Ready4H2:
Europe’s Local Hydrogen Networks

PART 1: Local gas networks are getting ready to convert

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Contents

This is part one of a series of three Ready4H2 reports - https://www.ready4h2.com

Executive Summary

Ready4H2 is a new alliance of 90 local gas network operators in 16 countries across Europe, dedicated to developing and sharing our expertise to deliver the hydrogen transformation in practice. We are passionate about the role that hydrogen and other green gases can play in achieving net zero.

1. **Hydrogen is essential to achieve net zero**, tackling the hard-to abate sectors, and delivering seasonal storage. Using hydrogen and other green gases across Europe would save €130 billion a year in 2050, compared to meeting net zero without them.
2. **The local gas networks in our alliance reliably supply** 150 000 industrial premises, 3 million commercial businesses and 64 million households. We are getting ready to become Europe's local hydrogen networks, with almost all of the pipeline infrastructure (covering 1,1 mio. km of pipelines) ready to be converted and many knowledge building pilots taking place.
3. **More than 99% of industrial and commercial customers** that are connected to gas are served by distribution networks, so both local and European hydrogen production will need local networks to get the hydrogen to the industries, commercial businesses and buildings that will need it.
4. **Therefore, European regulation should support hydrogen conversion** and distribution efforts at the local level, by giving local gas networks a greater role.

CONNECTED

Over 99%

of industry and commercial premises that are connected to gas are served by local gas networks

READY

Over 1 million km

of local pipelines in our alliance substantially ready for hydrogen, 96% of the total

COST EFFICIENT

€130 billion

annual saving in Europe in 2050 of using hydrogen and other green gases, compared with meeting net zero without them

LOW EMISSION

300 million tonnes

equivalent CO_2 saving if all the gas consumption from customers served by our alliance was converted to hydrogen or other green gases – more than the 2020 CO_2 emissions of France

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European local gas networks deliver cost-effective and safe energy to consumers

Ready4H2 alliance networks keep 64 million households warm in winter and supply a further 12 000 CHP plants to run district heating systems.

We supply 3 million commercial businesses, including the restaurant kitchens that prepare the meals we all enjoy, commercial heating, and gas for vehicle fleets.

We serve 150 000 industrial premises, including industries such as glass and ceramics that need a gaseous flame at a competitive price to produce their products.

Our networks are extremely reliable, with very few interruptions to gas supply, which is important for families to stay warm and businesses to function.

We are supporting green gas grid injection, with over 600 biomethane plants connected to gas networks across Europe.

We are providing the critical evidence and have gained fundamental practical experience from many hydrogen pilot and research projects, and previous towns gas conversion.

Hydrogen is key to net zero, and local networks are crucial to accelerate deployment

Hydrogen is needed for net zero

- **EU Strategy:** Hydrogen "is a key priority to achieve the European Green Deal", including as a seasonal store for renewable energy, in industrial and transport applications, and in natural gas infrastructure.
- **Cost:** DNV has found that using hydrogen and other green gases would save Europe €130 billion a year in 2050, compared to meeting net zero without them.
- **Seasonal storage:** In many countries, peak heating demand is far higher than peak electricity demand. Hydrogen can be stored seasonally and distributed in gas infrastructure, reducing the need for costly electricity grid reinforcement.
- **Employment:** Navigant concluded that the production of 1,710 TWh/year of green hydrogen would create around a million jobs in Europe by 2050.
- **Consumers:** Hydrogen conversion would entail less disruption for many industrial, commercial and residential consumers, and biomethane requires no changes for consumers.

Local networks are crucial to succeed

- **Decarbonization potential**: Converting all the natural gas that Ready4H2 members distribute to customers to hydrogen or other green gases (1 870 TWh), would abate over 300 million tonnes of CO_2 emissions – more than the CO_2 emissions of France in 2020.
- **Industry connections:** Over 99% of gas connected industry and commercial premises are served by local gas networks rather than national transmission pipelines.
- **Readiness:** Currently, 1 151 000 km of Ready4H2 member pipelines are ready for conversion, representing 96% of our combined network.
- **Best modality for distribution**: Even for short distances, it costs four times less to distribute hydrogen by pipeline than by truck. Transport by truck would be impossible to supply the volumes required for millions of users.
- **Integrated infrastructure:** Most of the Ready4H2 members also supply electricity to local users. We understand the benefits and challenges of both gas and electricity networks, and the opportunities of hydrogen and other green gases to couple them more effectively and make best use of Europe's growing renewable resources.

