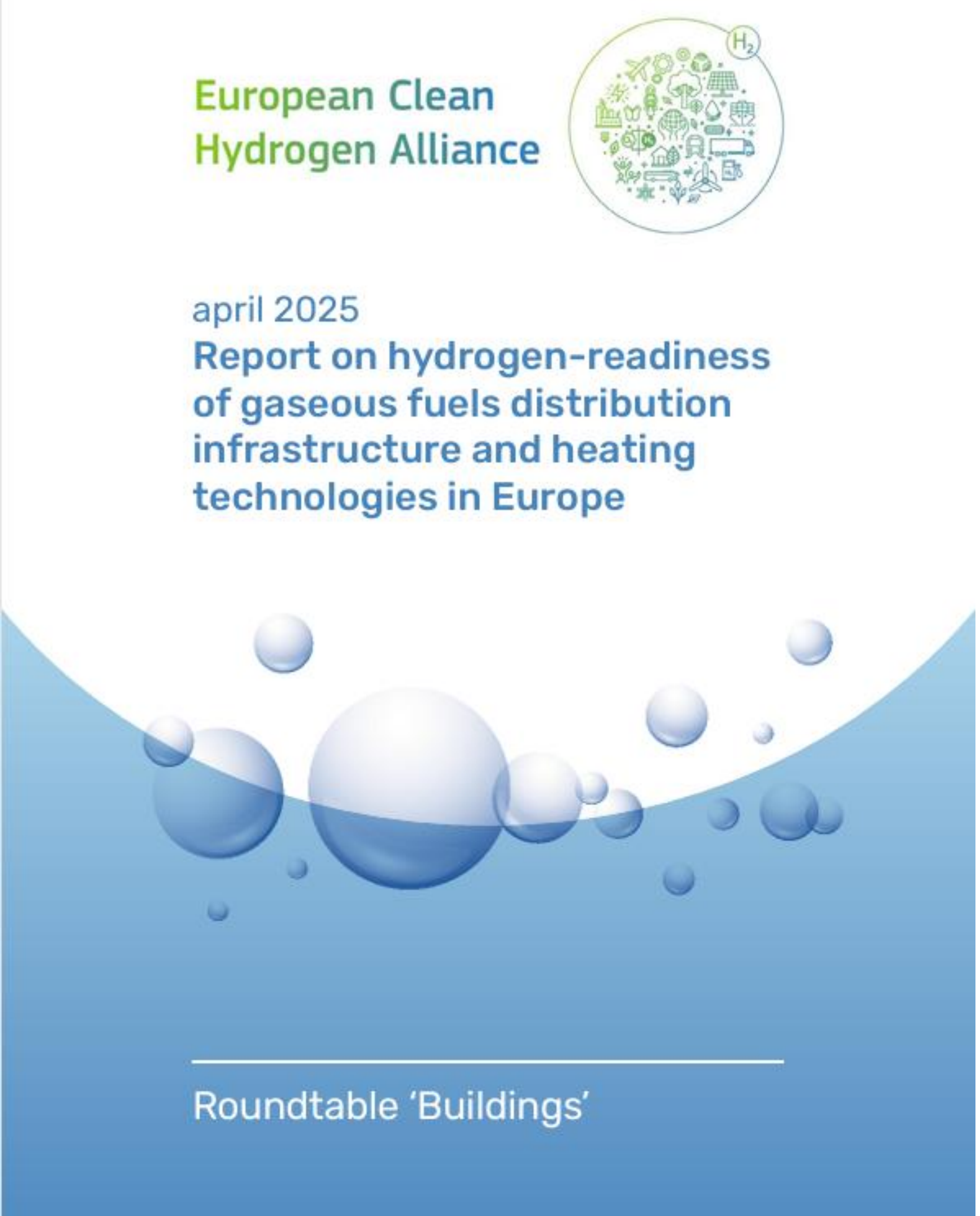

Report on hydrogen-readiness of gaseous fuels distribution infrastructure and heating technologies in Europe

Main takeaways

Alliance's Buildings Roundtable

Thursday 15 May 2025

Agenda

- Introduction
- Hydrogen readiness of gas grids (REN Portgàs)
- Hydrogen readiness of heating technologies (EHI and INNIO)
- Lessons learnt from field projects – Focus on Green Pipeline Project (Floene)

European Clean Hydrogen Alliance

A Report based on facts, not estimates or forecasts

Members of the Buildings Roundtable of the EU Clean H2 Alliance

Manufacturers | Distribution grids | EU Associations | Local authorities | Civil Society

Objective of the Report

Show most recent technological developments allowing the use of hydrogen in end-sector 'buildings' & distribution networks.

Sources for the Report

1. Existing and publicly available reports.
2. Know-how from Round Table industry members.

Focus on three pillars: networks, appliances & lessons learnt

Readiness of gas grids	Readiness of heating appliances	Lessons learnt from field projects
Focus on distribution grids specifically Both H2 blends and pure H2	H2-Readiness of the installed stock for H2 blend H2 ready-to-install technologies	Three different projects in The Netherlands, Portugal and Germany

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Readiness of gas grids

Nuno Fitas Mendes,

CEO of REN Portgás

Co-chair of the Buildings Roundtable

Natural gas grids can be repurposed to use other gases

Europe's existing gas infrastructure supplies around **40% of Europe's homes and commercial buildings** through its 2.200.000 km of pipelines, valued at **more than EUR 260 billion**.

