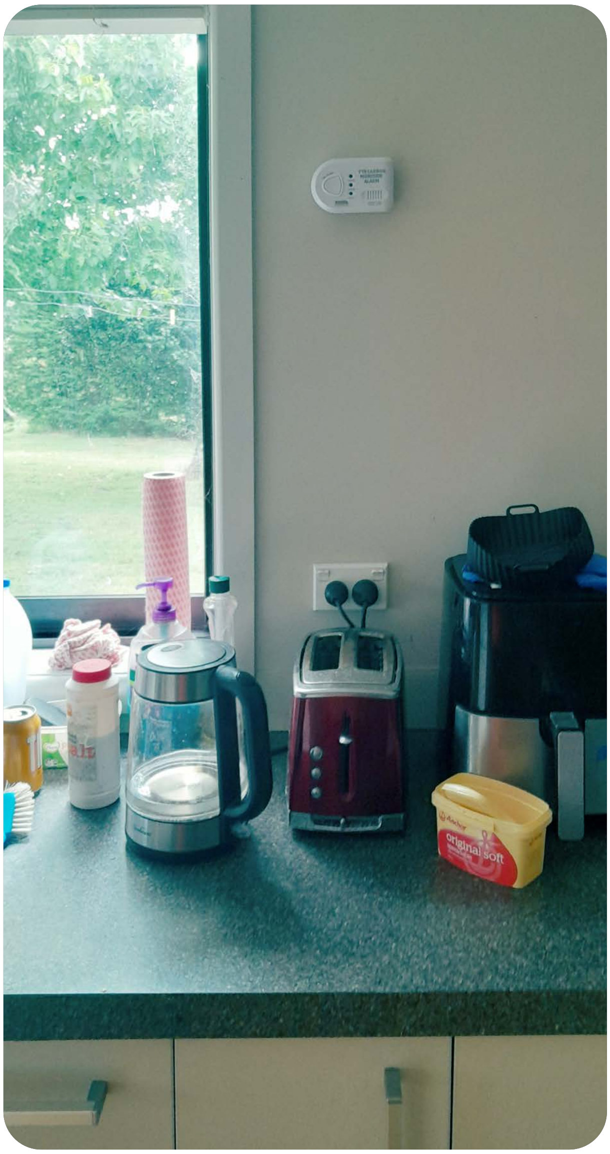


Figure 16. CO Monitor installed at property #5.

A full list of customer appliances (critical and all other) can be found in Table C1 of Appendix C. All appliances were tested throughout the pilot to assess any abnormal effects from hydrogen. Table C3 in Appendix C describes the testing completed on each appliance. Results showed that external surface temperatures remained within safe limits, controls operated reliably and no evidence of wear, damage, or flame abnormality was observed in relation to the pilot. Please refer to Table C2 in Appendix C for all issues identified during the pilot.

In addition, closed glass-fronted flame effect fires were already listed by WorkSafe as potentially unsafe, depending on maintenance and operation and it was decided to include properties with these types of appliances on the critical appliance check lists for regular checks throughout the pilot.

For cooker burners with upward facing injectors, incorrect ignition under the burner body can allow a flame to stabilise at the upward facing gas injector, which results in some of the fuel burning inside the burner rather than outside the burner as intended. This incorrect lighting technique has been named "light under". Light under has the potential to allow higher than normal levels of carbon monoxide in a room with inadequate ventilation. The FFCRC hydrogen blend investigation of a variety of gas cookers identified that "light-under" was possible, but only if the automatic ignition system was faulty and/or the end user tried to light the cooker burner manually. The following actions were recommended in the risk assessment prior to the pilot start:

- Initial survey of room to ensure adequate ventilation and extraction
- Initial survey of appliance to ensure customer can operate safely i.e. ignition system is working
- Provision of CO monitoring device to record high levels of CO and alarm
- Training for end user to not create light under situation.

Carbon monoxide (CO) sensors were provided to all households and installed close to the appliances (see Figure 16).

Flue gas analysis was completed for a small number of appliances at 0% and 12% hydrogen blend. Appliance efficiency generally reduced by 1.5%-2.0% when hydrogen increased from 0%-12%, see results in Table C4 of Appendix C. This was expected based on the significant overseas research showing a similar impact with hydrogen blends as hydrogen has a lower energy content per unit volume flow.

Table C5 in Appendix C shows the observed flame progression throughout the pilot stages. There were no noticeable changes to the flame as the hydrogen blend increased.

A summary of the monitoring activities performed is in Table 4 below.

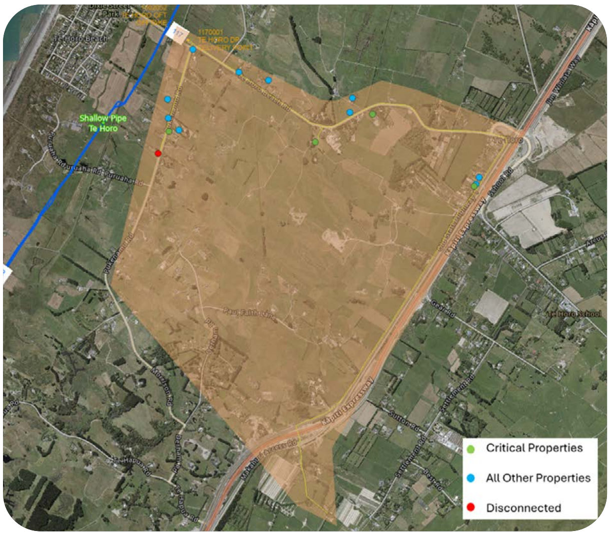


Figure 17. Customer properties on the Te Horo distribution network.

