Firstgas Group

Hydrogen trial study – FAQ's

About Hydrogen

1. **What is Hydrogen?**
   Hydrogen is a gas that can be burned (just like natural gas or LPG) or used in a fuel cell to generate energy. It is odourless, tasteless, colourless and non-toxic and avoids the generation of CO_2 when burned. It has a high energy content by weight – nearly three times that of gasoline. Hydrogen can be used to store energy – so it's a great way to ensure that our renewable electricity is maximised.

2. **How is hydrogen made?**
   Hydrogen is produced by splitting water using renewable electricity in an electrolyser. Oxygen is the byproduct of this process. Hydrogen produced this way is termed 'green' hydrogen as long as the electricity source is renewable.

   Hydrogen can also be produced from natural gas or coal through steam methane reformation or autothermal reformation. This process releases CO_2 and hydrogen produced this way is called 'brown' hydrogen. If the CO_2 is captured and sequestered (CCS), then it becomes low carbon and is called 'blue' hydrogen.

   Finally, hydrogen can be a byproduct of industrial processes without CCS. This is called 'grey' hydrogen.

3. **What is an electrolyser?**
   An electrolyser is a device that uses electricity to break water into hydrogen and oxygen in a process called electrolysis. There are three main types of electrolyser: alkaline electrolysis, proton exchange membrane (PEM) electrolysers and solid oxide electrolysers. These range in size and function, from small industrial plants to large scale facilities that can deliver hydrogen into gas pipelines. The electricity used by these electrolysers can either come from the electricity grid or purpose-built renewable electricity generation sources, such as wind turbines.

4. **Is hydrogen safe?**
   Hydrogen safety is about understanding how the gas behaves and how to handle it safely – just like natural gas, LPG and petrol. The gas has been well studied and there is a significant body of evidence already on safe handing. As Firstgas Group (and precedessors) have run the gas networks safely for almost 50 years, we're confident that we can adapt to the safety requirements of the new gas.

   A number of hydrogen's properties make it safer to handle and use than the fuels commonly used today. For example, hydrogen is non-toxic. In addition, because hydrogen is much lighter than air, it dissipates rapidly when it is released, allowing for relatively rapid dispersal of the fuel in case of a leak. Adequate ventilation and leak detection are important elements in the design of safe hydrogen systems – just like natural gas. While hydrogen is odourless and burns with an invisible flame, odorants and colourants will be added for use in the home, such that flames can be seen and

leaks can be detected by smell- just like natural gas'.. In addition, some metals can become brittle when exposed to hydrogen, so selecting appropriate materials is important to the design of safe hydrogen systems.

5. **What is happening globally?**
   There is a huge amount of international activity relating to hydrogen as it is seen as an important component of zero carbon energy systems. It's hard to put the level of activity in a nutshell. 30 countries have a national hydrogen strategy in place and $70 billion of funding has been committed globally over 228 projects ongoing.

   Key projects that are extremely relevant for Firstgas are:
   - The Western Sydney Green Gas Project commenced 2018 to test hydrogen generation, storage and blending in existing infrastructure.[1]
   - The Hydrogen Park South Australia commenced 2020 to blend hydrogen with natural gas to customers using existing infrastructure.[2]
   - The HyDeploy programme (UK) commenced 2019 to demonstrate safe blends of hydrogen within existing gas infrastructure.[3]
   - The Hy4Heat programme (UK) commencing 2021 will demonstrate the replacement of natural gas with hydrogen in residential & commercial buildings/appliances.[4]

6. **Why is Hydrogen key to decarbonising gas?**
   Hydrogen can be burned like natural gas or used in a fuel cell to generate energy. It offers the same storage and flexibility benefits as natural gas, but can be used in a zero carbon economy. Firstgas Group is exploring other zero carbon gases such as biogas (biomethane) and bioLPG. Hydrogen can be produced at greater scale than other zero carbon gases and therefore allows greater decarbonisation of gas use.

About the study

7. **Who is Firstgas group?**
   Firstgas Group proudly represents leading companies; Firstgas, Rockgas, Flexgas and Gas Services New Zealand. Our Vision is to lead the delivery of New Zealand's energy in a changing world. Our mission is to safely and reliably deliver energy that's affordable and accessible to Kiwi families and businesses. We're proud of the contribution gas makes and of the important role we play in peoples' lives every day, to ensure their needs are met.

   Our customers come first and we work as one dedicated team to create an industry leading operation. Integrity and respect are integral to our business and we empower our team to do their jobs safely – from working on pipeline operations and providing maintenance services; through to the safe distribution and the reliable, affordable

[1] https://jemena.com.au/about/innovation/power-to-gas-trial
[2] https://www.australiangasnetworks.com.au/hyp-sa
[3] https://hydeploy.co.uk/
[4] https://www.hy4heat.info/

delivery of natural gas and LPG, to around 430,000 industrial, business and residential customers up and down the country.