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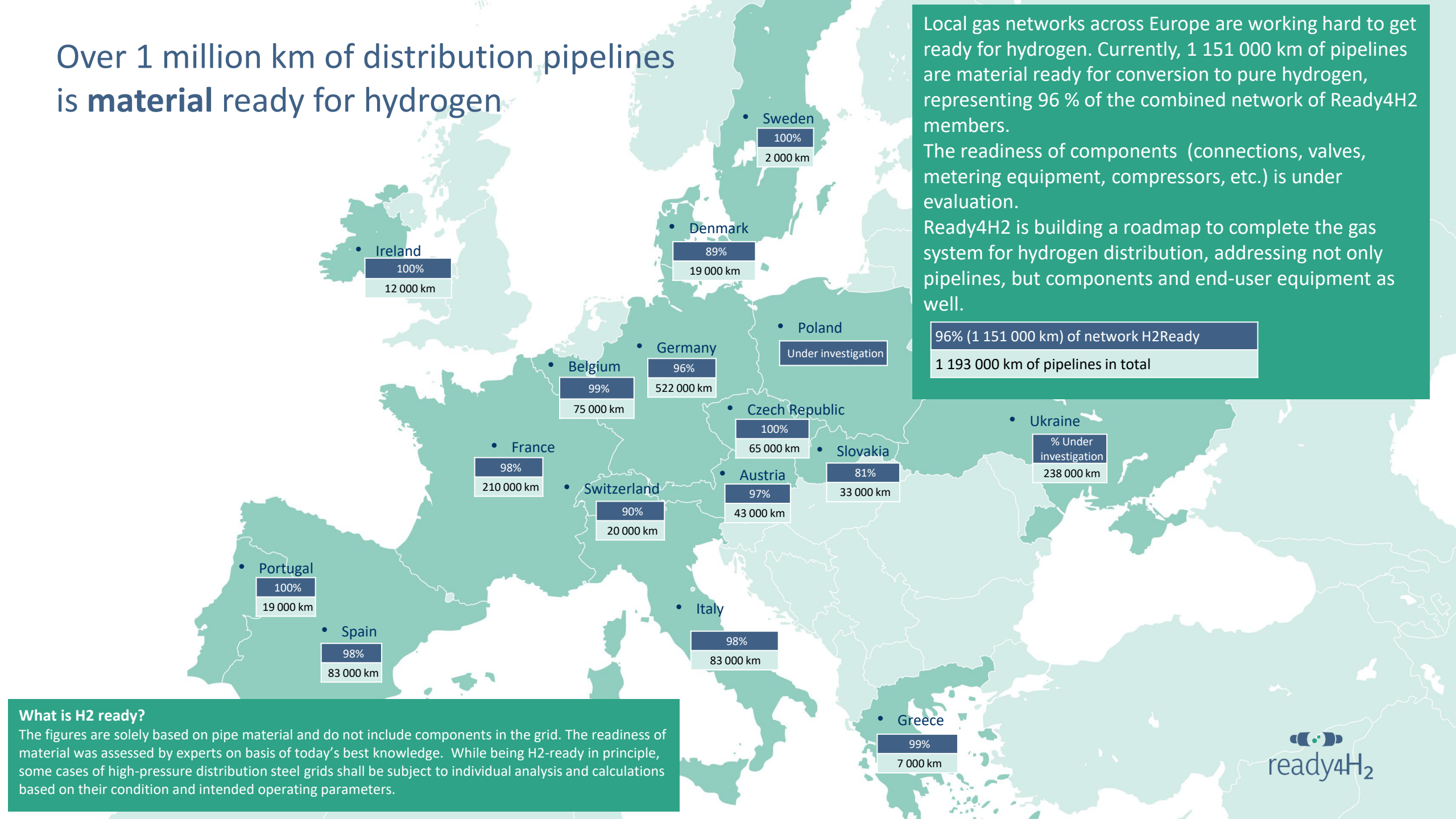
Over 1 million km of distribution pipelines is **material** ready for hydrogen



Local gas networks across Europe are working hard to get ready for hydrogen. Currently, 1 151 000 km of pipelines are material ready for conversion to pure hydrogen, representing 96 % of the combined network of Ready4H2 members.

