Ready4H_2:
Europe's Local Hydrogen Networks

PART 2: The value of local hydrogen distribution networks in a decarbonised Europe

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Contents

This is part two of a series of three Ready4H_2 reports - https://www.ready4h2.com

Executive summary (Ready4H_2 part 2)

For decades European local gas networks have shown the ability to deliver reliable, cost-effective and safe pipeline distribution to millions of customers. The Ready4H_2 alliance believes that local gas networks will also add value to address the challenges to achieve the huge growth and carbon reduction potential of hydrogen in Europe.

1. Gas infrastructure provides the means to cope with rapidly growing shares of variable wind and solar power by transporting hydrogen from decentralized production to consumers and the European hydrogen market.
2. Gas infrastructure has the capacity to handle large seasonality in demand (between summer and winter by a factor of 2 to 6) providing reliable supply of hydrogen even during the coldest winters. Large scale hydrogen underground storage facilities linked to gas networks are the only fast-acting, long-lasting (days to weeks) storage capacity at enormous scale to cope with variable power production and demand for gas among European consumers.
3. Local gas networks provide a flexible decarbonisation pathway for customers as they are well-positioned to distribute and manage varying local blends of molecules and, to a large extent, are ready to convert relatively quickly to adapt 100% hydrogen.
4. As 99% of industrial and commercial gas end-users are connected to local gas networks, we are crucial to bring the European hydrogen backbone to life and deliver large volumes of hydrogen to millions of customers. Local gas network will facilitate a competitive hydrogen market, meaning more hydrogen for users at a cheaper price.
5. Local gas networks provide a cost-efficient pathway. Cost analysis shows that in a decarbonisation scenario including significant volumes of hydrogen and green methane, investment in the combined power and gas infrastructure is estimated to save 41 bn EUR/year compared to a power dominated scenario. Essentially, spending a few billion a year more on gas infrastructure saves tens of billions per year of power infrastructure investment development per year
6. Local gas networks have a lot to offer meet Europe's ambitious climate goals. The Ready4H_2 consortium sees a clear role for local gas networks in the transition process towards net-zero.

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Introduction

Local gas networks and the Ready4H_2 initiative

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European local gas networks have always delivered cost-effective and safe energy to consumers

HOUSEHOLDS: Ready4H_2 alliance networks keep 64 million households warm in winter and supply a further 12 000 CHP plants to run district heating systems.

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

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

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

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

INNOVATION: We are providing the critical evidence and gained fundamental practical experience from many hydrogen pilots and research projects and previous towns gas conversion.

Ready4H_2: Transforming local gas networks and supporting climate neutrality across Europe

- For decades **European local gas networks** have shown the ability to deliver cost-effective, reliable and safe pipeline gas distribution
- **The Ready4H_2 alliance** represents 90 European gas distribution companies and aims to combine their hydrogen expertise and experience. The alliance believes that local gas networks, in strong coordination with gas transmission and storage infrastructure, are essential to achieve the huge growth and carbon reduction potential of hydrogen. We will deliver a faster energy transition and deeper emissions reductions to support Europe's decarbonisation ambitions.
- In this **Part 2** (of a series of 3) we show how European local gas networks will add value to future hydrogen developments, complementary with green methane developments, setting out:
  - Why green electrons and green molecules are needed to meet net zero;
  - How local gas networks can enable hydrogen for millions of customers;

The Ready4H_2 project consists of three studies:

PART 1 — **LOCAL GAS NETWORKS ARE GETTING READY TO CONVERT** Link

PART 2 — **THE VALUE OF LOCAL HYDROGEN NETWORKS IN A DECARBONISED EUROPE**

PART 3 — **ROADMAP FOR HOW THE DSOs WILL TRANSFORM INTO EUROPE's PRIMARY HYDROGEN DISTRIBUTION**

Hydrogen is key to net zero, and local gas networks are crucial to meet Europe's ambitious climate goals.