Given that hydrogen is a gas, the existing gas infrastructure has been identified as a possible way to distribute hydrogen, breaking the H2 chicken-egg dilemma.

Several initiatives were developed to test how these infrastructure reacts to hydrogen integration, both blended and pure, and identify technical issues.

Grids can adapt to two possible H2 applications: in blends or in pure form

Hydrogen can be used in pure form or blended with methane-based gases. Today, in Europe there are projects assessing blends of hydrogen with methane-based gases, and projects studying pure hydrogen.

Blends H2+CH4:

+ Installed gas appliances can handle up to 20%vol H2

+ Existing grids can accommodate H2 immediately

+ Integration with biomethane, increasing decarbonisation

- Gas Quality Tracking System required due to variable gas properties

- Some end-use equipment, such as those used by heavy industry may need to be adjusted to work with blends

Pure Hydrogen:

+ Grid can be operated as the existing ones

+ H2 appliances are already market available

+ Gas Quality Tracking System not required

- Conversion must be done for all connected consumers

- Large amount of H2 needed to start and maintain continuous security of supply

Three steps to adapt a gas network to hydrogen

Assess grid components: Evaluate materials, construction, and history using standards or studies to identify issues for safe hydrogen distribution.

Create a roadmap: Develop a budget-linked roadmap for grid repurposing, tailored to each operator's specifications and compliant with national laws.

Implementation: Roadmap's implementation can be adjusted according to budget and/or based on hydrogen production and consumption.

Projects confirmed gas networks are hydrogen-ready

Ready4H2 Project with over 70 European gas companies assess hydrogen readiness, identify upgrades, and share best practices. This project concluded that **96% (1.151.000 km) of pipelines are ready for hydrogen**, with 4% (ductile or grey cast iron or other unknown materials) need further investigation.

HyDeploy project in the UK demonstrated that **blending 20%vol hydrogen** into the natural gas grid "***does not interact negatively*** *with existing materials used within* ***infrastructure like network pipes or in homes or businesses*** *such as boilers, hobs, cookers, or meters.*"

H21 project in the UK provided clear evidence that **is technically possible to convert a gas network from natural gas to pure hydrogen.**

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Hydrogen readiness of gas networks (4)

A concrete application - Readiness of REN Portgas distribution grid

REN Portgás is Portuguese DSO operating on the north coastal region of Portugal. Its grid has more than 5.900 km, connecting more than 406.000 consumers, representing circa 10% of Portuguese natural gas total consumption.

Prior to hydrogen injection, an assessment was elaborated based on scientific studies and partnerships with academia, international entities, and product providers, supervised by the certifying entity *Bureau Veritas Rinave*.

In this assessment it was concluded that up to **10% hydrogen injection is feasible without additional investment**. 20% and 100% H2 scenarios require **small infrastructure adjustments, representing a 3-5% investment** over the gross assets value. A roadmap was created with these conclusions and actions that is already on going.

The integration of renewable hydrogen and biomethane requires the need to control continuous gas quality monitoring and managing complex, interconnected network systems. For that it is necessary to **develop new IT systems for real-time gas quality monitoring and accurate billing**.

A concrete application - Readiness of REN Portgas distribution grid **(2)**

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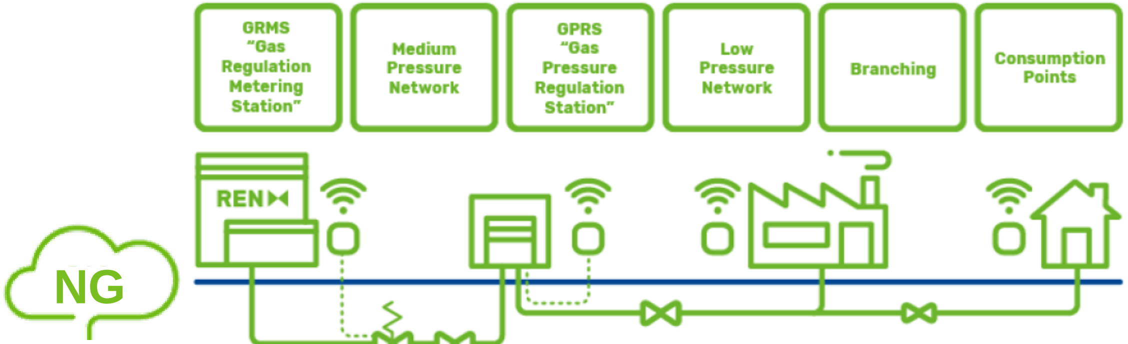