Table 4

Summary of monitoring activities.

Pilot Stage	Test Date	Results
Stage 1 Baseline	Gas Composition	Network at 0% hydrogen as expected.
	Wobbe Index	Compliant
	Odorisation	Compliant
	Leakage	No leaks
	In-home Appliance Testing	Baseline checks completed for all appliances and necessary changes made.
Stage 2 3.5% Hydrogen Blend	Gas Composition	Hydrogen blend 3.5%
	Wobbe Index	Compliant
	Odorisation	Compliant
	Leakage	No leaks
	In-home Appliance Testing	Checks completed for all appliances, 3 issues unrelated to the pilot noted and changes made.
Stage 3 5% Hydrogen Blend	Gas Composition	Hydrogen blend 5%
	Wobbe Index	Compliant
	Odorisation	Compliant
	Leakage	No leaks
	In-home Appliance Testing	Checks completed for all appliances, no issues.
Stage 4 10% Hydrogen Blend	Gas Composition	Hydrogen blend 10%
	Wobbe Index	Compliant
	Odorisation	Compliant
	Leakage	No leaks
	In-home Appliance Testing	Checks completed for critical appliances, 1 issue unrelated to the pilot noted and changes made.
Stage 5 12% Hydrogen Blend	Gas Composition	Hydrogen blend 12%
	Wobbe Index	Compliant
	Odorisation	Compliant
	Leakage	No leaks
	In-home Appliance Testing	Checks completed for all appliances, 3 issues unrelated to the pilot noted and changes made.
Stage 6 Post-Pilot	Gas Composition	Network returned to 0% hydrogen throughout.
	Wobbe Index	Compliant
	Odorisation	Compliant
	Leakage	No leaks
	In-home Appliance Testing	Checks completed for all appliances, no issues.

5.2 Incidents & notifications

Throughout the duration of the pilot, there were no incidents or notifications to report.

5.3 WorkSafe visit/audit

After the pilot started at a 3.5% H_2 blend on 24 June 2025, the WorkSafe team visited the site and conducted a site audit. The audit's primary objective was to determine whether the conditions of the exemption were being met, and that they were effective in meeting the safety objectives of the GSMR regulations.

A joint visit of the hydrogen pilot display home, the delivery point (DP) and parts of the network was conducted. WorkSafe shared an audit report confirming that there were no issues found during this visit.

5.4. Challenges during the pilot

- Tests at DP before the pilot started showed that the injection system was more stable at 3.5% H_2 blend instead of 2% due to very low hydrogen flows. Therefore, after agreement with WorkSafe, the starting injection concentration (Stage 2) was modified to 3.5%. See Figures A1-5 in Appendix A.
- The initial gas composition sample results were not showing hydrogen concentration as expected at the sample locations along the network. However, samples taken in the following weeks indicated acceptable hydrogen concentrations across the network.
- At stage 3 (5%) manual gas sampling within the distribution network indicated that oxygen and nitrogen concentrations were significantly higher than those recorded by the gas chromatograph, suggesting non-compliance with NZS 5442 standards for Oxygen and Wobbe Index. Investigation confirmed that air contamination occurred during the sampling process. It was determined that steel bottles provide better purging and reduced air ingress compared to sampling bags. Consequently, it was decided that all future samples would be collected exclusively using steel bottles.
- Due to the composition of the incoming gas, it was decided to revise the final blend percentage to 12% (instead of the proposed 15%) to ensure continued compliance with the Wobbe Index limit.
- One sampling location was located at a distribution dead end leg which affected hydrogen blend sample tests due to no flow. In future, samples should be located where gas is flowing or create flow using flare or purge equipment at the end of the network.
- The laboratory for gas sampling testing was in New Plymouth which is a significant distance from the pilot location. Samples needed to be received and processed within a certain amount of time. Consideration in the future for minimising the transportation time of samples to test laboratory.
- Hydrogen blending setup at the DP was designed with multiple fail-safe shutdowns requiring no operator intervention. A remote shutdown from the control room was also configured in the event of any emergency. Local control and shutdown are considered an important part of the future blending design.

6. Consumer survey results

The primary aim of the survey was to understand initial customer awareness and enthusiasm for hydrogen, gauge satisfaction after the pilot and evaluate how the pilot influenced views on safety, appliance performance, environmental impact and the future viability of hydrogen blending.

The survey also sought to identify any issues encountered, shifts in confidence, and participants' willingness to recommend blending or pay a premium for hydrogen's perceived benefits. Summary responses on customer perception of hydrogen and experience can be seen in Figures 18 and 19.