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The Ready4H$_2$ alliance is growing. As of March 2022, it consists of 91 European gas distribution companies working together to support net zero

Ready4H$_2$ participating countries:

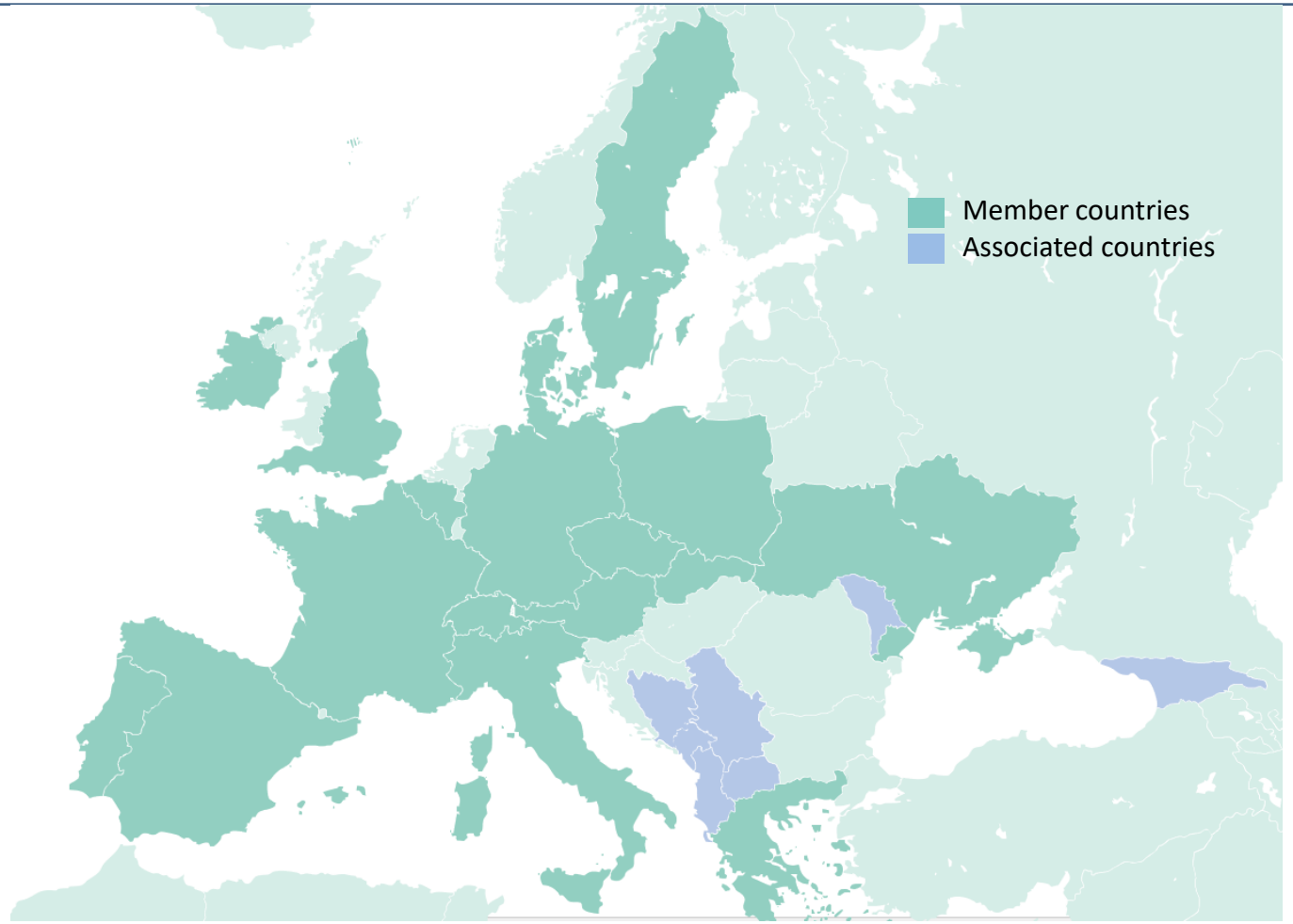
- Austria
- Belgium
- Czech Republic
- Denmark
- England
- France
- Germany
- Greece
- Ireland
- Italy
- Israel
- Portugal
- Poland
- Switzerland
- Slovakia
- Spain
- Sweden
- Ukraine