8. **Who was involved in the study?**
In May 2019, Firstgas Group announced it was starting to explore how hydrogen might be used in its existing gas pipeline networks as part of a low carbon energy system in New Zealand. Firstgas commissioned a technical desktop study from UK based Aqua Consultants and Element Energy to inform our hydrogen trial programme. Both consultants have significant experience in the gas sector and European hydrogen projects.

The study was supported by funding managed by the Provincial Development Unit, and co-funded by Firstgas.

9. **What will you do next?**
Our results set a good foundation forour future work on hydrogen. It provides a concrete platform for Firstgas Group's testing and development programme. We will begin design work in 2021 on a physical trial using pipelines that are blend ready (or nearly blend ready) to start building our experience. We would start with a small amount of hydrogen (1% by volume) and build to 20% by volume over the trial period. We will also start work on confirming what we know about both the materials that make up our networks and those of other distribution owners and the appliances connected to them. This will inform our forward testing programme.

Our study findings

10. **Why use hydrogen when we have lots of renewable electricity that can reduce emissions throughout our economy?**
Electricity isn't going to be able to decarbonise all parts of our economy – especially when it comes to heavy transport and high temperature process heat. Hydrogen can also help the economics of renewable electricity by storing electricity generated at times of low demand that would otherwise be wasted, storing energy for dry years and peaking, and addressing the intermittency of renewable energy.

11. **When you convert electricity to hydrogen, there are energy losses – why use it as it seems inefficient. Why not just use the electricity directly?**
Firstly, electricity isn't going to be able to decarbonise all parts of our economy, so we need something else to complement it and that's where hydrogen and other green gases can help.

Secondly, it's about economics and energy storage. Hydrogen can make renewable electricity more economic by storing renewable electricity produced at off-peak times and then either using this for parts of the economy that can't use electricity to decarbonise or converting back to electricity when required.

Something to consider is that electrical efficiency alone does not always equate to economic efficiency when considering associated infrastructure costs and the ability to get the job done in parts of the economy that require really high temperatures or lighter-longer range hydrogen fuel cell vehicles.

12. I understand that we need to store our renewable electricity, but can't smart grids, big batteries and electric vehicles manage that?

Yes, these electricity-based technologies are great and will go a long way to storing our excess renewable electricity until we need it. However, there's a limit to these technologies. Hydrogen can replace the intra-year, inter-seasonal and inter-year storage currently provided by natural gas to allow our electricity system to keep going

Storing excess renewable energy as hydrogen until it is required also increases our energy independence because we are able to maximise our resources to their fullest, reducing the need to import energy from abroad.

13. Would we need to generate more electricity to make hydrogen?

All studies agreed that we will need to generate much more electricity than today to reach zero carbon by 2050. Hydrogen can help make the generation of electricity much more affordable by using hydrogen to store energy.

Electricity needs to be used as its generated, this means that sometimes there is suplus renewable electricity that can't be used. This surplus electricity can be stored in the form of hydrogen. Hydrogen can then be used to generate electricity when lake levels are low and the wind isn't blowing.. Using hydrogen to store energy maximises the usage of the renewable generation and improves its efficiency.

In line with Transpower's Whakamana i Te Mauri Hiko report, our study represents a significant increase in electricity demand compared to today. The generation build required is massive and would require over 1GW of additional electricity generation capacity to be built per year. Just under half of the electricity demand in 2050 would be for generation of hydrogen. Our study presents a view of how to decarbonise our energy using hydrogen and is one of the potential futures for NZ. In this way, it contributes to the integrated energy discussion we need to have to get to net zero by 2050.

14. Will there be the need to consume lots of water to make hydrogen?

Water demand for the operation of electrolysers is around 12 litres of potable water per kilogram of hydrogen.

Our upper end projections suggest that annual demand could increase up to 13 million cubic metres of water per annum by 2050. By comparison, annual water demand of 13 million cubic metres is equivalent to:

- ~8% of the current freshwater demand of the city of Auckland, or
- ~0.1% of the current national maximum freshwater demand allocation for all sectors.

15. **How much will hydrogen cost compared to electricity and natural gas in 2050?**
    The largest contributor to the cost of hydrogen is the cost of electricity, followed by capex and opex costs of the electrolysers used to produce hydrogen. Our study forecasts hydrogen will cost $3.26/kg in 2050 in real terms. This is in line with higher end predictions of the natural gas price.

    As electricity cost is an input to our forecast hydrogen price, it becomes circular to directly compare our forecasts of the two. Given the diversity benefits of hydrogen and the potential for hydrogen to decarbonise high temperature process heat and heavy transport at lower cost than electricity, there is a benefit to our economy in using hydrogen rather than relying solely on electricity to decarbonise.

16. **Who's making the hydrogen?**
    Firstgas Group is the owner and operator of gas pipelines. We anticipate that, as we decarbonise and the market grows for hydrogen, it will be attractive for companies to generate hydrogen.