The survey revealed strong community support for the pilot, with participants reporting overwhelmingly positive experiences and stable appliance performance. No safety concerns or significant issues were noted, and most respondents became more positive about hydrogen as an energy source after the pilot. Confidence in hydrogen's safety and viability was high, with all participants agreeing or strongly agreeing that hydrogen blending is a safe and promising future energy solution. Environmental attitudes were generally supportive, though opinions were split with 50% prepared to pay a premium for hydrogen-blended gas. Satisfaction levels were extremely high, with two-thirds of participants giving the highest possible score for their experience.

Positive participant feedback is generally consistent across similar international trials such as those at Keele University, UK and Hydrogen Park, South Australia. Pride in participation and environmental motivation was similarly evident in each of these international instances, however, there were some concerns about compulsory participation. The Te Horo pilot approach of voluntary participation, compensation and proactive communication appears to have had a positive influence on the overall participant experience.

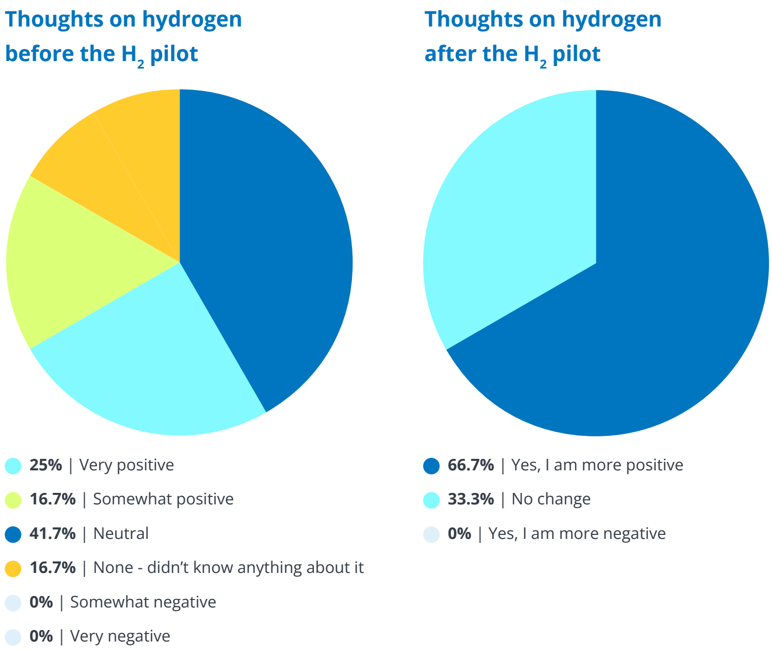


Figure 18: Perception of Hydrogen as an Energy Source.

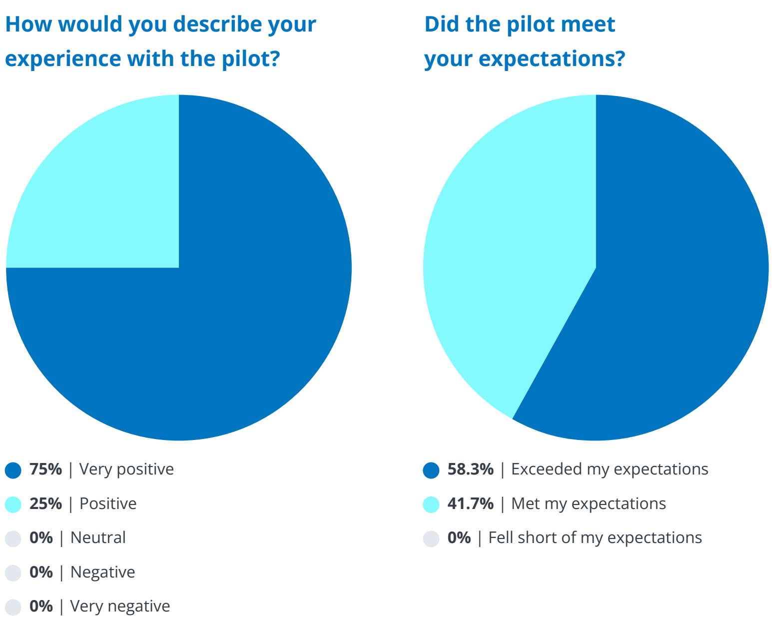


Figure 19: Consumer Experience.

7. Conclusion and next steps/outlook

Throughout the project, several aspects progressed particularly well. Strong project governance, provided clear direction and accountability.

The hydrogen display home and effective stakeholder engagement contributed significantly to public understanding and industry readiness. We also saw excellent participation from customers during the pilot sign-up, supported by reliable remote monitoring of the blending setup and responsive field technician support. In addition, the constructive engagement with appliance manufacturers and well received media engagement further enhanced the project's visibility and success.

On 1 October 2025, Standards New Zealand revised NZS 5442 to allow blending up to 10% hydrogen into gas distribution networks. This update reflects pilot results confirming safe integration with existing infrastructure and appliance compatibility. The new standard paves the way for further projects on larger gas networks and promotes hydrogen as a credible option for decarbonising New Zealand gas networks.

This pilot has shown that the economic case to produce hydrogen for blending into gas networks is very challenging without support mechanisms. Again, this is consistent with international experience. There may be emergent opportunities to develop permanent hydrogen blending facilities where other, higher value markets for low carbon hydrogen develop to maturity. However, electricity prices may be too high to support production of green hydrogen for network blending.