91 DSOs

18 countries

Gas & Electricity (62%)

Gas only (38%)



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Local gas networks can address the challenges of the future energy system

and provide a flexible and low-cost route towards net-zero

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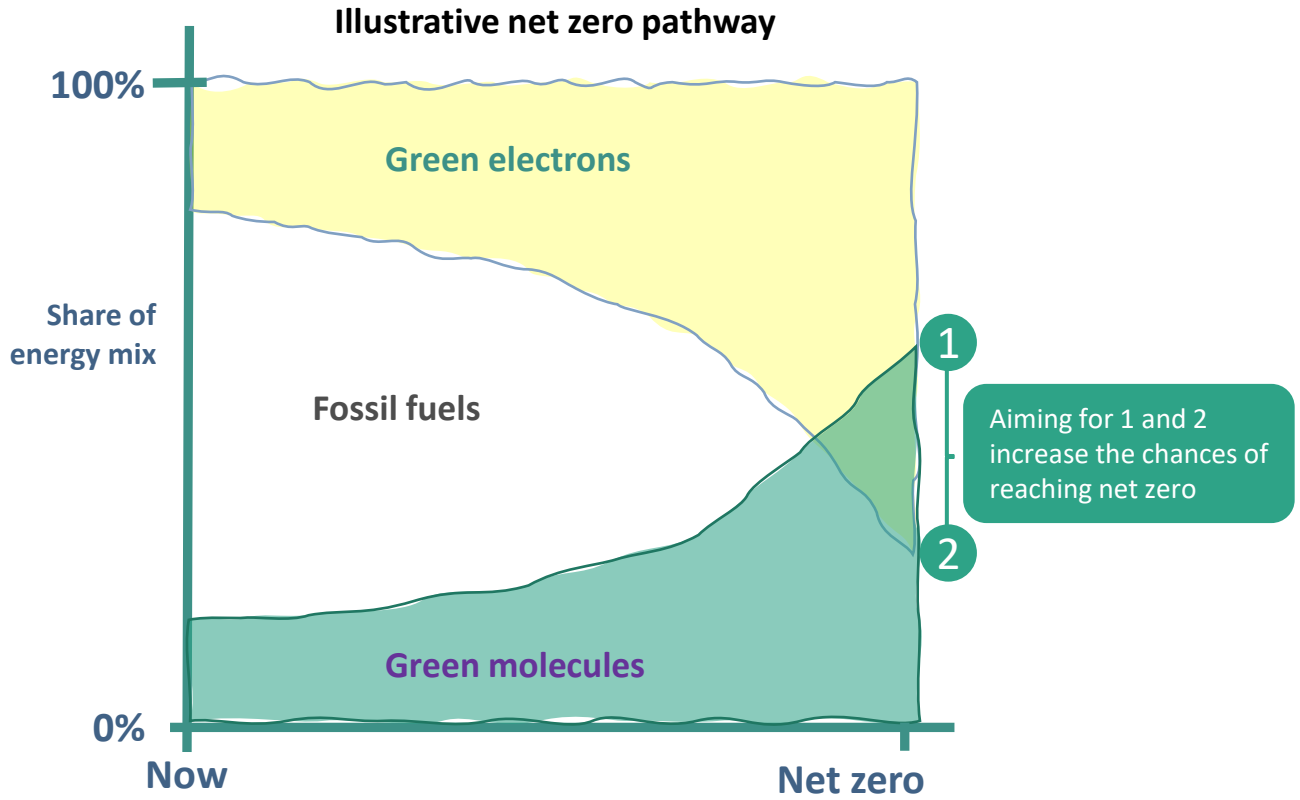
Europe needs green molecules and the infrastructure to deliver them