The readiness of components (connections, valves, metering equipment, compressors, etc.) is under evaluation.

Ready4H2 is building a roadmap to complete the gas system for hydrogen distribution, addressing not only pipelines, but components and end-user equipment as well.

96% (1 151 000 km) of network H2Ready
1 193 000 km of pipelines in total

What is H2 ready?

The figures are solely based on pipe material and do not include components in the grid. The readiness of material was assessed by experts on basis of today's best knowledge. While being H2-ready in principle, some cases of high-pressure distribution steel grids shall be subject to individual analysis and calculations based on their condition and intended operating parameters.

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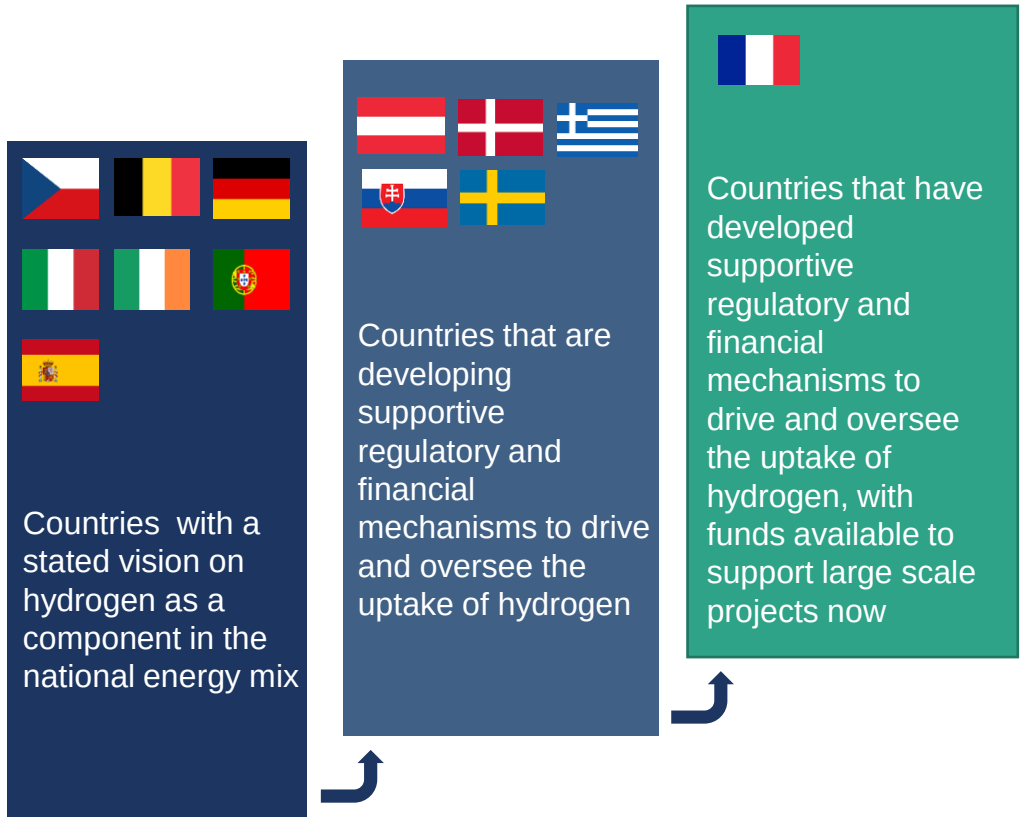
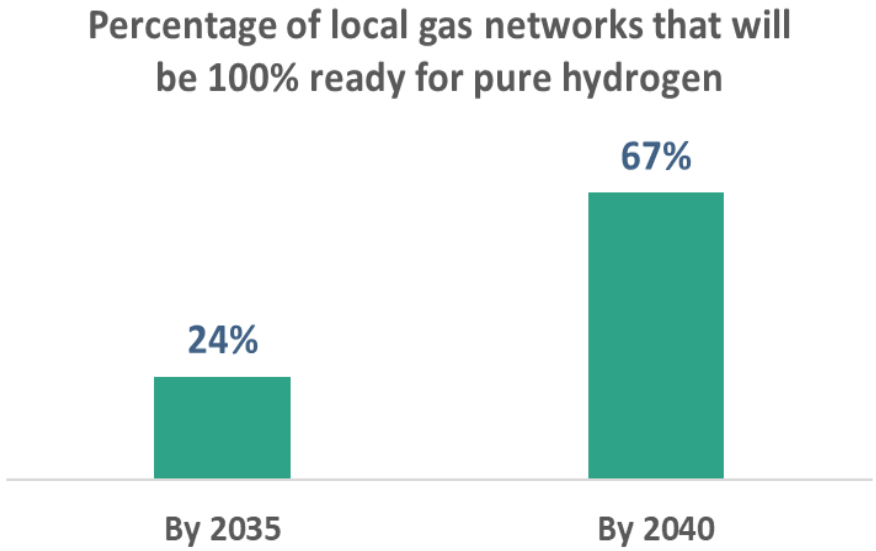
Countries are starting to provide support, but it needs to be accelerated