Figure 20 – Site visit at 10% blending stage.

New Zealand's Hydrogen Action Plan, released in November 2024, sets out the Government's steps to unlock private investment in low-emissions hydrogen and support the country's transition to a low-carbon economy. It focuses on creating an enabling regulatory environment, reduced barriers for investors and supports cost-effective and market-led transition.

Appendices

Appendix A:
Gas composition

Table A1

Hydrogen percentage reported from the IPL analysis at each sampling point throughout the pilot.

Pilot Stage	84 Pukenamu Rd	58 Pukenamu Rd	120 TH Beach Road	Opp 3 TH Beach Road SH1
Stage 1 Baseline	0.00%	-	0.00%	0.00%
Stage 2 3.5%	3.13%	3.13%	3.73%	3.13%
Stage 3 5%	5.01%	5.32%	5.05%	4.67%
Stage 4 10%	-	7.69%	9.98%	9.91%
Stage 5 12%	-	8.92% (1)	8.66% (1)	11.48%
Stage 6 Post-Pilot	0.00%	0.00%	0.00%	0.00%

[1] In-consistent samples results observed around the network due to reduced gas flows. However, Opp 3 TH Beach Road SH1 (with 11.48%) was the farthest sampling point on the network.

Appendix B: Flow appendix

This appendix contains the gas flow profiles observed on the Te Horo distribution network during the pilot.

Figures B1-4 – Network flow at half-hour intervals during each pilot stage.