- Europe's transition towards a decarbonised energy system will radically transform how energy is generated, transported, stored, distributed and consumed.
- **Europe's energy transition will require hydrogen and green methane at large scale alongside energy efficiency and electrification.** Green molecules offer a versatile, clean, and flexible energy vector for this ambitious transition. While hydrogen and green methane are not the only decarbonisation levers, they are essential to meet net-zero by mid century.
- **Hydrogen could alone provide up to 24% of the EU's energy mix by 2050** according to the Fuel Cell and Hydrogen Joint Undertaking**.** Adding biomethane to the energy mix and potential in different end user segments, Ready4H_2 expects a greater potential in some national scenarios for green molecules [12,13,14, 15]
- A net zero Europe needs both green electrons and green molecules. Ambitious targets in both areas means a higher chance of reaching net zero in 2050



Local gas networks enable easy distribution of green molecules to customers across Europe

Gas infrastructure can manage strongly growing variable renewable power production

Wind and solar power production will grow rapidly:

- In the coming decades, the European energy system will become increasingly reliant on non-dispatchable generation, with both wind and solar capacity forecast to rise to nearly 1000 GW. As the share of renewables increases, the impact of variability in renewable power also grows.

The impact of cloudy and windless winter weeks will therefore increase:

- Specific weather conditions (no wind, clouds and seasonal changes in availability of sunlight) can lead to a sustained reduction of wind and solar power generation. Europe has regular overcast winter weeks with low wind speeds. This occurs on average several times a year for a period of several consecutive days – much longer than batteries can provide back up for. Hydrogen storage and networks will provide the stability.

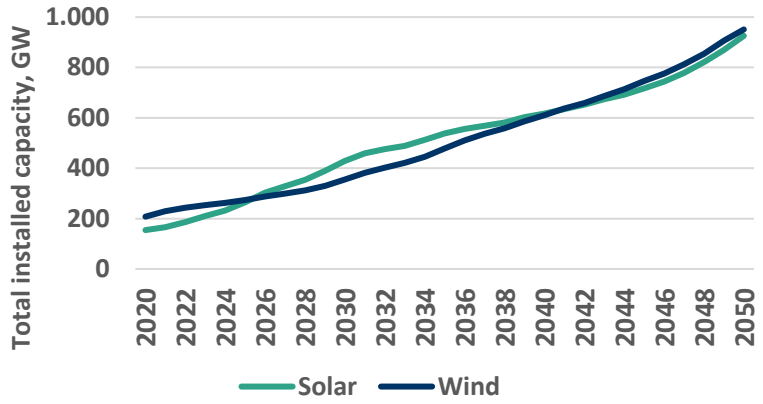
Storage delivered by gas infrastructure is critical to managing these periods:

- To ensure continued energy supply during these periods, fast-acting, long-lasting storage capacity at enormous scale is needed – which is provided by large scale underground storage facilities linked to gas networks. Gas storage in a number of European countries is enough to meet gas demand for 3 months, compared with electricity storage that can meet less than 1 day of electricity demand.

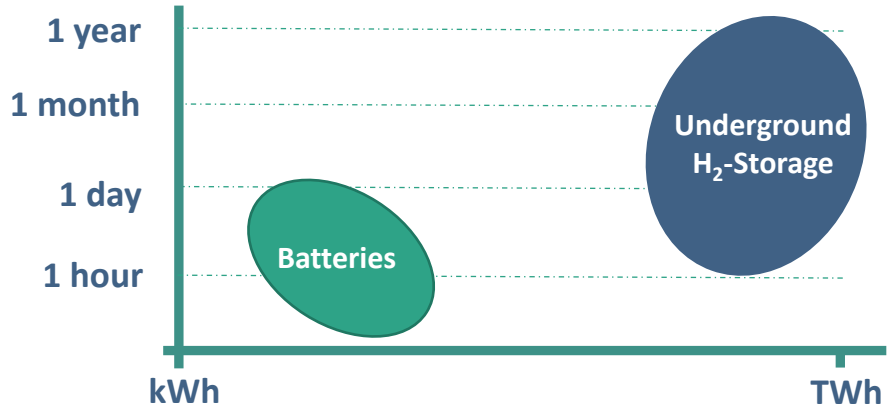
Hydrogen can benefit from this infrastructure

