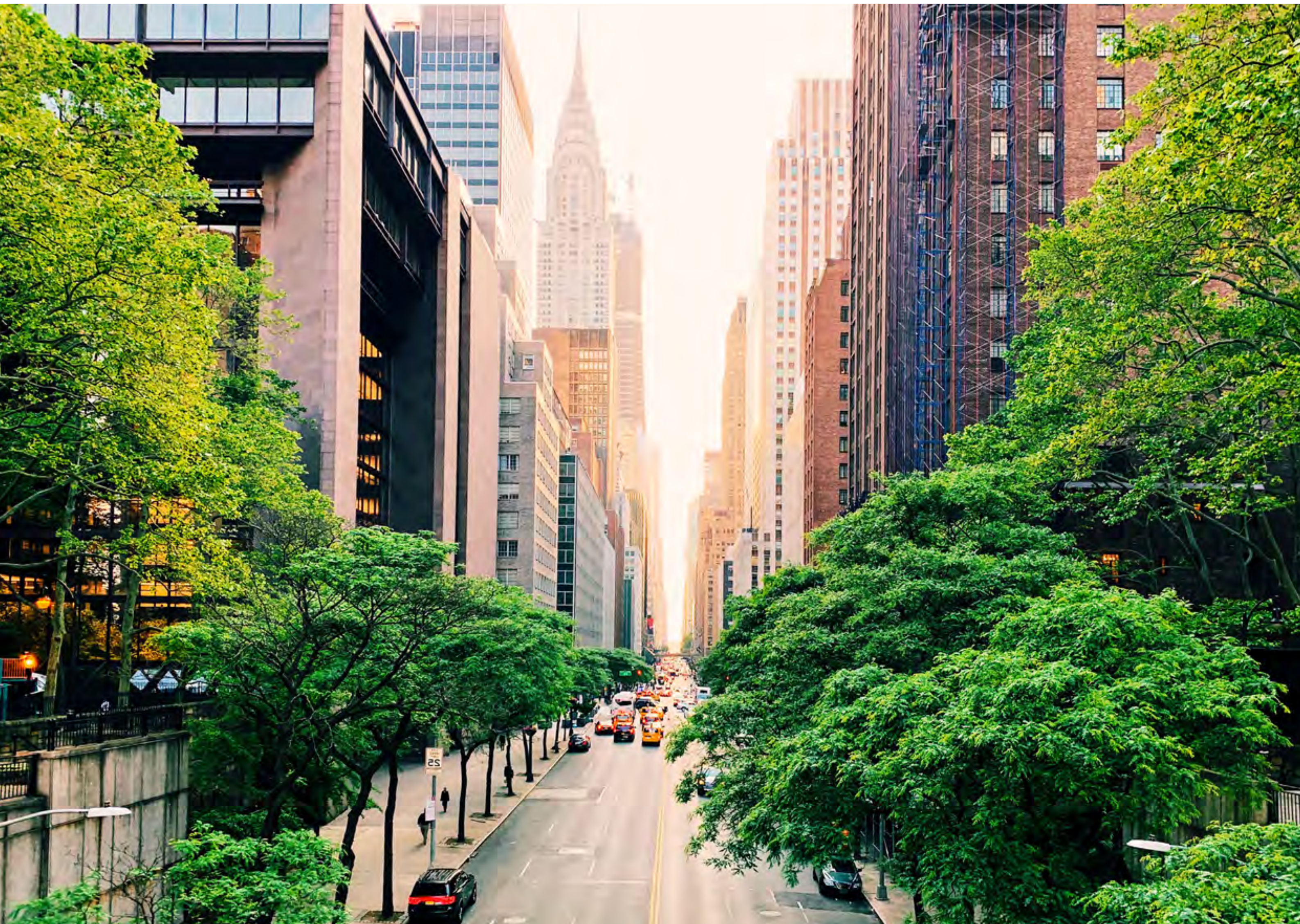
A greener H_2 economy: the time is now

↳ Hydrogen blending in natural gas systems



Foreword

In the race to transform our energy systems, a greener hydrogen economy is emerging at an exponential rate. Hydrogen blending is not a distant dream; it's here - happening now. It's a key element of the long-range transition: greener hydrogen blended with natural gas can deliver cleaner, zero-emission energy for industry, commercial, and household uses.