Table B1

3.5% Hydrogen Blend

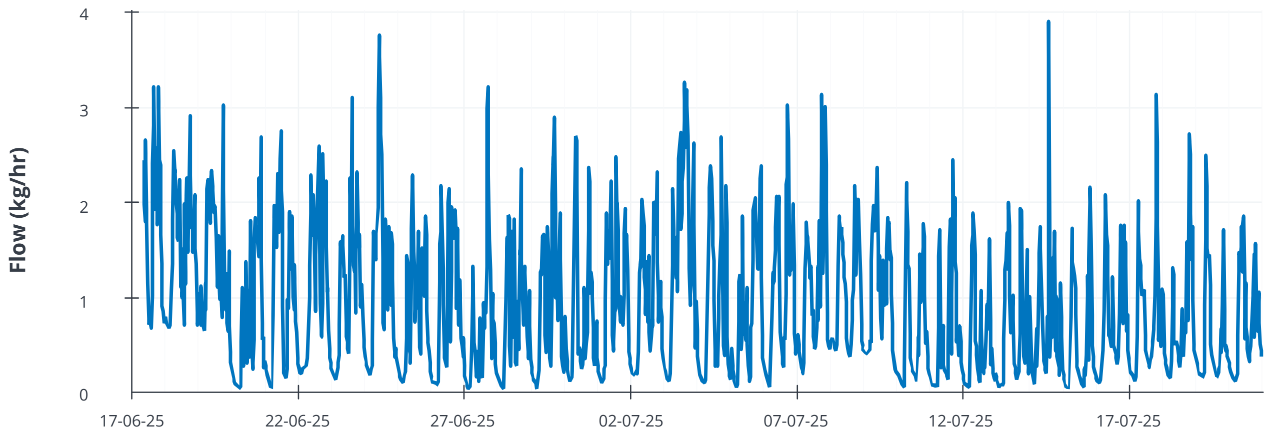


Table B2

5% Hydrogen Blend

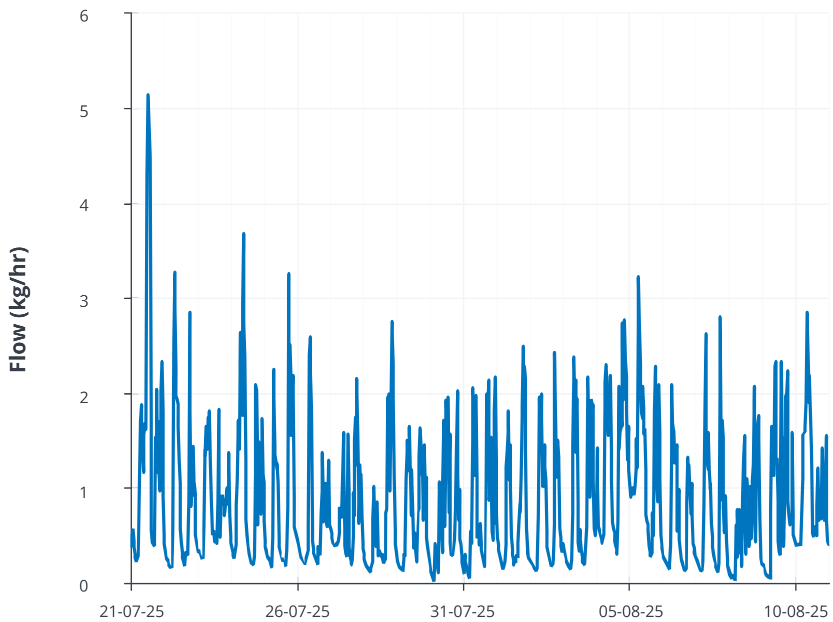


Table B3

10% Hydrogen Blend

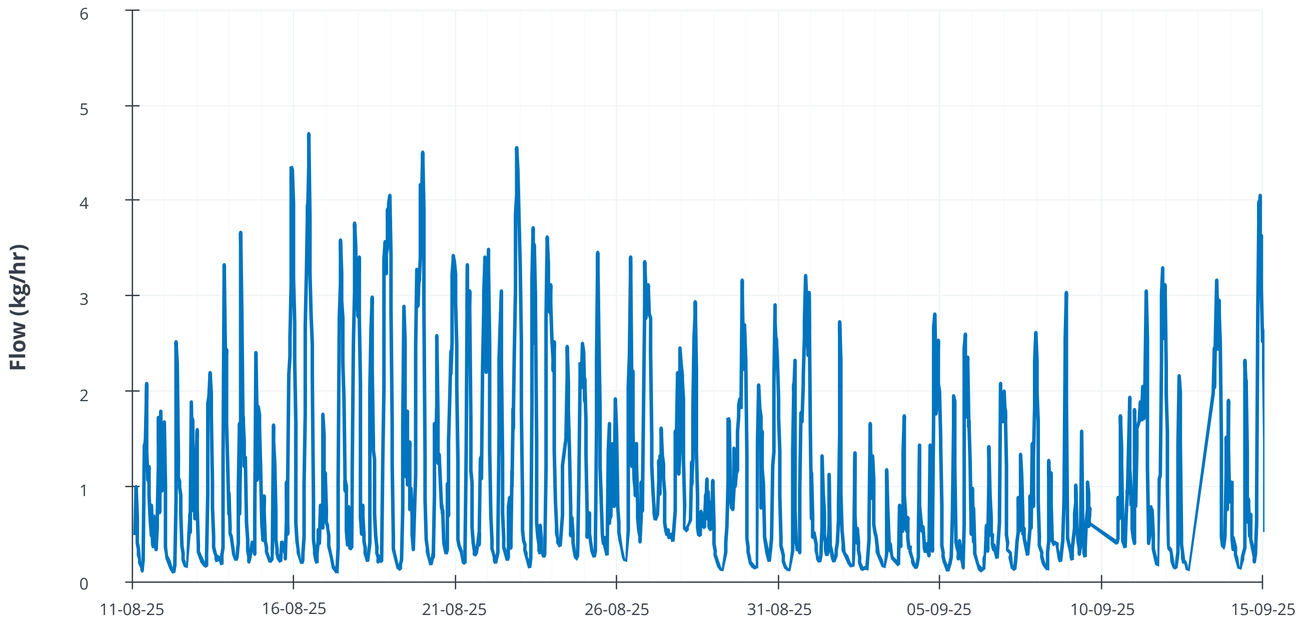
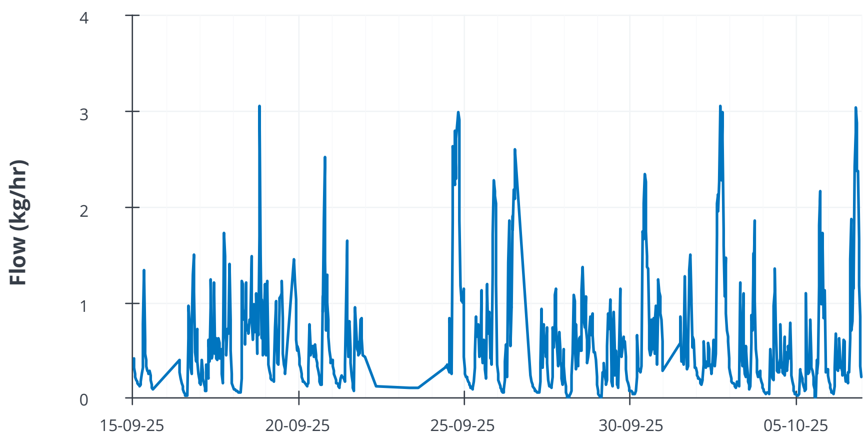
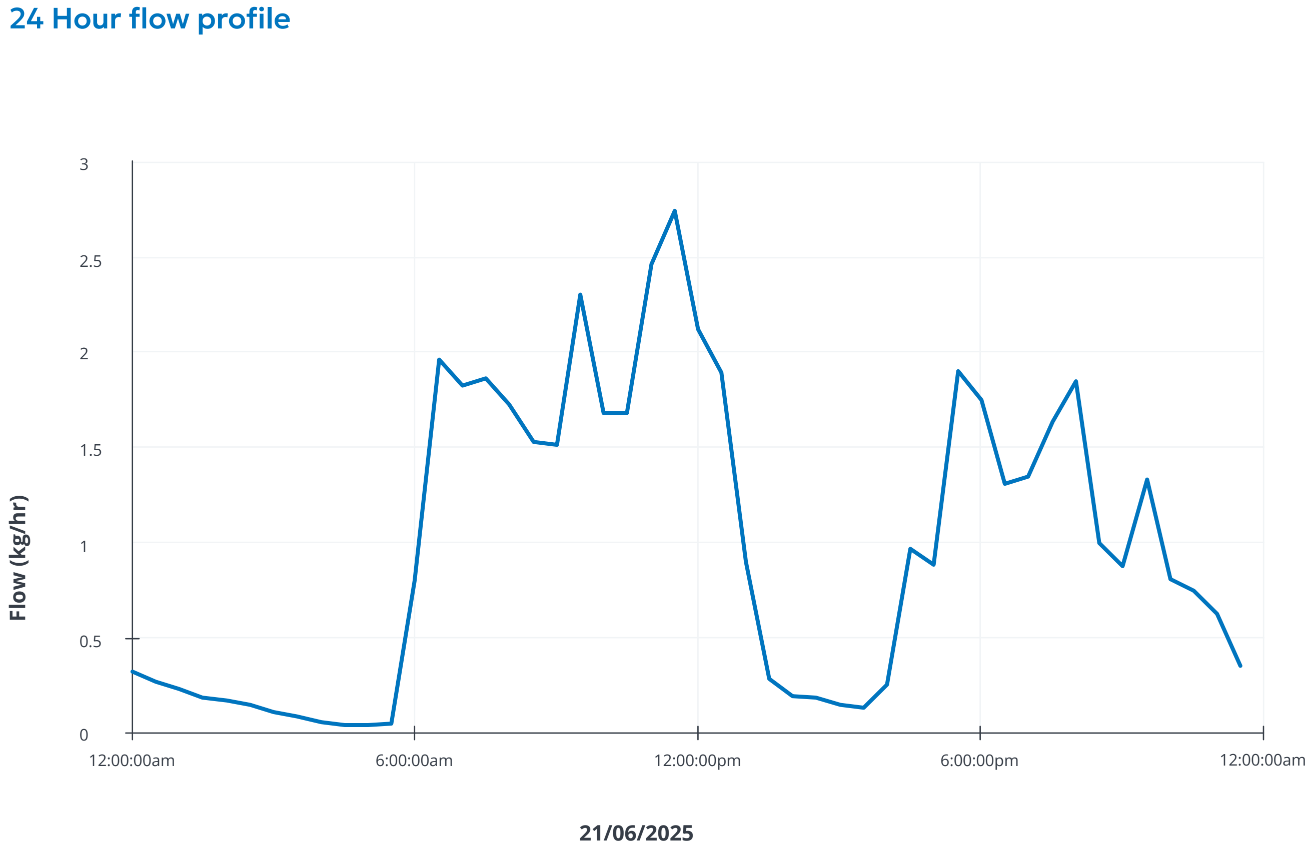