Most countries now have a hydrogen vision, but no country has GW-scale projects that have taken FIDs



Two thirds of Ready4H2 members expect to be fully ready* for 100% hydrogen by 2040, with parts of their networks able to convert sooner



*The network readiness includes the readiness of the pipe material, all components (connections, valves, metering equipment, compressors, etc.) and the end user equipment

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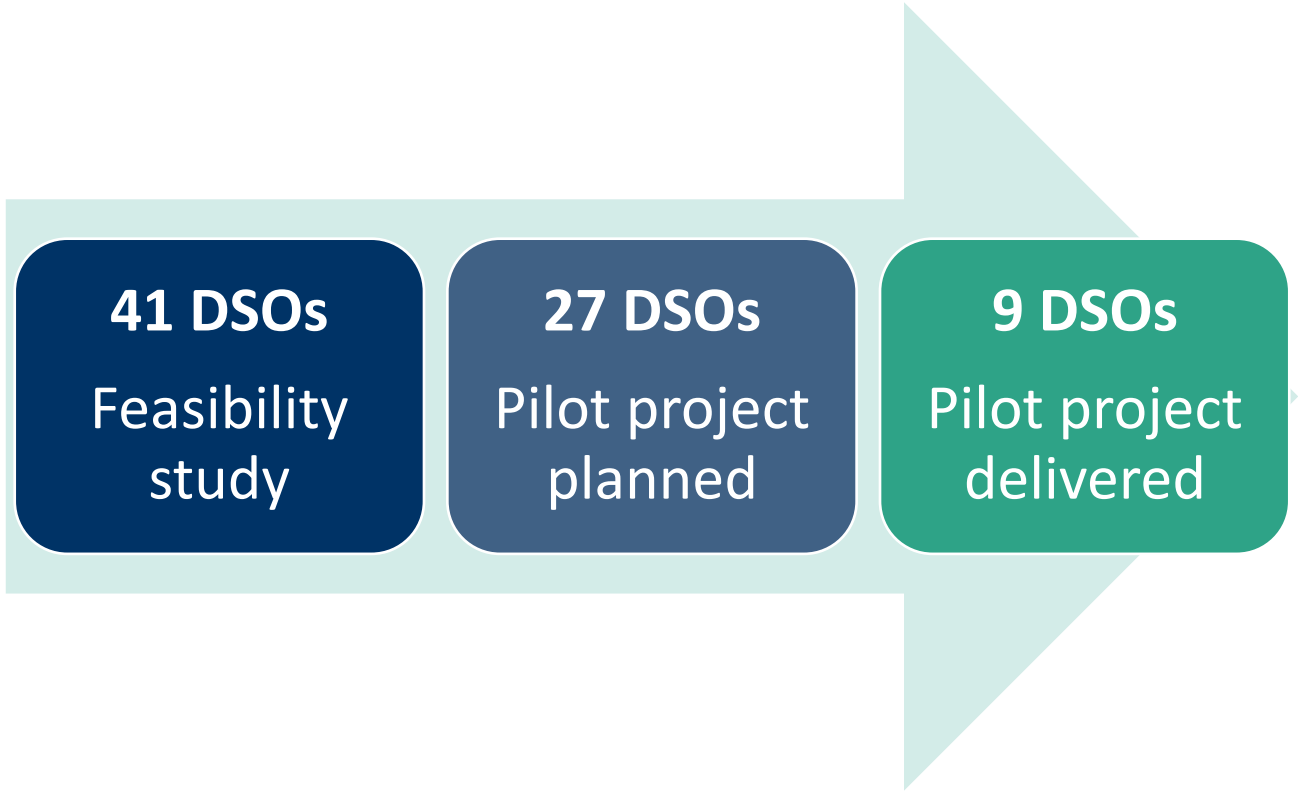
Over recent years we have been building relevant knowledge and experience