Historically, coal or town gas networks used up to 50% hydrogen before the transition to natural gas. Some networks, like Hawaii Gas, have successfully used over 10% hydrogen for 40 years. More recently, over 100 blending projects are under development globally, with some implemented in more extensive trials. For example, high-greenhouse gas emission industries are looking to hydrogen to help them decarbonise their operations. Energy utilities, spurred by investor ESG desires and consumer demand, are seizing the opportunity to introduce hydrogen seamlessly into wider society using existing natural gas networks. Governments are also making bold policy and investment decisions to provide their citizens and economies with affordable, reliable, low-carbon energy, leveraging the potential of hydrogen blending.

But what are the challenges and limitations of hydrogen blending? And where do the future opportunities lie? The recent work we led for the Pipeline Research Council International (PRCI) explored these and other pertinent questions to provide the industry with a current comprehensive state-of-the-art analysis (SOTA). The Study delivered a global analysis of current (completed and ongoing) hydrogen blending projects and research. Our team extracted key findings from this comprehensive work and demonstrated a clear path forward for the industry in both high-pressure transmission and low-pressure distribution systems. The SOTA report was finalized with PRCI late last year; a summary is provided herein as well as a future outlook prepared by GHD.

We continue to drive hydrogen blending forward. GHD and our clients are committed to staying ahead of the curve by sharing updated information around this topic and providing innovative solutions to the energy transition challenge.

↳ Acknowledgement

In 2020, GHD led a Hydrogen State-of-the-Art (SOTA) Study for Pipeline Research Council International (PRCI) with direct involvement from 20 gas companies and research institutes in North America and Europe. The study analysed the state-of-the-art of hydrogen blending, identified gaps and prioritized recommended research on various technical topics, including pipeline integrity, safety, metering, network management, underground storage and end-uses.

PR-720-20603-R01 Emerging Fuels - Hydrogen SOTA Gap Analysis and Future Project Roadmap

Why blend H_2 in natural gas systems anyway?

Utilities and energy companies are increasingly looking to blending hydrogen into their existing natural gas systems to:

1. Decarbonise their operations
2. Provide energy storage
3. Enable a hydrogen economy

01

To decarbonise natural gas systems

The two main ways to decarbonise natural gas systems are to displace fossil fuel-based natural gas with Renewable Natural Gas (RNG) or blend Hydrogen.

- While RNG is mainly Methane gas (CH4), it is a clean alternative produced from renewable sources such as biogas or landfill gas, but there is a limit to availability; it can only replace at most 10% of natural gas.
- Hydrogen (H_2) is a different molecule; it is the most widely occurring element and helps decarbonise as combusting a methane-hydrogen blend emits less carbon dioxide (CO2) than pure methane.

Blending enables natural gas users to decarbonise their emissions easily, quickly and economically, which is especially important in the short term while newer decarbonisation technologies are developed in hard-to-abate industries. It also provides natural gas utilities with a new market that can use existing assets transitioned to using hydrogen.

By 2050, global hydrogen demand is expected to increase by

10x

10% hydrogen was blended into the current North American natural gas supply → **~9.5M** tons of hydrogen would be required per year = **~2/3** of total current hydrogen production

Hydrogen production pathways

Hydrogen can be produced using various resources, including hydrocarbons (e.g., steam methane reforming or coal gasification), biomass (e.g., gasification or microbial biomass conversion) or water (e.g., electrolysis using grid, wind, or solar electricity). The pathways have varying degrees of carbon intensities and are often categorized as Green, Blue, Grey and/or Brown Hydrogen although there are no universally accepted definitions. Green Hydrogen is produced via electrolysis of water using renewable power and has the least carbon emissions.

02

To provide energy storage

Hydrogen is a great energy storage mechanism for renewable power. It can be produced with dedicated or excess renewable power and utilized later using stationary fuel cells (for electricity, or combined heat and power), internal combustion engines or fuel cell vehicles. It has a higher energy density and is more flexible than other grid-scale storage technologies, such as pumped hydroelectric, compressed air or battery storage.

Hydrogen storage systems can be any size, from micro-generation daily power storage to large-scale seasonal grid balancing with underground gas storage (UGS) in depleted oil & gas fields or salt caverns.

One of the benefits of blending H_2 in the natural gas grid is that it provides massive storage capacity, in the pipelines themselves or in existing UGS infrastructure, without the need to develop new large-scale storage.

03

To enable a hydrogen economy

Leveraging existing natural gas infrastructure can facilitate the transition to a greener hydrogen economy. For example, about 3 million miles of natural gas pipelines in the US connect natural gas producers, treatment facilities, storage, and end-users. Blending hydrogen into the natural gas systems would connect H_2 producers and end-users without massive investments and time to build new infrastructure. Most conventional end-users of natural gas can use a methane-hydrogen blend to generate power and heat, allowing the smooth introduction of hydrogen into society.