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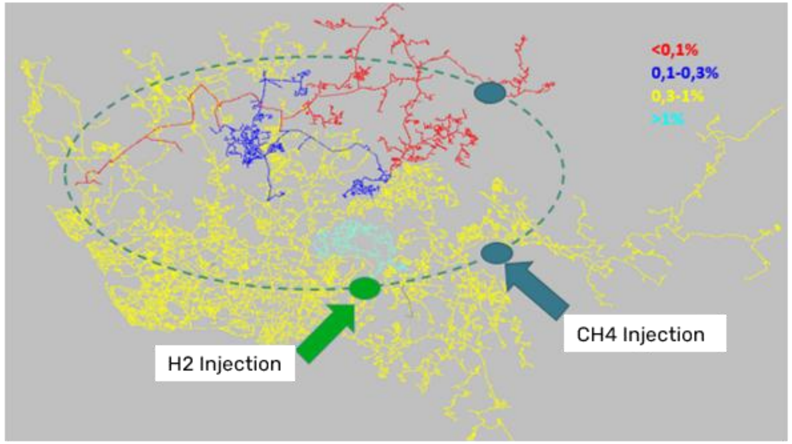
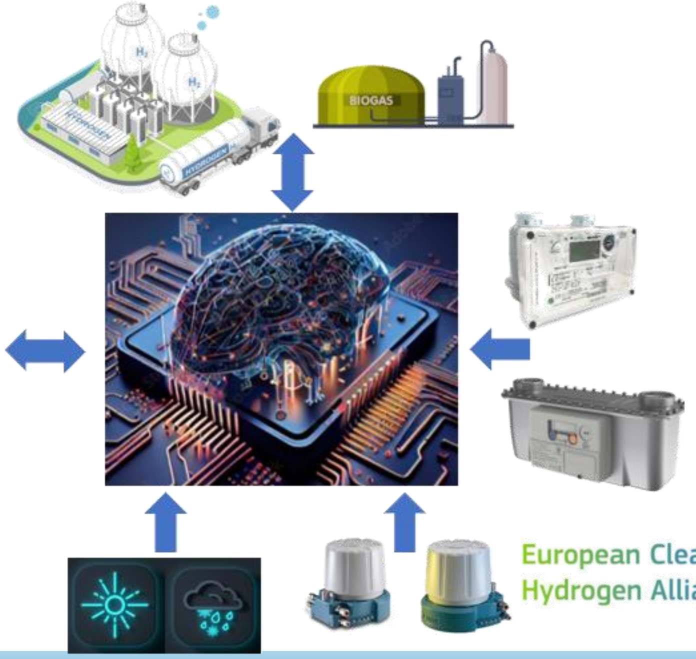




Readiness of heating appliances

EHI

Facilitating Organisation of the Buildings Roundtable

& Klaus Payrhuber,

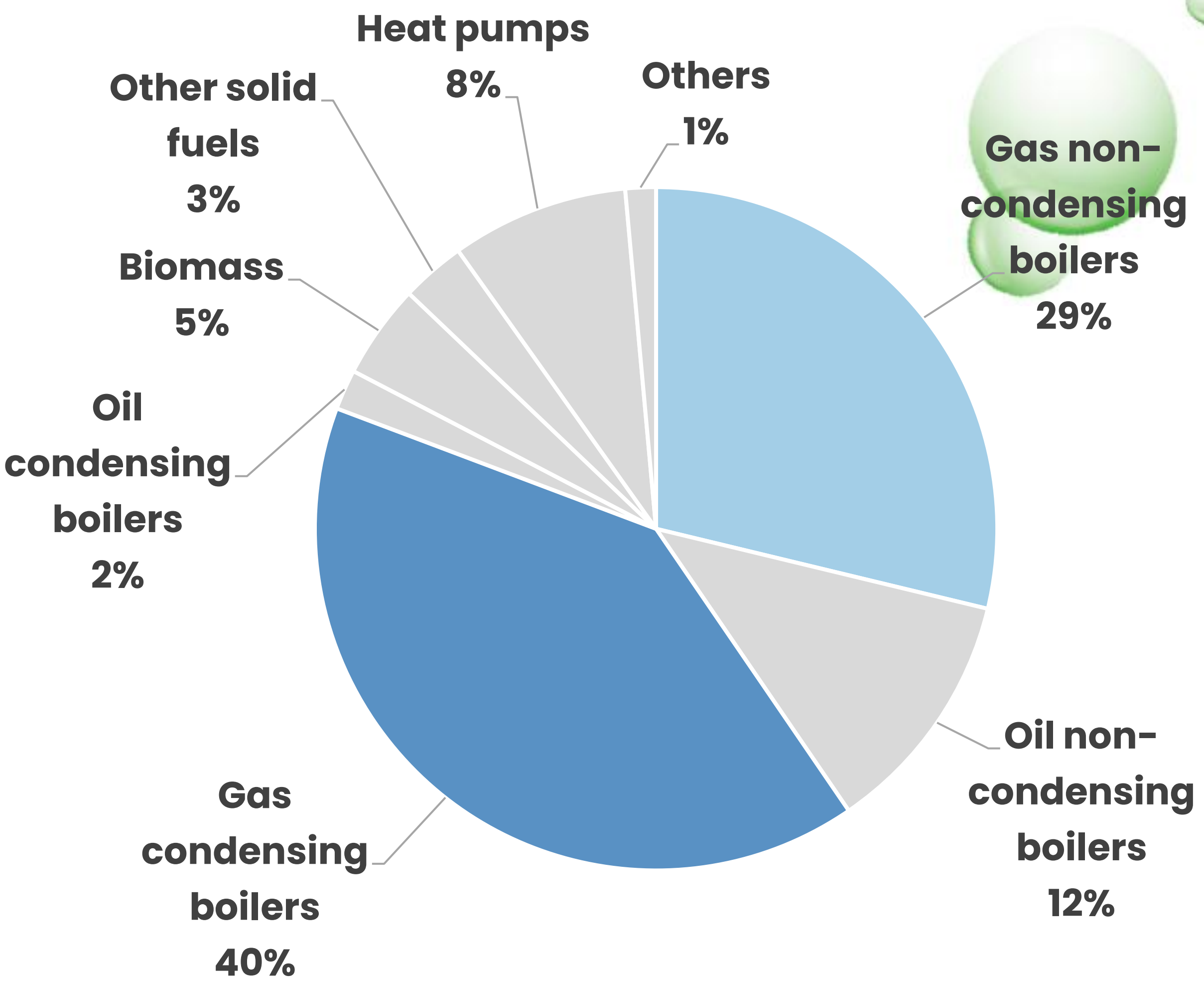
Strategic Product Development, INNIO Jenbacher & Co-chair of the Buildings Roundtable