Through tens of feasibility studies, planned and successfully executed hydrogen pilots at various blend rates, up to 100%, we have built a body of knowledge in key areas:

- Technical feasibility of network repurposing (network components and material)
- Effect of different levels of hydrogen on end-user appliances (industrial and residential)
- Cost of network upgrading/repurposing
- Safety case of hydrogen
- Future availability and price of hydrogen
- Demand development per customer segment
- Regulatory gaps
- Procedures and working methods (including staff training)



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We are carrying out a wide range of blending and 100% hydrogen projects in Europe

Blending

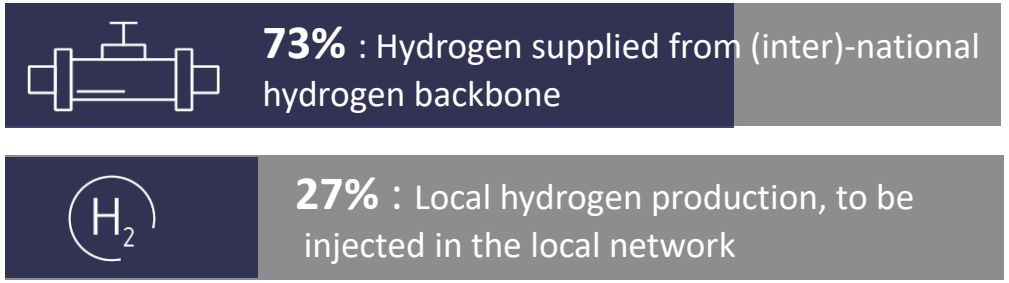
Project	Evidence
GRHYD, France, 2018-2020	• Residential grid in France with up to 20% H2 blend, which ran for 2 years, reducing CO2 emissions by more than 60% and NOx by 40%.Equipment functioned successfully without issues, and without safety concerns of participating voluntary households.
WindGas, Germany, 2012-2016	• Grid blending pilot in Hamburg, Germany from 2012, which ran for 4 years. Locally produced H2 by electrolysis on wind power. • Successful pilot fed 100 000 m3 of H2 into Hamburg grid without complications.
RGC Hydrogen Project, 2020-2025	• Testing and assessing the impact of clean hydrogen and its different mixtures with natural gas on the various parts of the real distribution network (pipelines, valves, meters, other equipment) and gas appliances. 180+ tests on distribution network until 2023 and delivering hydrogen mixture to the end-consumers starting from 2023, identifying necessary changes in the legal and regulatory framework in terms of distribution network operation and maintenance.
Green Pipeline project, Portugal, 2021	• The Green Pipeline Project is a pioneering project in Portugal that, for the first time, will introduce Green Hydrogen into the Natural Gas network. Taking place in a closed network in Seixal, it will distribute a mixture of Hydrogen and natural gas to around 80 consumers in the residential, non-residential and industrial sectors. With injection due to start in January 2022, the mix will contain 2% Hydrogen initially, and gradually increase to 20% within 2 years.
Hydrogen Injection, Denmark, 2021	• Hydrogen injection in Denmark into an isolated high- and low-pressure grid without end users. Successful 4-month pilot with 15% H2 showed no emissions or leakages. Gas grid stations and equipment functioned without issues with a 15% H2 blend
HyDeploy, UK, 2019-ongoing	• Phase 1 successfully provided blended H2 of up to 20% to 100 homes and 30 university buildings. • Phase 2 has been blending up to 20% H2 for 668 houses, a school and some small businesses in Winlaton.
THYGA, 2020-2022	• Closing knowledge gaps regarding technical impacts of hydrogen blends on residential and commercial gas appliances. • The project includes the test of 100 appliances with blends of natural gas and hydrogen up to 60%.