Next steps

17. **What will happen to natural gas?**
    As hydrogen is introduced to our pipeline networks, natural gas will be displaced. At levels of hydrogen <20% there will be no changes to the natural gas system. However, after 2035 we will start to convert sections of the network to 100% hydrogen, and there will need to be changes to user appliances and our network to carry hydrogen to customers.

18. **What will happen to LPG?**
    LPG appliances are not connected to the natural gas network. There will be no impact on LPG from the work we are currently undertaking. Firstgas Group is investigating other means to decarbonise LPG such as BioLPG.

Technical questions

19. **What other zero-carbon gases are you investigating?**
    There are a number of 'green gases' that Firstgas Group is exploring. Hydrogen, biogas (biomethane) and bioLPG are all produced in different ways, with different inputs and are used in different ways. This study focusses on green hydrogen as it has zero emissions and can be produced at a scale that can displace fossil fuel use in multiple parts of our economy.

20. **What will Firstgas have to do to accommodate hydrogen within the gas network?**

Our preliminary findings are that our transmission (high pressure) network has enough capacity to transport the projected upper-end hydrogen demand. There will be some changes to our compressors as electrolysers will inject hydrogen into the network at pressure and spread across the North Island. This is a change as currently all gas is produced in Taranaki

Distribution (low pressure) networks are also likely to require minor reinforcements in order to deliver enough hydrogen to customers. The high density polyethylene (HDPE) components, which make up most distribution networks of our network are compatible with hydrogen usage.

The high strength steel that comprises approximately 30% of our transmission network may be susceptible to embrittlement. We're keeping a close eye on international research on this topic and expect more certainty by 2023. Given the transition to hydrogen will occur slowly over time, the required changes to our network can be done as a part of our ongoing network renewal programme.

What does it mean for me?

21. Can I still run my business on gas?

Yes. Based on the study timing there will be no change prior to 2035 as most existing equipment can run on blends of up to 20% hydrogen. After this point we will progressively convert networks to hydrogen. On this timeframe, appliances will need to be able to use hydrogen after 2035.

Appliance manufacturers are bringing hydrogen ready appliances to market. We anticipate that these will be available in NZ soon so that when you need to renew your appliance you'll be able to prepare for the change.

LPG equipment is not connected to our natural gas transmission or distribution networks. We are investigating how to provide our Rockgas LPG customers with zero carbon LPG equivalents.

22. When's it going to happen? When do I need to do anything?

We are beginning with live network trials of a blend of hydrogen within the next year. This network will be selected to be 'hydrogen ready'. This work will inform our offline testing programme for distribution and transmission networks out to 2030.

Our programme has us commencing blending from 2030. We will gradually increase from 1% to 20% over the years to 2035. However, as most appliances will not be affected by blends of hydrogen up to 20%, we do not anticipate that any changes will be required. Hydrogen enabled equipment will be required from 2035 as we start to convert the network to 100% hydrogen.

23. Will I need to make changes to my existing gas connection? How long will I be off gas during the transition?

There will be no change to gas connections until we start to convert the networks to 100% hydrogen after 2035. This will require technician intervention – just as we did when we switched from town gas made from coal in the 1970s. When we come to plan the final conversion strategy we'll develop an in-depth plan on connections and how to minimise disruptions.

24. Will I need to make changes to my existing gas appliances?

Research to date shows that most appliances (from heating to home cooking) will not be affected by blends of hydrogen up to 20%. However, existing appliances may not operate with greater than 20% hydrogen blends and will therefore need to be replaced as the gas grid transitions from 20% to 100% (between 2035 and 2050). We anticipate that many appliances will be able to be replaced as a part of their natural retirement cycle.

Appliance manufacturers are bringing hydrogen ready appliances to market that can work through the transition. We anticipate that these will be in market prior to any changes being required.

25. I'm building a new home and have been considering connecting to gas, should I be thinking about using electricity instead?

If you're building a new home you can still connect to natural gas or LPG. Gas services (natural gas and LPG) will continue for the foreseeable future, while the gas industry works with the government to transition to renewable, zero carbon gas and supply it to our customers.

26. Can I use hydrogen through my new or existing gas connection now?

No. Green hydrogen is currently only produced and used in small scale, specialised commercial operations within New Zealand. That production will ramp up over the coming years and our work will ensure we can safely transport it to you through our networks.

27. Can I buy gas appliances and/or equipment that can run on hydrogen?

Yes. Firstgas has a hydrogen barbecue that cooks excellent sausages. At the moment it's rather niche but developing rapidly. Appliance manufacturers are scaling up the production of hydrogen-powered appliances for the home and commercial applications. These will be available widely in the coming years given the pace of developments overseas.

Manufacturers are also developing hydrogen ready appliances that can work on natural gas now and transition to hydrogen as it's introduced.

Hydrogen cars and trucks are available and have been imported to New Zealand.