Relevant portion of installed heating appliances can already operate with blends of hydrogen & gas

Most modern gas condensing boilers can safely operate with hydrogen blends up to 20%vol without significant modifications.*

Some adjustments relating to specific components (e.g. burners and flame sensors) needed for older models.*

* According EU-funded THyGA (Testing Hydrogen Admixtures for Gas Appliances) project



2023 total hydronic space heaters EU 27: 110.727.000 pcs

Some examples of 100% hydrogen-ready technologies available today: H2 ready boilers

H2-ready boilers - Boilers working with methane-based gases today, that can be converted into 100% hydrogen with a kit to adapt some of the components (e.g. burners, flame sensors) to H2 properties.

Relevant for the grids that are planning to be repurposed to pure hydrogen.

100% H2 boilers – Pure hydrogen boilers already exist today and can be connected to gas grids that converted to pure hydrogen.

Source: Vaillant Group

Some examples of 100% hydrogen-ready technologies available today: hybrids, thermally driven heat pumps

Source: Ariston Group

Hybrid heat pumps – Combination of a heat pump with a condensing boiler. They can be operated and managed with one control to grant the most efficient use of each energy source.

The condensing boiler can be powered by hydrogen (up to 20%vol in case of blends but also 100% H2 directly).

Thermally-driven heat pumps (TDHP) – TDHP are using gaseous fuels such as natural gas or biomethane to transfer heat present in the environment to the interior of buildings.

They can be convertible to pure hydrogen by adapting a few components similarly to condensing boilers (e.g. burner system, ignition and safety controls).

Source: Ariston Group

Some examples of 100% hydrogen-ready technologies available today: CHP, mCHP, fuel cells

Source: INNIO Jenbacher

Combined Heat and Power (CHP) – CHP are systems producing power and heat, using different gaseous fuels. Existing CHP can deal with up to 25% vol of hydrogen and some can run on 100% H2 without stringent hydrogen purification requirements (next slide).

micro-Combined Heat and Power (mCHP) – They are a sub-segment of CHP and can be used in commercial and public buildings, apartments, individual homes, or small residential collectives.

Fuel cells – They produce electricity and heat based on an electrochemical reaction instead of a combustion process. Different types of fuel cells (SOFC and PEM*) are already 100% hydrogen-compatible. They require high hydrogen purity.

* Solid Oxide Fuel Cell and Polymer Electrolyte Membrane

Source: Bosch Group

ean
liance

RAG underground Hydrogen storage, Austria

Seasonal renewable energy storage

Summer operation

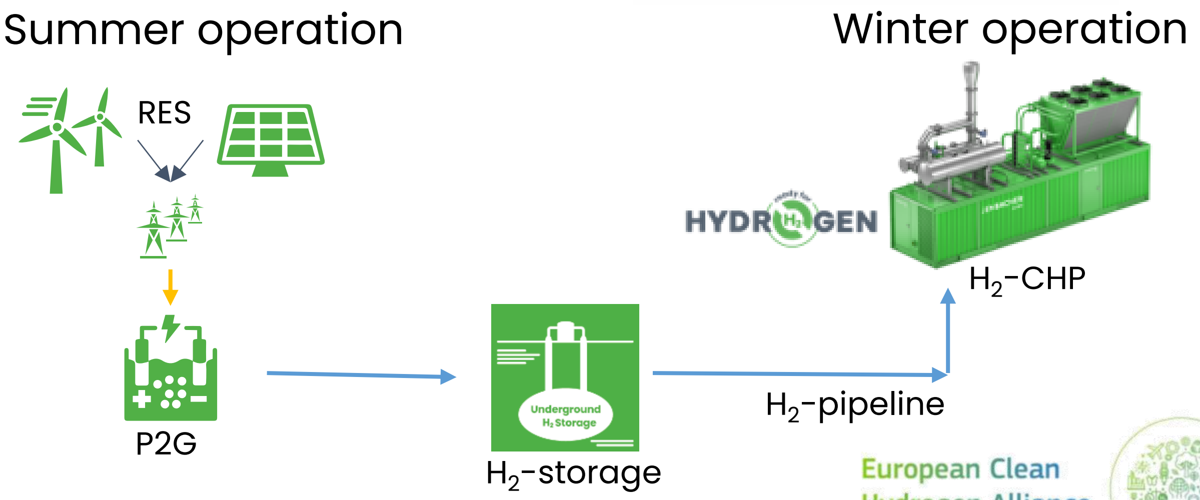
- Solar PV overcapacity
- 2 MW electrolyzer for green H_2 production
- H_2 compression