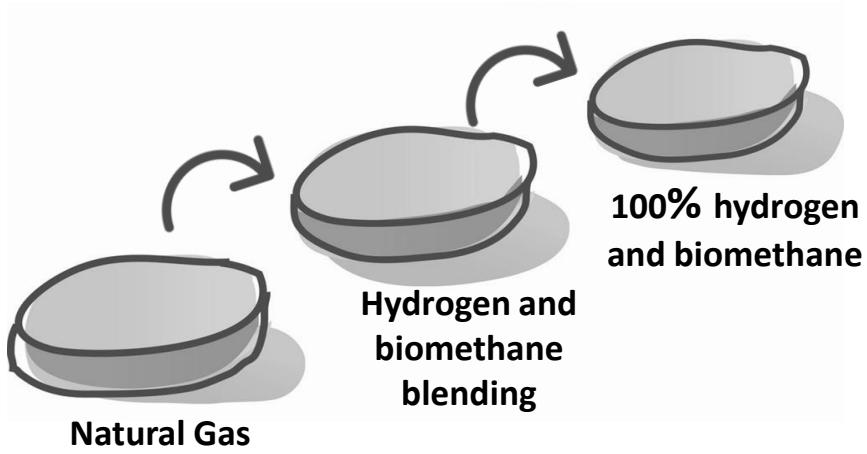
100% hydrogen

Hy4Heat, UK, 2016-2020	• Hy4Heat establishes if it is technically possible, safe, and convenient to replace natural gas with hydrogen in buildings and appliances. • The project provides the technical, performance and safety evidence to demonstrate hydrogen use in buildings heat.
HyStreet and HyGrove, UK, 2019-ongoing	• For HyStreet, a row of terraced houses was constructed at DNV's Spadeadam facility to test the safety of hydrogen in the home. • For HyGrove, two homes have been built with 100% hydrogen appliances, to show to members of the public.
Rozenburg/Stedin, Netherlands, 2019-ongoing	• A project led by gas and power networks operator Stedin aims to show that homes can be heated safely and efficiently with clean (locally produced) hydrogen. Apartments in a residential block are being heated with 100% hydrogen.
HIGGS, 2020-2022	• The project covers the gaps of knowledge of the impact that high levels of hydrogen could have on the gas infrastructure, its components and its management. It includes mapping of technical, legal and regulatory barriers and enablers.

We aim to facilitate both central and local hydrogen production and integrate markets for decarbonised power, gas and heating but we need proper regulation to do it

- **Local production:** We foresee that a considerable share of hydrogen will be delivered from local production directly in distribution networks, in addition to a central hydrogen backbone currently under development.
- **Planning for flexibility:** Therefore, we are planning to manage several sources of local and central hydrogen supply in our networks as we progress from blending to 100% hydrogen.
- **Gas quality:** This means that, as local gas networks, we will need to ensure consistent gas and hydrogen quality for our customers. At the moment, gas quality tends to be managed at transmission level, but with local sources of biomethane and hydrogen, local management will be increasingly important.
- **Regulatory barriers:** We can manage these issues, but our ability to navigate them is currently hampered by:
  - The current lack of regulatory permission formally to manage and convert to 100% hydrogen networks.
  - A lack of national/local mandates on quality management in our networks.
- These regulatory barriers will need to be addressed for us to enable hydrogen and other green gases rapidly and effectively to reduce our customers' carbon footprints.





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Local gas networks face additional challenges to accelerate hydrogen deployment

Regulation

Exclusion of 100% hydrogen delivery by gas networks is a major obstacle, while an EU-wide regulatory framework to support hydrogen uptake is also lacking.

Public perception

The decarbonisation benefits of hydrogen are less well known, and due to the rapid development of hydrogen infrastructure the safety records are currently being analyzed with promising results

Operational mandate

Overall we identified both a need for a stronger operational mandate for local gas networks (DSOs) at a European level, and a need for more operational flexibility at a national/local level to accelerate tailor-made hydrogen solutions for consumers.