- Many of these gas storage facilities can be repurposed to hydrogen, ensuring continuous hydrogen supply to users. In addition, applications that run on hydrogen do not burden the electricity system, reducing the risk of power shortages.
- In this case gas infrastructure can make the hydrogen supply chain stronger and support renewable power production and use.

Build up of solar and wind in Europe



Battery and underground hydrogen storage compared



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Local gas infrastructure is designed to meet seasonal demand peaks

Heat demand in many European countries is strongly seasonal:

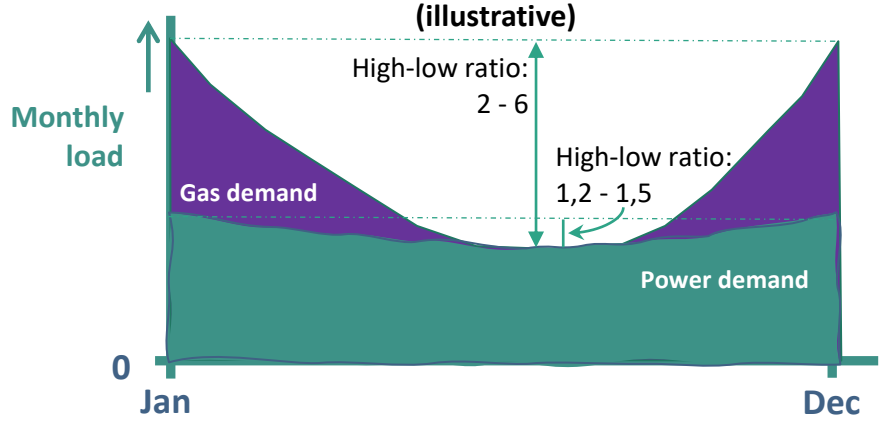
- A large portion of **gas demand** has always been temperature-driven, reflecting the way gas is used in many countries for heating purposes. Gas demand reflects this seasonality in heat demand, with average monthly gas demand fluctuating between summer and winter by a factor of 2 to 6.
- By contrast, peak winter **electricity demand** is only factor 1,2-1,5 higher than in summer.

Gas infrastructure is designed to meet the coldest winters:

- Today's **gas infrastructure** has been built to cope with large seasonality, providing reliable supply even during the coldest winters.
- **Electricity infrastructure** deals mostly with demand that is comparably flat over the course of the year. Therefore, there would be extraordinary challenges and investments for electricity generation, storage, transmission and distribution from heating electrification.

Today's gas infrastructure, with some local changes, can meet peak demand for hydrogen and green methane for millions of end-users, becoming a pillar of sector integration.

European seasonal load pattern for gas and power (illustrative)