Table B4

12% Hydrogen Blend



Figures B5. Network flow profile over a typical 24-hour period.



Appendix C: Appliance appendix

This appendix provides appliance lists, compliance checklist, issues identified, flue gas and flame progression figures.

Appliance list

Table C1. Presents a list of appliances categorised by property and level of criticalness.

*Critical Appliance

Property	Cooking	Heating	Hot water
		Critical Properties	
Customer #1	*Parmco Turbo TH613-3GW. Replaced with Master Kitchen 320358 (30/07/2025)	*Rinnai Cosy Panel R800TF Rinnai Energy Saver 309 RHFE309FT	Rinnai Infinifty HD200I
Customer #2	Haier HOR60S9MSX1	Rinnai Novo cube FS heater	Rinnai EF 26 Infinity
Customer #3	DeLonghi DE906GWF	Rinnai Timberflame FS35 *Cannon Coalridge flame effect fire	
Customer #4		*Brivis down flow C/H	Rheem 135 Int 441135NO
		All Other Properties	
Customer #5	Elba OR90SCBGX1		Rinnai XR24 | Rinnai XR26
Customer #6			Rinnai Infinity REU2420
Customer #7	Belling FSG61TCSFNG	Radiant RS24 Boiler A271A112H101	Rinnai HD200I
Customer #8		RINNAI -RHFE 559FT ENERGY SAVER	Rinnai Infinity A26
Customer #9	Bosch PCH6A51390A		Rheem indoor cylinder
Customer #10	Delonghi DEGH70W	Rinnai Arriva 752	RINNAI A26
Customer #11	Euromaid CF6GS	Brivis ME20	RINNAI A26
Customer #12	FISHER AND PAYKEL GC900		RINNAI A26
Customer #13			Rinnai 2425
Customer #14	Parmco CS-900G-BLK		Rinnai 2020W | Rinnai 2020W

- Customer #1 was added to the list of critical properties due to the installation of a Rinnai Cosy Panel flueless heater and Parmco Turbo, which was replaced during the pilot period by the customer.
- Customer #2 was kept on the critical property list because Firstgas rented it for the pilot. The property's convenient accessibility allowed appliances to be tested at all stages.
- Customer #3 was on the critical property list due to the Cannon Coalridge flame effect fire. This appliance is considered critical due to WorkSafe advise on closed glass-fronted flame effect heaters from 5 September 2017.
- Customer #4 was on the critical property list due to the Brivis down flow C/H. This appliance was deemed critical due to not having confirmation that they have ever been through a certification tested with a hydrogen blend.

Appliance issues

Table C2. List of appliance issues detected during each pilot stage.