The growing global demand for H_2

It is expected that global hydrogen demand will grow as the world transitions away from grey hydrogen to blue and green hydrogen as an industrial feedstock and an alternative to carbon-based fuels for power generation, heating and transportation. The International Renewable Energy Agency projects the global demand for green hydrogen (electrolysis with renewable power) could reach 130 MTH_2 per year, and blue hydrogen (electrolysis with non-renewable power or hydrocarbon-based production with carbon capture and storage or reuse) could reach 70 MTH_2 per year in 2050. These projections are on the order of a 10-fold increase in hydrogen production both globally and regionally.

For a typical North American city with a population of 1 million people

10% H_2

↓

21Ⓚ tons/yr

H_2 blending – it's happening

There are currently more than 100 projects throughout the world trialing, demonstrating and starting implementation of hydrogen injection and blending components, including research, laboratory experimentation, pilot, demonstration-scale and commercial projects. There has been a significant acceleration in the number of projects in recent years, focusing on Europe, followed by North America and Australia.

Laboratory experimentation and research projects are often focused on integrity and safety topics and the suitability of end-use appliances. Pilot, demonstration-scale or commercial projects are usually combined with renewable power to produce green hydrogen. There are numerous tests with less than 5% hydrogen blend by volume (e.g., Enbridge in Canada, Snam in Italy, HypSA in Australia) but only three projects to date with up to 20% blends (HyDeploy in the UK, GRHYD in France, and Ameland in the Netherlands). There are currently numerous underground natural gas storage facilities globally; and a handful of hydrogen storage facilities, with more hydrogen facilities being trialed (e.g., Underground Sun Storage in Austria, RINGS in France).

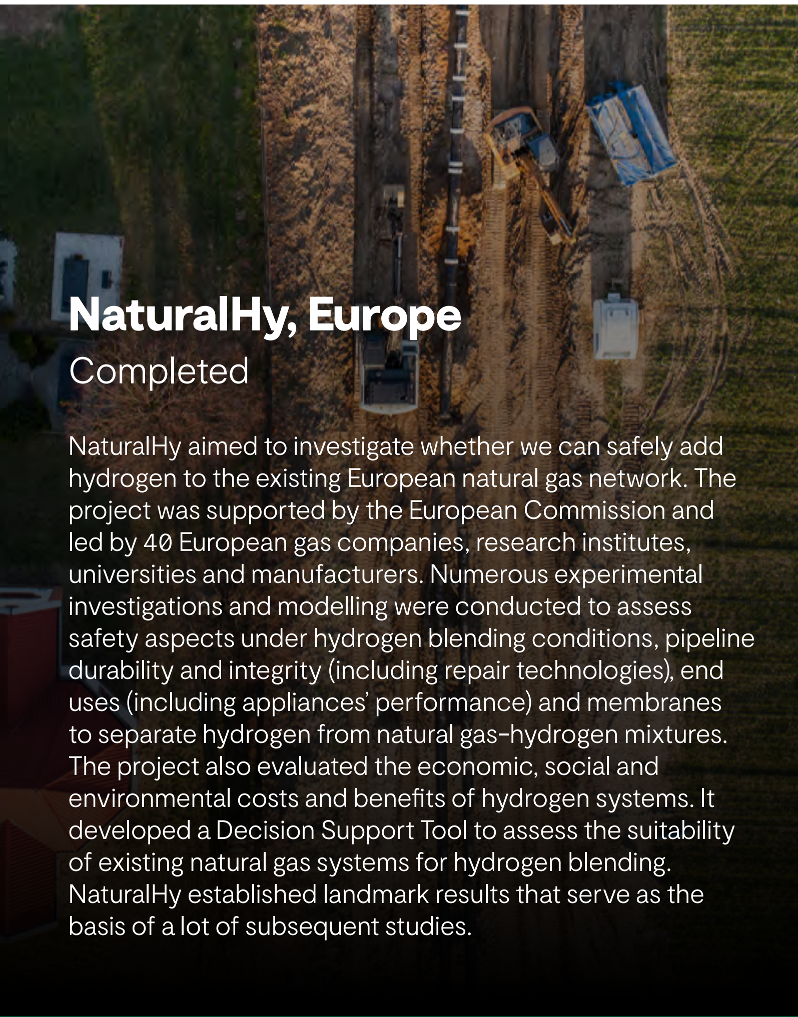
There has been a significant acceleration in the number of projects in recent years.