Gas networks keep houses warm during cold winters

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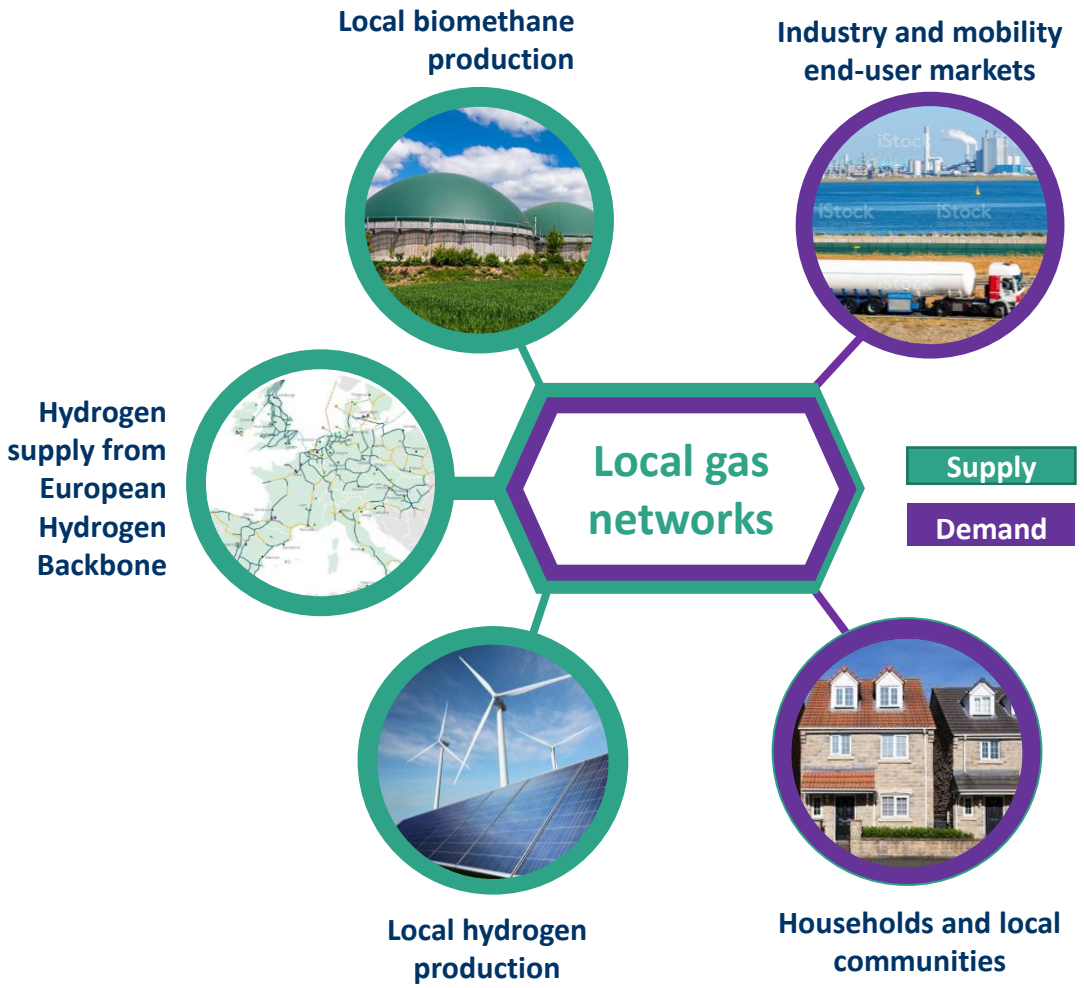
Local gas networks are flexible hubs connecting supply and demand, and are ready to convert to hydrogen

- **Local gas networks are flexible** and can distribute and manage varying blends of molecules, depending on the local mix of supply and demand. They connect large portions of end-users and provide decarbonisation options for millions of European consumers, businesses and industries and at the same time give local producers of hydrogen and biomethane a cost effective route to market. They can offer rapid decarbonisation with no changes for many consumers through blending of hydrogen and green methane.
- Local gas network are to a large extent ready for hydrogen. Currently, more than **1 million km of the pipeline material is ready for conversion to pure hydrogen, representing > 95% of the combined network of Ready4H$_2$ members**. The readiness of components (connections, valves, metering equipment, compressors, etc.) is under evaluation.
- Given the importance of hydrogen and other green molecules, the EU's framework to decarbonise gas markets states that national network development plans should be based on a joint scenario for electricity, gas and hydrogen to cover the energy needs of buildings, industry and transport.
- Local gas network are key to managing the complexity of joint planning, as they are the crucial hubs connecting numerous sources of (local) hydrogen supply with most end-users.