Seasonal storage

- 1.2 mio. Nm^3 H_2 storage as modified NG storage
- Gas chromatograph at H_2 discharge
- 8 km H_2-pipeline from H_2-storage to CHP unit
- Up to 600 Nm^3/h H_2-pipeline capacity

Winter operation

- J412 containerized CHP
- 530 kW electrical output and 550 kW heat output
- 100% H_2 and up to 40% NG / 60% H_2 mixture
- Commissioning date early 2024
- ~2,000 to 4,000 oh/yr



Source: INNIO Group to deliver innovative hydrogen technology... Press Release

Containerized solution for Jenbacher Type 4 engines - example only for illustration purposes

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Hydrogen City project

Lessons learnt from field projects

Three different field projects…

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Hydrogen City

- Where? Stad aan 't Haringvliet
- Repurposed gas grid for pure hydrogen
- 637 homes and utility buildings (H2 boilers & hybrids, TDHP..)
- Hydrogen produced locally from solar and wind
- District heating and full electrification not possible.

Green Pipeline Project

- Where? Seixal
- H2 blends in a dedicated grid built for the project
- 80 customers, mainly residential
- Hydrogen produced with an electrolyser using solar energy
- Current blends is 12% H2 – 20%vol hydrogen by end of the project

H2Direkt

- Where? Hohenwart, Bavaria
- Part of a local gas grid repurposed for pure hydrogen
- 10 private households and one commercial customer (H2 boilers)
- Green hydrogen transported by trailer

… but similar lessons learnt

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Hydrogen City

- Involve citizens in the project;
- Set up a project management group & draft guiding principles;
- Address safety concerns first;
- Take into account local infrastructure and building stock.

Green Pipeline Project

- Communicate with the consumers, involve them;
- Define your needs (technical, communication) in advance with key stakeholders;
- Progressive phase in of hydrogen (step-by-step).

H2Direkt

- Create synergies at the local level (involve municipality, local grids, inhabitants…);
- Put in place procedures to address safety concerns;
- Have a clear stakeholder communication.

Focus on Green Pipeline Project

Nevin Alija,

European Affairs Manager,

Floene

European Clean Hydrogen Alliance

Floene

The largest operator of gas distribution networks in Portugal, managing 9 of the 11 regional concessions

Shareholding structure:

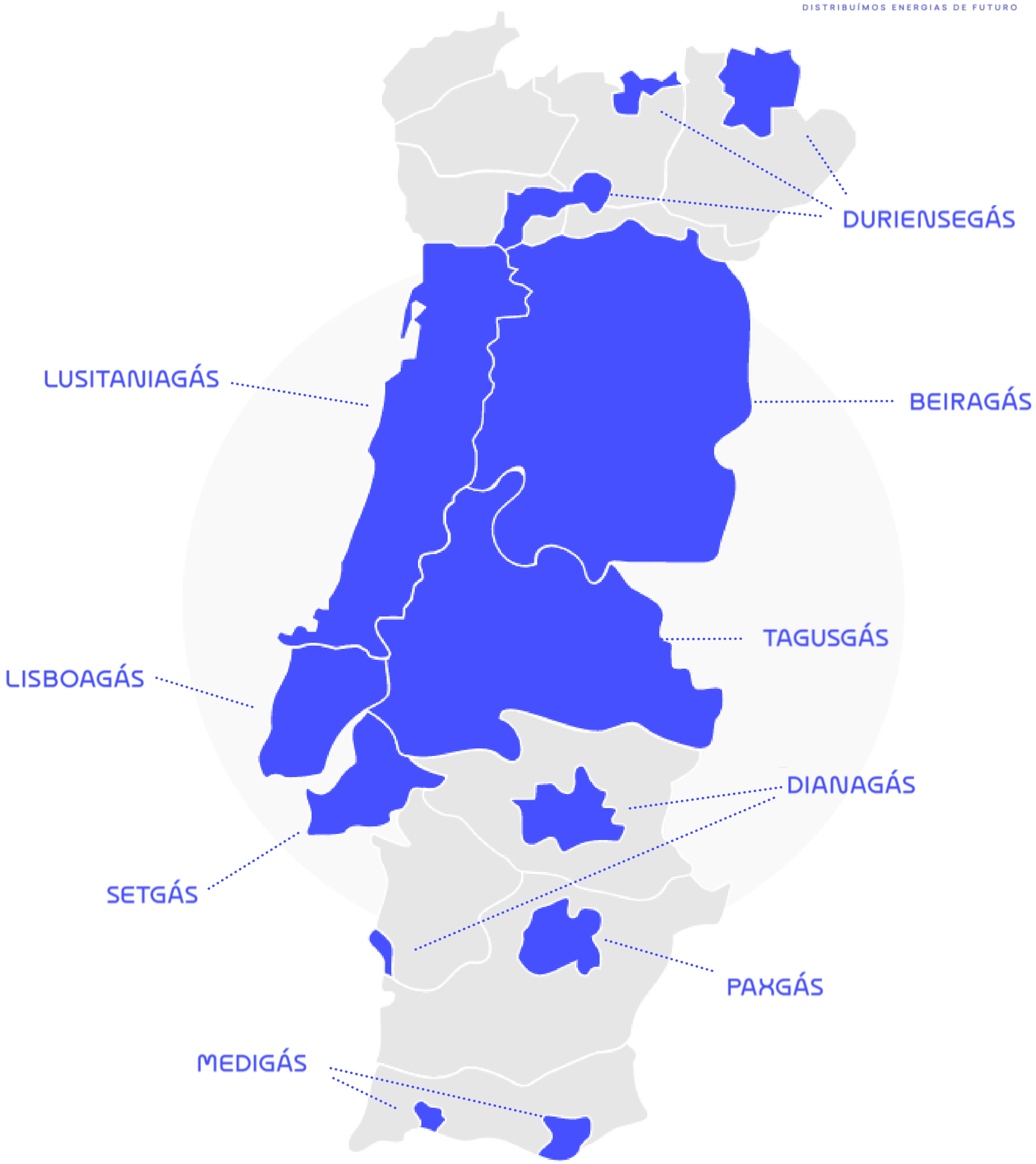
Allianz Infrastructure Luxembourg II S.à	Allianz European Infrastruct. Acquisition Holding S.à r.l.	Meet Europe Natural Gas, Lda.	Petrogal, S.A.
45,51%	29,50%	22,50%	2,49%

FLOENE ENERGIAS

Floene is the **main DSO in Portugal**, distributing a total of:

2025

- **~16 TWh of energy**
- **~13,800 km network** (94% in polyethylene)
- **1,13 M costumers**
- **70% of the market**