National H_2 Strategies →

An increasing number of countries throughout the world recognize the role hydrogen will play in the path to decarbonization and have developed national hydrogen strategies, which often include hydrogen blending in natural gas networks. These include Australia, New Zealand and Canada, as well as the EU and several countries in Europe (France, the Netherlands, Norway, Portugal, the UK), Latin America (Chile), and Asia (Japan, South Korea).

Landmark H_2 blending projects

» around-the-world tour



NaturalHy, Europe

Completed

NaturalHy aimed to investigate whether we can safely add hydrogen to the existing European natural gas network. The project was supported by the European Commission and led by 40 European gas companies, research institutes, universities and manufacturers. Numerous experimental investigations and modelling were conducted to assess safety aspects under hydrogen blending conditions, pipeline durability and integrity (including repair technologies), end uses (including appliances' performance) and membranes to separate hydrogen from natural gas-hydrogen mixtures. The project also evaluated the economic, social and environmental costs and benefits of hydrogen systems. It developed a Decision Support Tool to assess the suitability of existing natural gas systems for hydrogen blending. NaturalHy established landmark results that serve as the basis of a lot of subsequent studies.

HyBlend, US

Ongoing

The US National Renewable Energy Laboratory (NREL) leads the HyBlend research and development project to address the technical barriers to blending hydrogen in natural gas pipelines. The team comprises six national laboratories and more than 20 participants from industry and academia. The two-year project is organized into three research tasks: hydrogen compatibility of piping and pipelines, life-cycle emissions analysis of technologies using hydrogen and natural gas blends, and techno-economic analysis of hydrogen production and blending into the natural gas network.

Hawaii Gas, US

Ongoing

In the 1970s, Hawaii Gas began producing and using hydrogen from the conversion of naphtha, a by-product from the local oil refineries, to manufacture synthetic natural gas (SNG) in the Campbell Industrial Park, Kapolei, on the island of Oahu. To this day, approximately 12% of the gas in natural gas pipelines on the island of Oahu is hydrogen – the highest blend and longest use of hydrogen in a natural gas system reported by any gas utility in the US. The project demonstrates successful long-term blending in natural gas distribution and transmission pipelines.

HyDeploy Keele Pilot, United Kingdom

Ongoing

The HyDeploy Keele Pilot demonstrates injecting up to 20% (by volume) of hydrogen into Keele University's existing natural gas network, feeding 100 homes and 30 faculty buildings. The 20% hydrogen blend is the highest in Europe, together with a similar project run by Engie in Northern France. The HyDeploy consortium, led by Cadent, will conduct a second demonstration in the North East with more than 650 homes.

GRHYD Power-to-Hydrogen Demonstration Project, France

Ongoing

GRHYD is producing hydrogen from a power surplus using wind turbines via a PEM electrolyzer. The hydrogen can be stored in the form of metal hydrides or injected into a small dedicated natural gas grid in blends of up to 20% by volume supplying around 100 homes and a health center's boiler. The project also tests a mixture of hydrogen and natural gas (Hythane) to fuel a bus fleet.

Technical challenges and solutions

Hydrogen,H_2, is a much smaller molecule with different chemical and physical properties than methane, CH4, the primary component of natural gas. It is lighter, travels faster, burns hotter and has a lower heating value by volume. Blending hydrogen into natural gas impacts key gas properties, such as permeation, density, calorific value, explosivity, flammability and dispersion speed.

Here, we discuss the technical challenges and state-of-the-art solutions associated with hydrogen blending in natural gas, with a focus on blending at levels of 5% to 50% hydrogen by volume.