99% of industrial, CHP and commercial gas end-users are connected to local gas networks

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Local gas networks will facilitate a competitive hydrogen market, meaning more hydrogen for users at a cheaper price

Local gas networks can bring the hydrogen backbone to life:

- As we showed above, 99% of industrial and commercial gas end-users are connected to local gas networks. The hydrogen backbone can not only be used directly to decarbonise a small number of large users, but to fully decarbonise industry, combined heat and power (CHP) and other sectors, local gas networks will be needed to distribute hydrogen from the backbone.
- The customers connected to the distribution grid will generate the demand that is needed for the creation of the European hydrogen backbone and allow for transmission pipelines to be converted.

Local gas networks can also provide a route to market for local producers:

- As we also showed, local gas networks can connect local green H_2 producers with demand across Europe, including solar and wind farms with constrained electricity grids.
- The hydrogen backbone take time to be fully constructed. Local hydrogen networks can connect local producers and consumers more quickly and cost effective

Combined, this will lead to a more competitive market and lower prices:

- By connecting more users across Europe, local gas networks can help to increase the size and competitiveness of the hydrogen market, reducing costs to consumers.
- A competitive hydrogen market will help to keep industry in Europe. In many cases, hydrogen will be the most cost-effective decarbonisation option for local industry, so a local hydrogen network will help to reduce carbon leakage.

European Hydrogen Backbone, 2022

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Investing in local gas networks will provide energy infrastructure savings overall

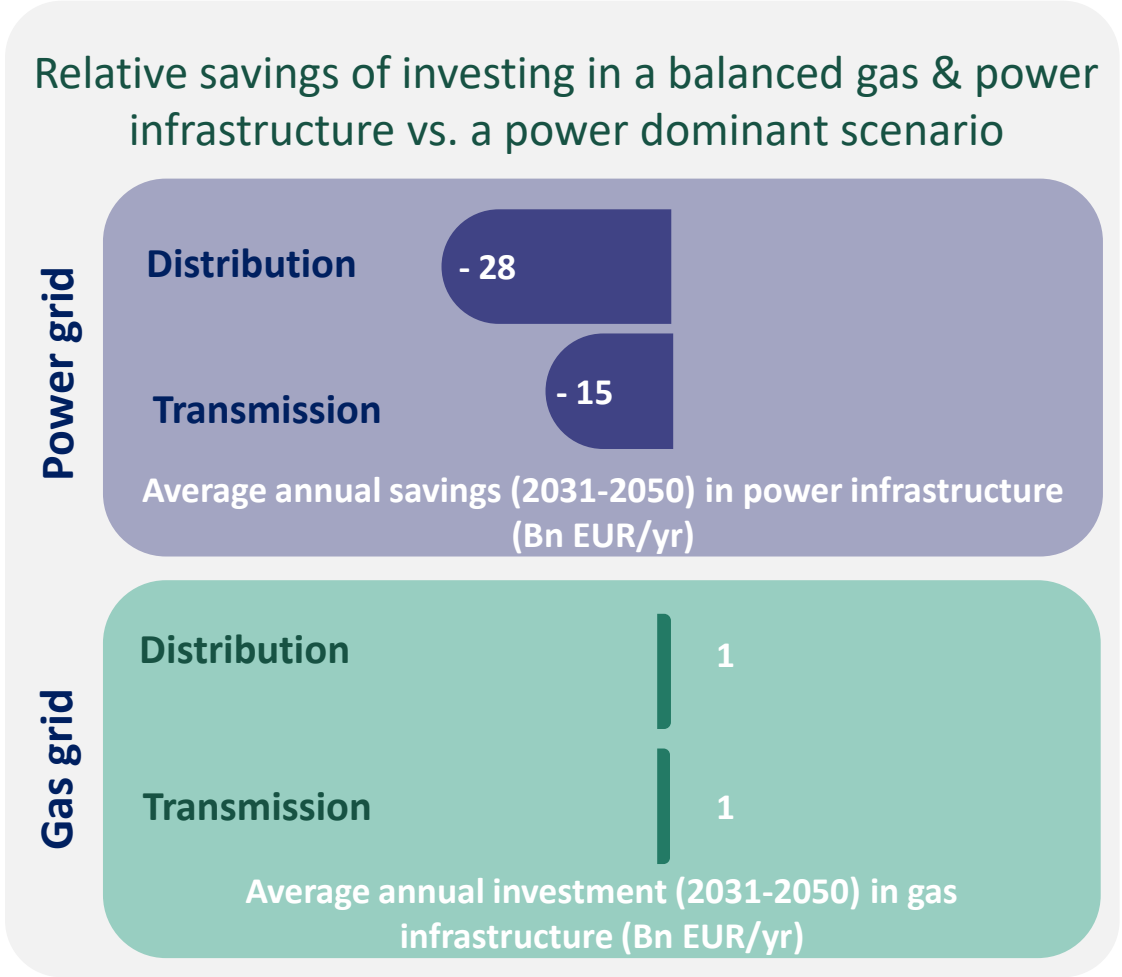
The Eurogas study [3] presents insights on CAPEX for two net zero decarbonisation scenarios: one having a balanced power & gas mix, and another relying strongly on electrification. From the 2031 -2050 investment analyses two key observations can be made.