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What needs to be done, now

The energy transition will increasingly become more local and distributed, which underscores the necessity of the existing competencies and knowledge of the European DSOs. This requires regulatory frameworks in which the following is recognized:

1. At the EU level the DSOs* should have the possibility to be **allowed to operate dedicated hydrogen grids** (rather than blending in networks only), to be able to facilitate (where appropriate) faster moving local geographies in their transition.
2. Requiring Member States to provide DSOs with a **mandate to engage in blending or distribution of 100% hydrogen**, to facilitate supply from both local (hydrogen and green gas) and TSO sources, and thus to enable fit-for-purpose decarbonisation solutions for local suppliers and consumers.

*The regulation should also be harmonized as fast as possible for the Energy Community's members

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The Ready4H2 alliance is growing. As of 8 December 2021, it consists of 90 European gas distribution companies working together to support net zero

Ready4H2 participating countries:

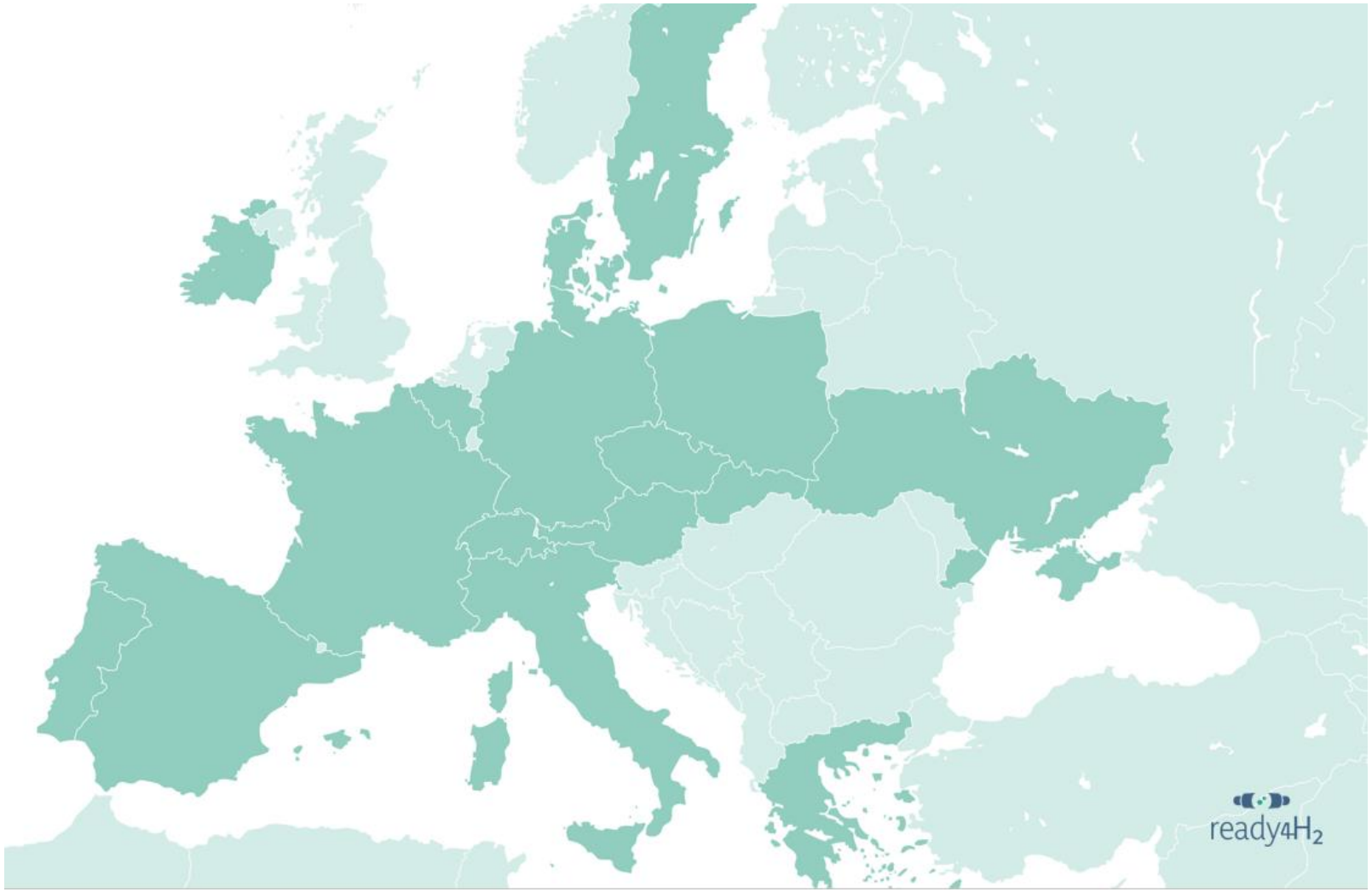
- Austria
- Belgium
- Czech Republic
- Denmark
- France
- Germany
- Greece
- Ireland
- Italy
- Poland
- Portugal
- Slovakia
- Spain
- Sweden
- Switzerland
- Ukraine