Pipeline integrity – high-pressure transmission vs. low-pressure distribution

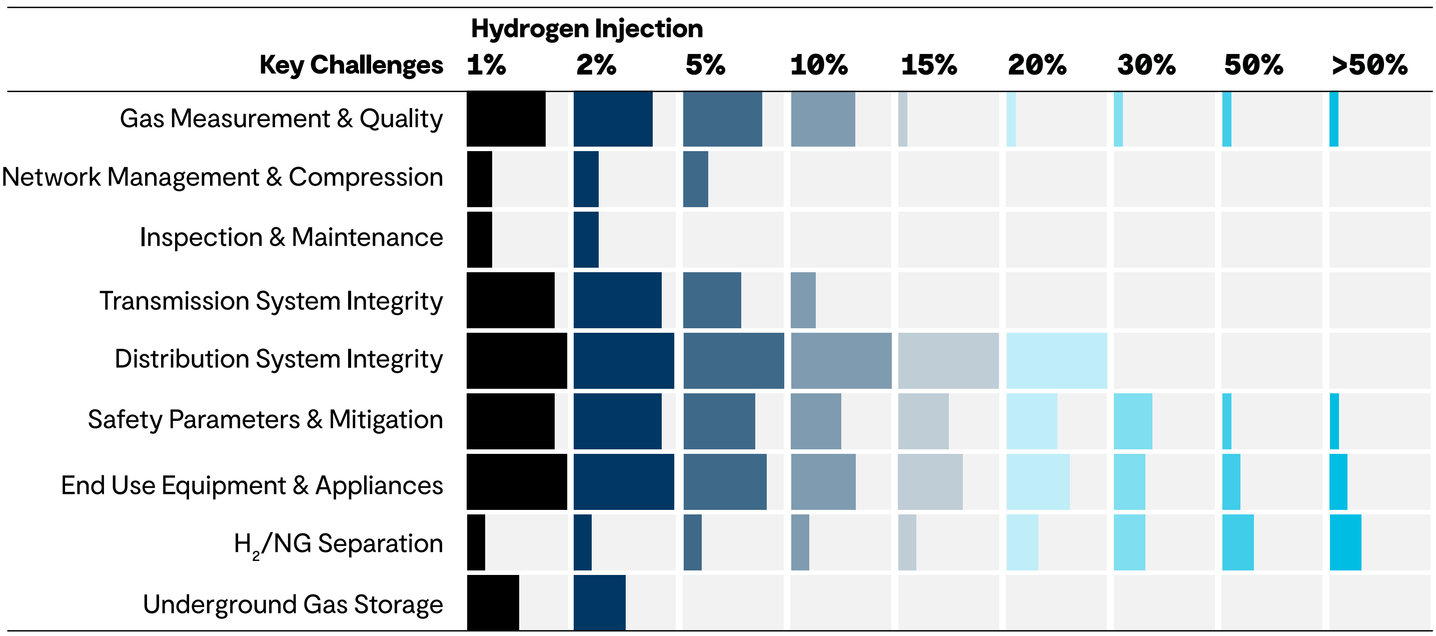
Challenges with pipeline integrity are primarily concerned with the impact hydrogen may have on increasing the rate of cracks and failures in the pipeline and other network equipment.

Hydrogen has an active electron that can easily migrate into the crystal structure of most metals. High-strength steels are particularly susceptible to hydrogen embrittlement mechanisms, increasing the risk of critical failures. Fracture toughness and resistance of the pipeline are reduced by hydrogen absorption into the pipe wall. The number of fatigue cycles to crack initiation is diminished, and crack propagation is enhanced. In short, hydrogen blending reduces the integrity of high-strength steel pipelines, causing a higher cracking and failure occurrence. It is important that asset evaluation of existing systems (e.g., age, materials of construction, and historic inspection conditions) is undertaken before blending is started. Maintenance programs must be enhanced to inspect the pipeline condition more often and expect more frequently required repairs. Higher partial pressure corresponds to a greater risk of embrittlement and diffusion for hydrogen blending in natural gas. This explains why the technical challenges are more pronounced for high-pressure transmission systems than for low-pressure distribution systems and why higher blend percentages can be used in distribution systems.

Plastic pipes, more common to distribution systems, are also better suited to hydrogen blending, and blends of up to 30% have been successfully demonstrated in small distribution networks. Hydrogen does not cause embrittlement or degradation of polyethylene pipes. Rather, the primary concern for distribution networks is hydrogen permeation through the pipe, seals and connections leading to losses, especially in older systems. Given the variety of components in existing distribution systems, there is insufficient information to fully understand the potential impact of introducing hydrogen on any system. Each system needs to be evaluated on a case-by-case basis before blending can be started.

↳ A note on partial pressure vs. percent blend

In this paper, we discuss hydrogen blending in natural gas on a percent by volume basis to allow for consistent comparison across applications. However, it is important to note that in terms of several fundamental challenges with hydrogen such as embrittlement and diffusion, it is the partial pressure of hydrogen that determines the severity of the blending impact. The percent of hydrogen in the total mixed gas volume is the same as the percent of hydrogen partial pressure compared to the total mixed gas pressure. For example, in a 200 psi natural gas distribution pipeline, a 5% hydrogen blend level translates to hydrogen partial pressure of 10 psi. In a 1,200 psi transmission pipeline, a 5% hydrogen blend gives 60 psi partial pressure. This explains why hydrogen blending presents a more significant challenge for high pressure transmission systems than for low pressure distribution systems.