Customer	Issues	Solution Completed
	Stage 1 (Baseline) - All appliances	
Customer #1	Cooktop - Less than 200mm from a combustible surface.	Fit non-combustible protection on wall.
	Space heating - Both heaters require servicing.	Serviced appliances.
Customer #2	Hot water cylinder - Standing on combustible surface. Incorrect seismic restraint.	New appliances installed.
Customer #7	Cooker - Rangehood 500mm above cook top. Cooker hose needs replacing non-compliant.	Raise rangehood to 600mm and installed new cooker hose and reg.
	Boiler - Fan not working and water thermistor corroded.	Replaced parts.
Customer #8	Gas meter - Isolation valve letting by.	Replaced isolation valve.
Customer #9	Gas meter - Inlet valve letting by.	Changed valve.
	Rheem HWC - Water leak.	Changed cold water expansion and moved shelf around draught diverter.
Customer #10	Gas meter - Venting reg too close to heat pump 500mm from vent, 600mm from riser.	Changed valve and fit OPSO reg.
Customer #11	Riannai Infinity - Flexible gas hose damaged not leaking.	Replaced hose.
Customer #4	Rheem HWC - Flue slip joint needs altering.	Made up slip joint and fitted flue kit correctly to DD diverter.
Customer #13	Gas installation - leaking copper pipe.	Removed and capped off open ends.
	Stage 2 (3.5%) - All appliances	
Customer #1	Gas hob burner will not cross light due to more corrosion on burner.	Replaced.
Customer #13	Valve letting by.	Replaced.
Customer #7	Customer mentioned the CO detector had gone off the night before this visit.	The detector was replaced and tests in the property showed no signs of CO produced when the gas oven was working.
	Stage 3 (5%) - All appliances	
No issues.		
	Stage 4 (10%) - Critical appliances only	
Customer #3	Gas hob ignition pack failed	Replaced ignition pack
	Stage 5 (12%) - All appliances	
Customer #7	Central heating system was leaking	Boiler was isolated and no 12% test completed on the appliance. Owner is planning repairs. Not related to the gas circuit.
Customer #9	Gas hot water cylinder leaking	Minor leak; not related to the gas circuit.
Customer #12	Gas hob burner pressure high due to faulty appliance regulator	Regulator to be replaced by Kapiti Gas. Customer informed that this is a prior issue and they are planning to replace the appliance.
	Post-Pilot - All appliances	
No issues. Updates as seen below.		
Customer #9	No issues with water heater	Customer informed that they are planning to replace their water heater.
Customer #12	Gas hob replaced	Customer has replaced the gas hob that had regulator repaired previously.

Appliance checklist

Table C3. Template of the appliances testing at all H_2 blend stages (3.5%, 5%, 10% & 12%).

Performance criteria	Evaluation method	Verification result	Compliance	Details of non-conformance	Safety
General Test installation for gas tightness. Gas pipework should be designed and installed to: Convey gas at a predetermined pressure and volume; Avoid leakage of gas; and (c) Avoid damage by corrosion, stress, or other means.			Y | N		NUS | US
Unburned gas release. The gas appliance is gas tight.			Y | N		NUS | US
Ignition is rapid and complete.			Y | N		NUS | US
Any evidence of light back or light under observed.			Y | N		NUS | US
Re-ignition is rapid and complete.			Y | N		NUS | US
Release of unburned gas is minimal when the flame is extinguished.			Y | N		NUS | US
Flame failure equipment prevents accumulation of dangerous quantities of unburned gas.			Y | N		NUS | US
Unburned gas does not accumulate during appliance operation.			Y | N		NUS | US
Temperature hazards External surfaces of the gas appliance do not attain unsafe temperatures.			Y | N		NUS | US
There is no evidence of degradation to the appliance from excessive temperatures which might render it unsafe.			Y | N		NUS | US
All controls can be operated safely under operating conditions.			Y | N		NUS | US
Ignition and re-ignition are reliable and complete.			Y | N		NUS | US
Cross lighting is satisfactory.			Y | N		NUS | US
No flame abnormality is present. Photo of flame			Y | N		NUS | US
Consider - Are any parts of the appliance worn or damaged in a way that makes operation unsafe?			Y | N		NUS | US

NOTE: In column 2, NE = not evaluated, NA = not applicable | In column 4, Y = yes, N = no | In column 6, NUS = not unsafe, US = unsafe

Flue gas analysis

Table C4. Flue gas analysis results.

Address/Appliance	CO (ppm)		CO_2		O_2		Efficiency		Temperature (°C)	
	0%	12%	0%	12%	0%	12%	0%	12%	0%	12%
Customer #14 (Rinnai 1)	5.6	7.0	6.7%	6.8%	9.1%	9.0%	90.3%	88.8%	184	182
Customer #14 (Rinnai 2)	140.0	162.0	7.6%	7.3%	7.5%	8.0%	91.1%	89.1%	192	190
Customer #6 (Rinnai Infinity)	15.6	7.0	7.8%	7.6%	7.1%	7.7%	93.1%	91.6%	159	184
Customer #8 (Rinnai Infinity)	6.5	9.8	7.0%	8.0%	7.4%	7.6%	91.9%	90.4%	-	-
Customer #8 (Energy Saver)	3.0	4.2	6.0%	6.4%	9.0%	9.2%	91.0%	92.4%	-	-

Flame Progression

Table C5. Flame progression on the gas hob at Customer #2 (H_2 display home).