1. Lower energy infrastructure CAPEX in a balanced gas and power scenario

- Analysis shows that in a decarbonisation scenario including significant volumes of hydrogen and green methane, investments in the combined power and gas infrastructure is estimated to be around a third lower summarizing to an average annual **saving of 41 bn EUR/year in power and gas infrastructure.**
- There is a need for investment, but a relatively small additional investment in gas infrastructure will save tens of billions in power infrastructure development per year.

2. To deliver these savings, local networks (gas and power) need investment

- In both scenarios, local gas and power grids have the biggest investment need moving to net-zero by mid century.



In summary, hydrogen is key to net zero, and local gas networks are crucial to meet Europe's ambitious climate goals

Local gas networks **connect producers** of climate neutral gas with **customers in all sectors** aiming for decarbonisation through flexible distribution structures

By leveraging and converting existing infrastructures, local gas networks can deliver hydrogen for millions of European customers

Local gas networks can enable a substantial hydrogen market and are essential to **meet Europe's climate goals**

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References

1. Ready4H_2, 2021- Europe's Local Hydrogen Networks – part 1: Local gas networks are getting ready to convert - link
2. EU Commission Hydrogen Strategy 2020 - link
3. Eurogas, 2020 - European Carbon Neutrality: The Importance of Gas - link
4. FCH, 2019 - Hydrogen Roadmap 2019 - A sustainable pathway for the European energy transition - link
5. DNV, 2021 - Energy Transition Outlook 2021 - Europe regional forecast - link
6. DNV, 2021 - Energy Transition Outlook 2021 - Pathway to net-zero emission - link
7. Frontier economics , 2019 - The value of gas infrastructure in a climate-neutral Europe - a study based on eight European countries - link
8. European Hydrogen Backbone 2020 - How a dedicated hydrogen infrastructure can be created - link
9. European Hydrogen Backbone, 2021, Extending the European Hydrogen Backbone – a European hydrogen infrastructure vision covering 21 countries - link
10. European Hydrogen Backbone - Analysing future demand, supply, and transport of hydrogen - link
11. European Association for Storage of Energy, 2021 - Market Analyses March 2021 – link
12. The Danish minister of Climate and Energy on biomethane potential in Denmark, February 2020 – link
13. European Hydrogen Backbone, The future role of biomethane – link
14. DVGW 2019 - Ermittlung des Gesamtpotentials erneuerbarer Gase zur Einspeisung ins deutsche Erdgasnetz – link
15. Impact of the use of the biomethane and hydrogen potential on trans-European infrastructure – link

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