Network management, metering and gas quality

The calorific value of natural gas is impacted significantly as the hydrogen blend percentage increases. This is because hydrogen has a significantly lower energy content by volume than natural gas. At 1 bar and 25°C, the gross calorific value of methane is approximately 40 MJ/m3, about three times that of hydrogen (12.7 MJ/m3).

Billing customers on an energy basis (GJ delivered) requires an accurate assessment of the blended gas composition delivered. A blending station at point A may be introducing hydrogen into a natural gas network at 10% by volume, but a customer at point B may receive a gas that fluctuates in hydrogen composition between 8% and 12% due to normal network operating conditions. The challenge of controlling a blend level throughout a network and metering or assessing gas quality and flow for customers are thus tied together.

Network management

For many blending projects today, there is only one injection and blending station feeding hydrogen into an isolated natural gas network. Project developers and researchers are evaluating different blending techniques to determine which method provides the most effective gas mixing. Strategies such as distributed blending, where multiple injection and blending stations are strategically placed throughout a distribution system, are also considered to maintain a consistent blend across an extensive network. Hydrogen blending additionally reduces overall network capacity, increases the energy required for compression, and may increase pipeline pressure drops at higher blend levels. Network operators need to assess existing equipment and develop strategies and tools for managing these impacts.

Metering flow and gas quality

Measuring the hydrogen content in a pipeline or at the point of end-use is a challenge today. Existing gas chromatographs that are typically used to evaluate gas composition are generally unable to detect hydrogen, and therefore may become obsolete in networks using hydrogen blending. There are solutions under development to tackle this challenge. New gas chromatographs are being developed with an argon carrier to support hydrogen evaluation, as are advanced devices that use light and sound measurements to assess hydrogen concentration.

Accurately measuring the flow rate of the blended gas is just as important as evaluating the hydrogen content. Generally, inferential measurement meters such as orifice, ultrasonic and turbine meters become less effective with hydrogen blending. Direct measurement techniques such as diaphragm meters and rotary meters are less impacted by the hydrogen addition.

Compression stations

Hydrogen blending impacts the thermodynamic and transport properties of natural gas at given pressures and temperatures. For typical pipeline mixtures, the introduction of hydrogen increases the gas compressibility for a given pressure/

temperature case, lowers the specific gravity and energy content by volume. These factors contribute to a loss in pipeline system capacity, increased pipeline pressure drops, and an increase in gas compression costs.

While further research is required, it is understood that compressors' rotating speed and power compression requirements will increase with higher hydrogen blends. Compressors in operation today can generally be expected to operate sufficiently without requiring restaging or replacement for hydrogen blends of up to about 20%, due to their design speed margin. However, each compressor system should be evaluated on a case-by-case basis.

Further research is also required regarding compressor integrity and potential impact on catalysts used in some compression processes.

End-use – domestic appliances and heating

Domestic appliances such as natural gas-fired stoves, fireplaces, boilers and building heating systems are known to operate effectively without notable issues for blends up to 20% hydrogen by volume, with no less than three demonstration-scale projects proving this for appliances in Europe. Testing has been completed by a confidential network operator in Canada as well for up to 40% hydrogen blending in typical existing domestic appliances, with no significant issues or needed refurbishments identified.

The key risks for domestic appliances with hydrogen blending are summarized as follows:

- **Less visible flame:** the higher the hydrogen content in natural gas, the less visible open flame on stovetops or fireplaces. This potentially presents a safety hazard for residents who may not see the flame as easily for high blend levels.
- **Leaks:** as mentioned earlier, there is no known odourant light enough to travel with hydrogen as it disperses. In a domestic or commercial building leak, this has been shown not to present a significant safety hazard as hydrogen does not separate from natural gas. Therefore, the natural gas odourant is sufficient for identifying a leak. However, this has not been tested for higher blend levels above 30% hydrogen by volume.

End-use – industrial equipment

The effects of added hydrogen in methane on combustion properties are well understood. Many original equipment manufacturers (OEMs) already have considerable experience with other hydrogen-rich fuels, such as town gas.

Impacts to key properties, such as flame velocity and temperature, affect flame stability and pollutant emissions. This causes a higher risk of flashback and elevated nitrous oxide (NOx) emissions which must be mitigated. While NOx emissions increase, emissions of carbon monoxide (CO) and unburned hydrocarbons from a standard industrial nozzle-mix gas burner tend to decrease with the addition of hydrogen. Equipment rating decreases under hydrogen blending due to the lower energy content by volume in blended gas. Hydrogen

Where GHD has partnered with clients on industry-leading projects

Western Sydney Green Gas Project (formerly Jemena H_2GO), Australia, ongoing

The Western Sydney Green Gas Project could see Sydney homes and businesses using 'green gas' in as little as five years for cooking, heating and hot water. The project involves a green hydrogen pilot plant located adjacent an existing natural gas distribution hub. The plant includes a 500kW electrolyzer, on-site hydrogen pipeline for buffer storage, injection/blending into a local gas main, a fuel cell and a "micro-turbine" for electricity generation, hydrogen cylinder filling and on-site solar power generation.