0%

3.5%

5%

12%

Appendix D:
Photos of the pilot

This appendix contains pictures of the DP set up and the Firstgas hydrogen display home.

Photos of the DP set up

Figure D1. Te Horo DP set up.

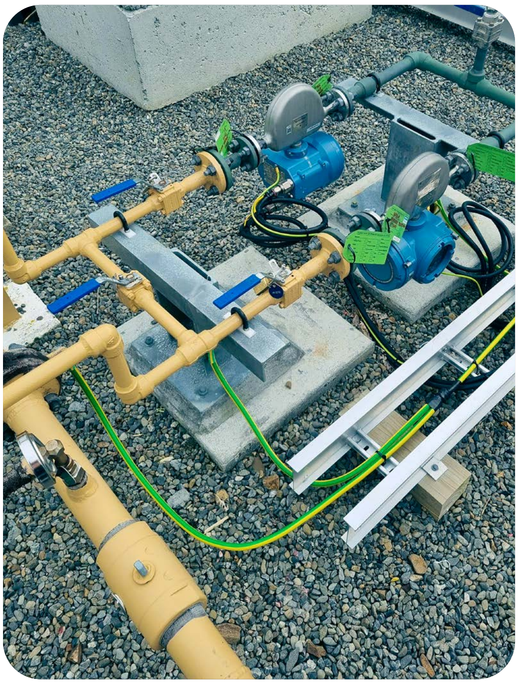


Figure D2. Gas meters piping at the DP.

Figure D3. Solar & PLC container at the DP.

Figure D4. Welker H_2 injection & GC container at the DP.

Figure D5. Welker H_2 injection & GC calibration cylinders at the DP.

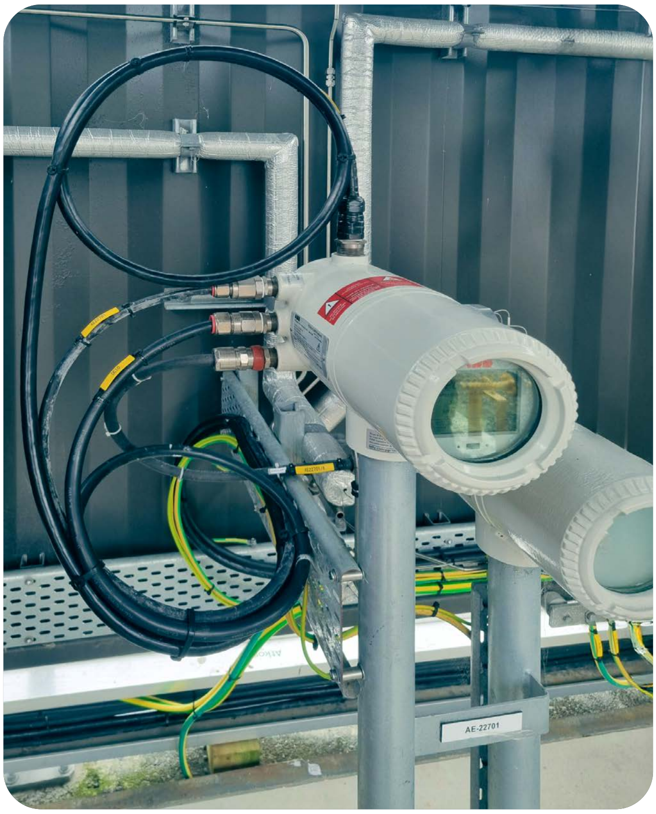


Figure D6. GC at Te Horo DP.

Figure D7. H_2 mixing loop with tank.

Figure D9. Welker PLC at 10% stage.

Figure D10. Firstgas hydrogen display home.

Figure D11. Rinnai Novo Cube heater installed at the display home.

Figures D12. Rinnai Infinity at the display home.

Figure D13. Informative banner within the display home.

Appendix E: Glossary

ARENA – Australian Renewable Energy Agency

BOC – BOC Gas New Zealand

FFCRC – Future Fuels Cooperative Research Centre

GIC – Gas Industry Company – New Zealand's gas industry co-regulatory body

GPA – GPA Engineering, Australia

GSMR – Gas (Safety and Measurement) Regulations 2010

H_2 – Hydrogen

Hr - Hour

IPL – Independent Petroleum Laboratory, NZ

kg – Kilogram

kPa – Kilopascal

LHV –Lower Heating Value

m^3–Cubic meters

MAOP – Maximum Allowable Operating Pressure

MBIE – Ministry of Business, Innovation and Employment

MJ – Megajoule (unit of energy). 106 Joules = 1,000,000 J

Mol% – Mol percentage – to express the concentration or a component in the mixture

NZS – New Zealand Standard

OATIS – Open Access Transmission Information System. Online information system used in the New Zealand gas industry to manage and facilitate information exchange related to access to and use of the gas transmission pipelines

PE – Polyethylene

Pre-85 – distribution network pipes installed before 1985, after 1985 industry started to use a more modern resin for manufacturing of Polyethylene (PE) pipes