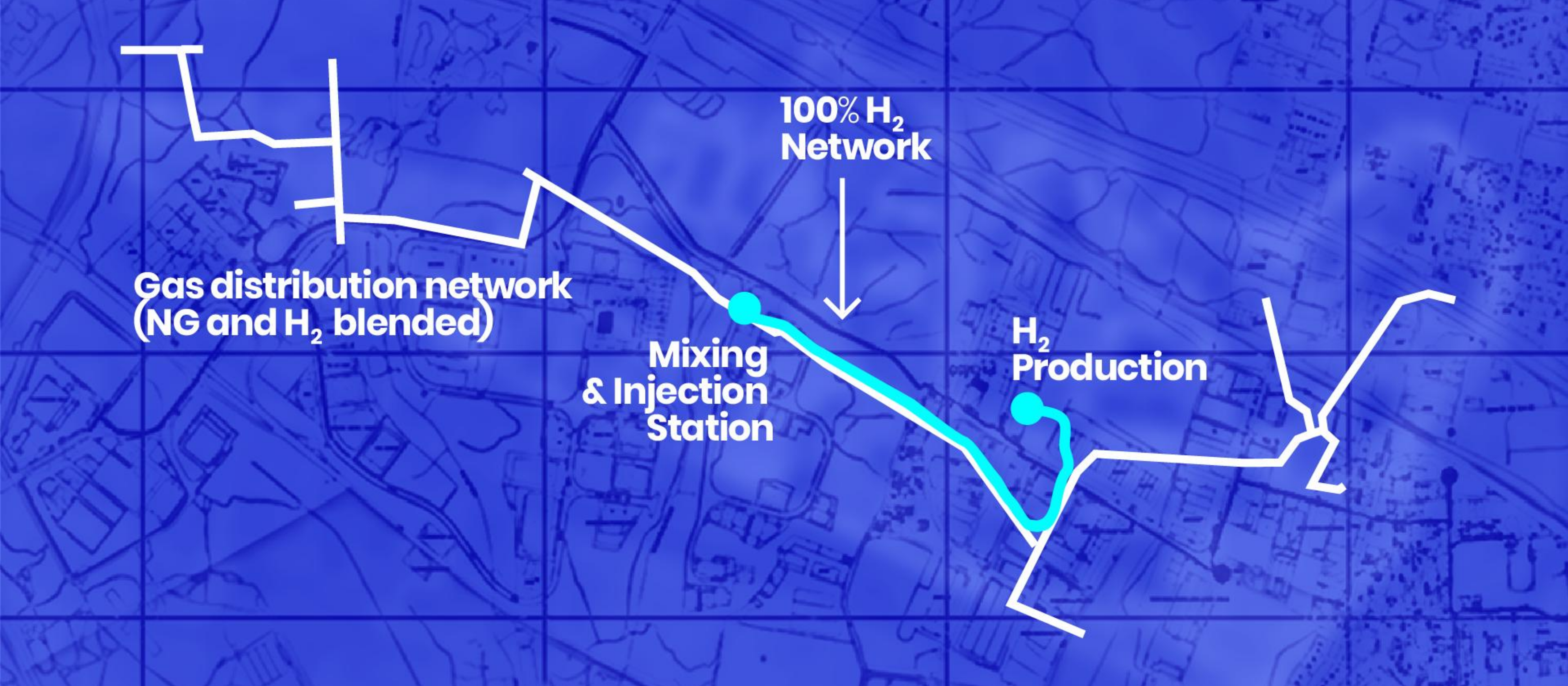
A pioneering project in Portugal

THE NATURAL ENERGY OF HYDROGEN

1st Project in Portugal with Hydrogen injection into the existing Gas Grid.

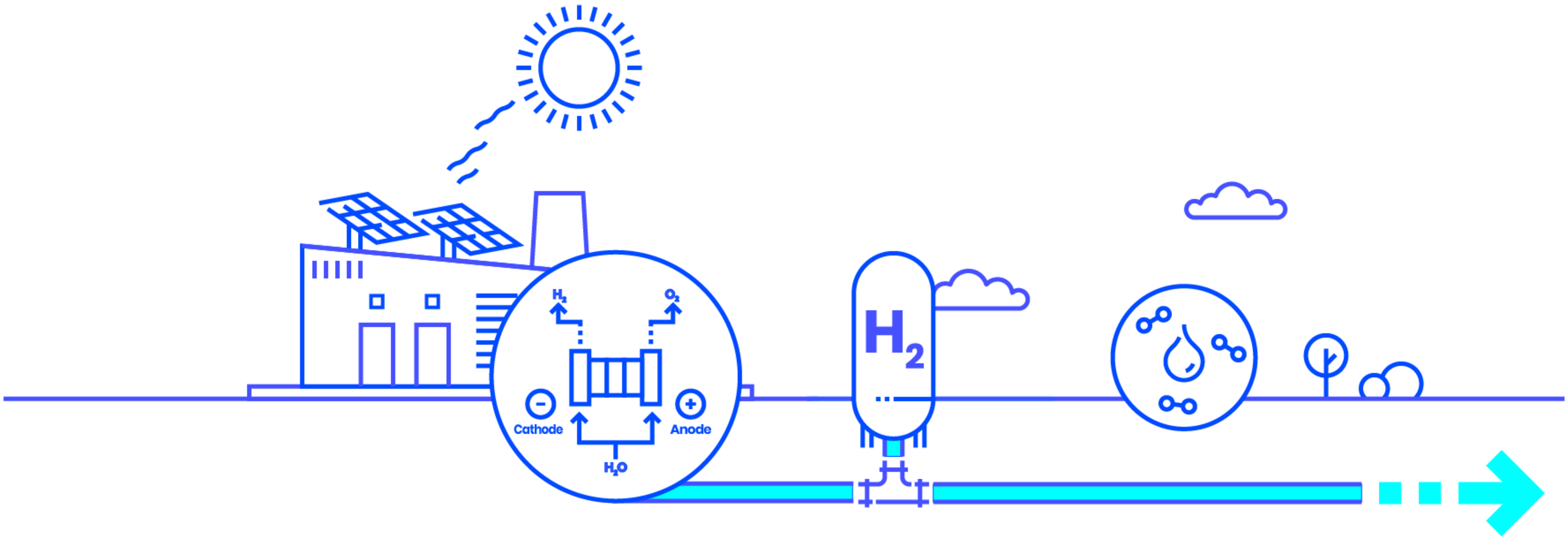
Clear position of Pioneering, Innovation and Commitment to Decarbonization.

Pilot Project
Located south of Lisbon (Seixal)



Hydrogen Production

FLOENE
DISTRIBUÍMOS ENERGIAS DE FUTURO



01.
Panels

Solar Panels FV: 25 kW
Batteries: 34 kW

02.
Electrolyser

Alkalyne Electrolyser
Power: 57 kW
Consumption: 5,9kWh/Nm^3H_2
Purity (H_2): 99%
Powered by: Solar Panels
or public green energy network