Hydrogen Park South Australia (HyP SA), Australia, ongoing

The HyP SA project, developed by Australian Gas Networks (AGN), will supply approximately 710 homes with a blend of 5% renewable hydrogen in natural gas, delivered through the local distribution network. The project's first production of green hydrogen occurred in December 2020 during commissioning of its key component, a 1.25 MW electrolyzer. It is the first Australian demonstration project of its scale and size and will allow for future expansion of a second gas network injection point and tube-trailer filling facilities.

burns fast, has a wide flammable region, high diffusivity, and low ignition energy when compared to natural gas. The resulting effects, which need to be managed, include the risk of flashbacks for higher blends of hydrogen, larger fuel flows in the fuel system, and change of explosion risk characteristics. Blending hydrogen into methane will reduce the fuel's methane number, which will increase the tendency to knock in reciprocating engines. Each system's sensitivity is different, and a case-by-case analysis is required.

Most studies show these properties can be controlled using more robust control systems or mitigation strategies.

Some legacy gas turbines and engines will not reliably accommodate blends of hydrogen greater than 5% without significant modifications. Due to the vintage, it is most likely that these engines would be replaced rather than modified to accommodate measurable quantities of hydrogen. Certain OEMs are offering equipment available today that can handle blends of up to 30% under controlled admixing conditions and developing equipment to handle blends of hydrogen up to 100% for the future.

Further research is required to understand hydrogen blending limits with specific end-use units, particularly existing and older equipment.

Also, further development is needed to advance controls of air-fuel ratios with fluctuating hydrogen blend levels to ensure consistent operation, as current testing is typically done in highly controlled blending situations, without fluctuations in hydrogen concentration.

Underground storage

Underground gas storage is a common method of large-scale gas storage for natural gas and other fossil fuel systems. The technical challenges for natural gas storage are well studied and understood, with numerous projects globally demonstrating solutions and technical capabilities. Depleted gas and oil reservoirs have been the most prominent and commonly used reservoir for natural gas storage to date. Salt caverns also present an opportunity for underground natural gas storage; however, they do not offer anywhere near the capacity of reservoirs and therefore cannot be used to meet baseload needs. Salt caverns are excellent candidates for peak load cycling, and gas can be released within hours of notification at high delivery rates. Hydrogen has been stored underground primarily in salt caverns for many years, particularly in high industrial utilization areas (i.e., around oil and gas refining regions that require pure hydrogen as feedstock). Increasingly, underground storage of pure hydrogen is seen as a sustainable method of grid balancing and seasonal power storage, supporting renewable energy systems, where it can be done with regional geological conditions.

While there is confidence and long-standing experience with storing these gases underground individually, the question is whether the gases can be stored together in a blended state. To date, there has been one field demonstration of hydrogen blending in underground natural gas storage: The Underground Sun Storage Project in Austria. The project included laboratory experimentation and in-situ field trials of 10% hydrogen in a small and isolated rock reservoir. The demonstration was ultimately concluded to be a success; however, blended storage challenges remain significant. For the time being, network operators are better off storing the gases separately and blending them together at pipeline injection aboveground.

The key challenges for blended gas storage are summarized as follows:

- **Microbial activity and hydrogen sulphide (H2S) formation:** In the presence of hydrogen, some bacteria may produce methane, carbon dioxide, H2S and acids, which can lead to significant losses of hydrogen. Porous reservoirs such as depleted gas fields can experience water and oxygen intrusion that promote microbial growth. Salt caverns and lined rock caverns are better candidates for hydrogen storage in terms of microbial activity.
- **Leaks and losses of hydrogen:** Losses of stored hydrogen can be caused by diffusion through porous rock (the diffusivity of hydrogen is four times larger than methane), fluid-gas-rock interactions causing precipitation of calcite or other minerals, impacts to capillary threshold pressure, and microbial activity. All these present a greater challenge for the storage of hydrogen in porous sites.
- **Impacts on aboveground well integrity:** Hydrogen can potentially create integrity issues with well infrastructure, including impacts on tubing, casings, valves and packing. The formation of H2S and acetic acid through microbial activity can facilitate corrosion in underground storage equipment.