90 DSOs

16 countries

Gas & Electricity (62%)

Gas only (38%)



References

- EU Commission Hydrogen Strategy 2020: https://ec.europa.eu/energy/sites/ener/files/hydrogen_strategy.pdf
- DNV ETO Net Zero 2021 https://eto.dnv.com/2021/highlights/pathway-to-net-zero and Eurogas 2020 study https://eurogas.org/website/wp-content/uploads/2020/06/DNV-GL-Eurogas-Report-Reaching-European-Carbon-Neutrality-Full-Report.pdf
- Gas For Climate employment study https://gasforclimate2050.eu/sdm_downloads/demo-download/
- CO_2 emissions of France in 2020 – 277 million tonnes https://ourworldindata.org/co2/country/france#what-are-the-country-s-annual-co2-emissions
- Pipeline vs truck costs: For one-way distances of 20-30km, DNV analysis shows that the levelised cost of hydrogen transport by truck is €0,24 per kg, compared with €0,06 per kg by pipeline. And as distances increase, the costs of truck transport also increase by far more than the costs of pipeline transport.
- Industry connections: The 2020 monitoring report of the German gas regulator (Bundesnetzagentur) shows that there are 1 768 300 industrial, commercial and other non-residential connections to Germany gas distribution networks, compared with 500 such connections to gas transportation networks i.e. 99,97% of such connections are to distribution networks. See p.337 https://www.bundesnetzagentur.de/SharedDocs/Mediathek/Berichte/2020/Monitoringbericht_Energie2020.pdf;jsessionid=472291664C839665B7F41CCA9033EA92?__blob=publicationFile&v=8. Data for other European countries, including Spain, France and Denmark, provided by Ready4H2 members – all at 99,9%.
- CO_2 savings: Calculation based on natural gas combustion emissions of 184,21 gCO2/kWh (UK Government GHG Conversion Factors for Company Reporting, 2020) and natural gas supply chain emissions of 35,3 gCO2/kWh (H21 North of England, 2018). For green hydrogen using renewable electricity, emissions are assumed as zero, and so the saving would be 219,51 gCO2/kWh – this means that total emissions savings for green hydrogen, compared with the 1 870 TWh of gas used in the distribution networks of the alliance members, would be 410 million tonnes. For blue hydrogen, the natural gas supply chain emissions are assumed to be 25% higher than for natural gas use (given an assumed blue hydrogen production efficiency of 80%), and the emissions associated with blue hydrogen production are assumed as 14,47 gCO2/kWh (H21 North of England, 2018), so the saving would be 160,92 gCO2/kWh – this means that total emissions savings from blue hydrogen, compared with 1 870 TWh of natural gas, would be 301 million tonnes.
- Biomethane plants: Gas Infrastructure Europe and the European Biogas Association https://www.europeanbiogas.eu/wp-content/uploads/2020/06/GIE_EBA_BIO_2020_A0_FULL_FINAL.pdf
- HyDeploy: https://hydeploy.co.uk/about/news/first-uk-trial-of-hydrogen-blended-gas-hailed-a-success/ and https://hydeploy.co.uk/app/uploads/2018/02/21063_2PP_HyDeploy_Carbon_Savings_Handout_DIGITAL.pdf
- Hy4Heat safety assessment: https://www.hy4heat.info/wp7
- HyStreet: https://www.dnv.com/oilgas/perspectives/heating-homes-with-hydrogen-proving-the-safety-case.html
- HyGrove: https://www.northerngasnetworks.co.uk/2021/07/15/first-hydrogen-homes-open-to-the-public/
- H100 Fife: https://www.sgn.co.uk/H100Fife
- RGC Hydrogen Project, 2020-2025 https://rgc.ua/en/cleanenergy

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