03.
Storage

Capaity:
12 m^3 @10 bar

04.
Odorization and reduction of pressure to 4 bar

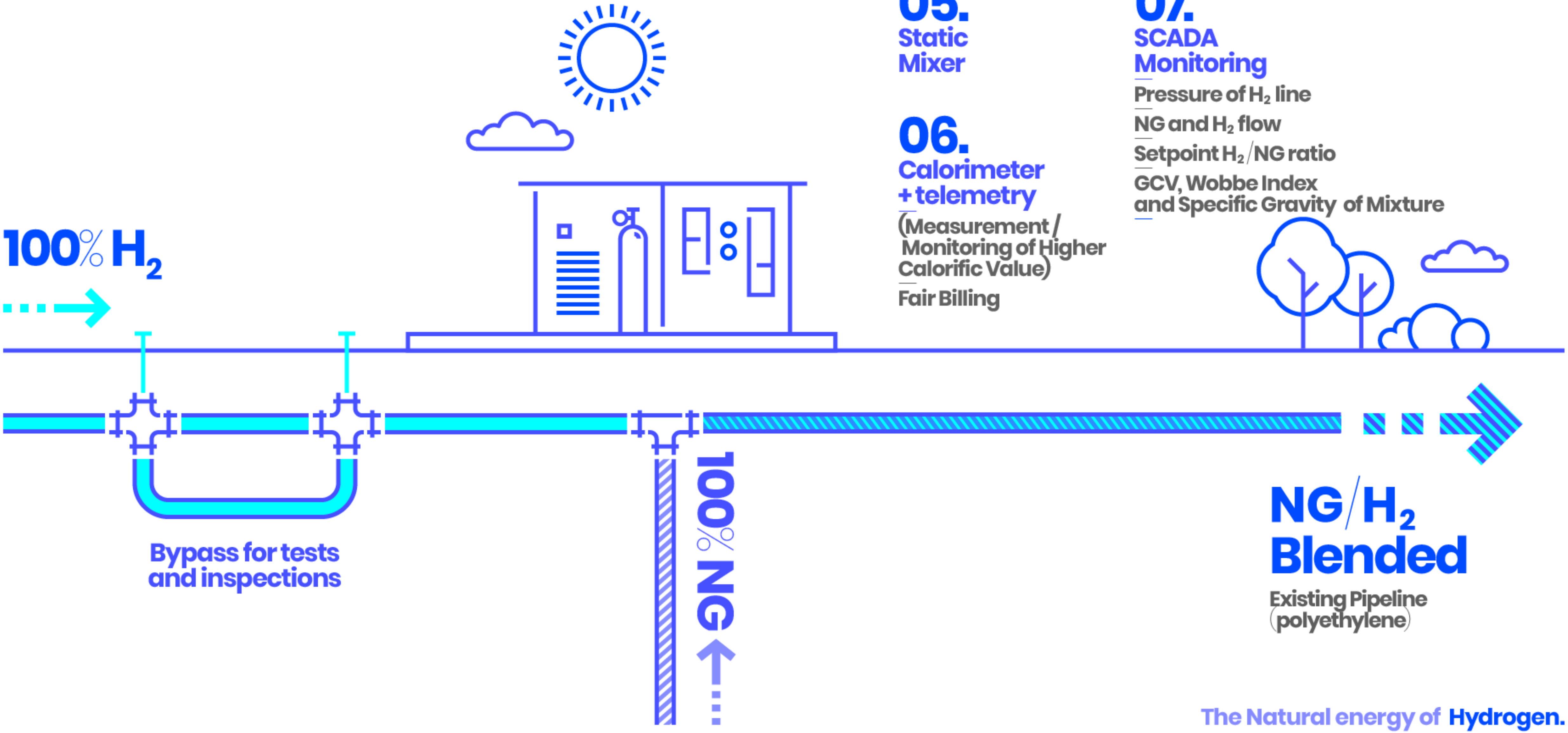
100% H_2
1.400 m

Polyethylene pipes

The Natural energy of **Hydrogen.**

Mixing and Injection Station

FLOENE
DISTRIBUÍMOS ENERGIAS DE FUTURO



05. Static Mixer

06. Calorimeter + telemetry

- (Measurement / Monitoring of Higher Calorific Value)
- Fair Billing

07. SCADA Monitoring

- Pressure of H_2 line
- NG and H_2 flow
- Setpoint H_2/NG ratio
- GCV, Wobbe Index and Specific Gravity of Mixture

Gas Distribution Network (NG and H_2 Blended)

FLOENE
DISTRIBUÍMOS ENERGIAS DE FUTURO

NG/H_2 Blended
Existing Pipeline (polyethylene)

7.700m
Extension of the gas distribution network containing blended gas.

End Users

Residential	Commercial / Services	Industrial
70	8	4

DISTRIBUÍMOS ENERGIAS DE FUTURO

Thank you

Nevin Alija, European Affairs Manager, Floene

Conclusion

1. Most distribution grids can switch to hydrogen (blends and pure hydrogen) with limited technical adjustments.
2. A significant part of the installed stock of heating appliances can deal with up to 20%vol H2 blend with gas and there are many technologies on the market that can support pure hydrogen.
3. For a successful implementation, any ‘Hydrogen in buildings’ project should consider best practices such as a clear roadmap with key stakeholders, a transparent communication with the inhabitants and local stakeholders & industry and addressing safety concerns.


European Clean
Hydrogen Alliance
april 2025
Report on hydrogen-readiness of gaseous fuels distribution infrastructure and heating technologies in Europe
Roundtable 'Buildings'

Questions?