Separating hydrogen and natural gas

Separation of hydrogen and natural gas could be employed for two primary purposes:

1. Separating hydrogen from the blend to provide mostly pure hydrogen to end-users, such as a hydrogen refueling station, or on the contrary.
2. Providing mostly pure methane to customers who may be sensitive to hydrogen, such as an industrial user with an older model gas turbine.

The NaturalHy project included research and development into the separation of hydrogen from natural gas for blended hydrogen-natural gas distribution networks. Carbon membranes were identified as a promising technology and evaluated under laboratory conditions. The volume and footprint of these membranes are expected to be small, and they could be conveniently placed at commercial end-use sites. The separated streams could then be used by end-users seeking mostly pure natural gas or hydrogen. Other technologies that may feasibly be employed to separate the gases include pressure swing adsorption (PSA), electrochemical hydrogen separation (EHS, also known as hydrogen pumping), and various membranes. These technologies are progressing; however, significant technical challenges remain, and costs are currently prohibitive.

Overall, currently, it is not technically and economically feasible to implement membrane separation technology at pipeline off-take points.

Further research and development is required to advance this solution. The future potential to have a natural gas refueling station co-located with a clean hydrogen refueling station, where blended gas is delivered from the pipeline and separated into the two gas streams in a separation facility, is a promising technology for supporting the future hydrogen economy. Several hundreds of miles of existing 100% hydrogen pipeline systems throughout the world have been used for many decades and thus are a conventional technology. A simple option in many cases is to provide a new 100% H2 pipeline to deliver H2 where it is needed for blending, and several gas utilities have also been evaluating repurposing existing natural gas pipelines instead of building new infrastructure.

Safety considerations

Explosivity: Adding hydrogen to natural gas increases the risk of ignition and explosion severity, however the impact is not considered material for blends up to 20% hydrogen.

Dispersion: Gas flow rates increase as hydrogen concentration increases.

Safety zones: While well-defined and regulated for natural gas systems, network operators may need to assess changing safety zones for higher hydrogen blends. Country/jurisdiction codes and standards and network-specific evaluations are required to inform regulators on appropriate safety zone adjustments under hydrogen injection and blending.

Odourants: Currently, no known odourant is light enough to travel with hydrogen (at an equal dispersion rate). There is ongoing research to assess the impact hydrogen has on typical natural gas odourants and potential odourants for higher blends.

Leaks: The potential hazard of a leak increases slightly in low-pressure distribution systems due to increased dispersion speed, wider flammability limits, higher flame speed and a decrease in required ignition energy.

What's on the horizon for H_2?

Going forward, we predict the number and scale of hydrogen projects will continue to significantly increase as a vital component of the hydrogen economy which is driving decarbonization across many industries, businesses, cities and communities. In addition to natural gas blending, numerous projects are already underway or plan to use hydrogen to support the global energy transition in the following ways:

1. The exponential increase in green hydrogen production from renewables
2. The exponential decrease in green hydrogen production costs
3. Large-scale blue hydrogen development as a transition to large-scale green hydrogen production
4. Large-scale underground storage of hydrogen/natural gas
5. Extensive fuel switching projects in industry and power generation starting with blends and transitioning to 100% hydrogen
6. An increasing number of hydrogen pipeline distribution networks
7. Increased hydrogen adoption with fuel cells in larger vehicles like buses, trucks, construction, and mining equipment

Interested to learn more?

Get in touch with one of our Future Energy experts to discuss how we can help you harness the exciting opportunities the growing global hydrogen economy presents.

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About GHD

GHD recognises and understands the world is constantly changing. We are committed to solving the world's biggest challenges in the areas of water, energy and urbanisation.

We are a global professional services company that leads through engineering, construction and architectural expertise. Our forward-looking, innovative approaches connect and sustain communities around the world. Delivering extraordinary social and economic outcomes, we are focused on building lasting relationships with our partners and clients.

Established in 1928, we remain wholly owned by our people. We are 10,000+ diverse and skilled individuals connected by over 200 offices, across five continents – Asia, Australia, Europe, North and South America, and the Pacific region.

We have long recognised the need to shift to a more sustainable energy landscape, where renewables play a larger role and emissions-intensive industries move to a decarbonised future. Future Energy is GHD's commitment to the energy transition; a promise to bring everything we have – expert people, global perspectives and diverse experience – to this urgent need for change.

Discover more about our commitment to Future Energy at ghd.com/futureenergy

→ The Power of Commitment