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TECH FORUM

Cost estimation of hydrogen admission into existing natural gas infrastructure and end use

Presentations

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Study: Cost estimation of hydrogen admission in the gas system

Gert Muller-Syring

CEO of DBI

23 November, 2023

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Technical Association of the European Gas Industry

Cost estimation of hydrogen admission into existing natural gas infrastructure and end use

Presentation of final results (23rd Nov. 2023)

Gert Müller-Syring, Hagen Bültemeier, Philipp Pietsch (all DBI), Aurélie Carayol (GRTgaz)

Agenda

- Goals of the study
- Scope and overview of involved competencies
- Methodology
  - General approach
  - Asset volume approximation
  - Mitigation measures
  - Cost estimation
- Results
- Key findings
- Infografic on H_2 tolerance of gas infrastructure and end use 2023

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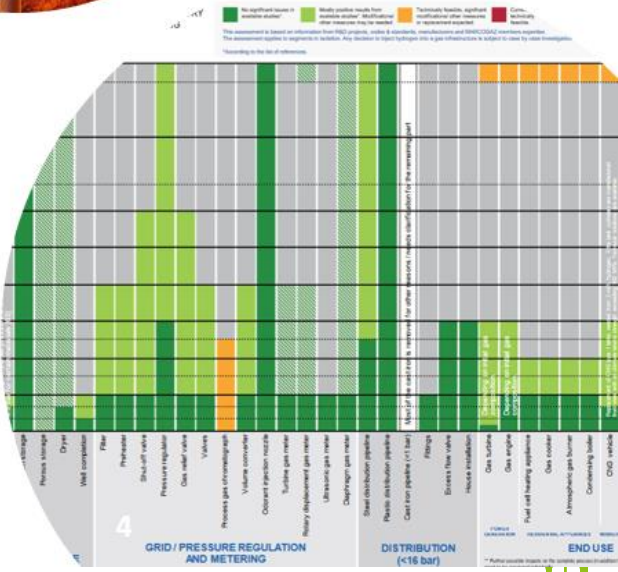
Goals of the study

- The objective of the study is to analyse the **mitigation measures** related to retrofitting/repurposing the **existing gas infrastructure** and **end use** (domestic and commercial appliances) for different **H_2-concentrations**

- **Cost estimations for 2, 5, 10, 20, 30 and 100 vol.-% H_2 admission are provided** considering installed asset volumes and mitigation measures where needed

- **Update of the initial H_2-admission infographic** published in 2019



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Scope and overview of involved competencies

Scope and overview of involved competencies

Considered infrastructure

- Gas-Transmission
- Underground gas storage
- Gas-Distribution
- Gas pressure regulation and metering
- End use (domestic and commercial appliances)

Evaluation of infrastructure key elements based on e.g.

- Marcogaz documents/statistics,
- TYNDP and NDP
- hydrogen backbone report, 11th EGIG report, …
- Project results (e.g. THYGA)
- and many contribution of the TF-members and MG working groups

Focus on key infrastructure H2-tolerance

- Capacity increase of pipelines, compressors etc. that might be necessary in case of higher hydrogen concentrations is not considered.
- This and further topics that focuses on individual aspects of operation are acknowledged by a statement of ENTSOG

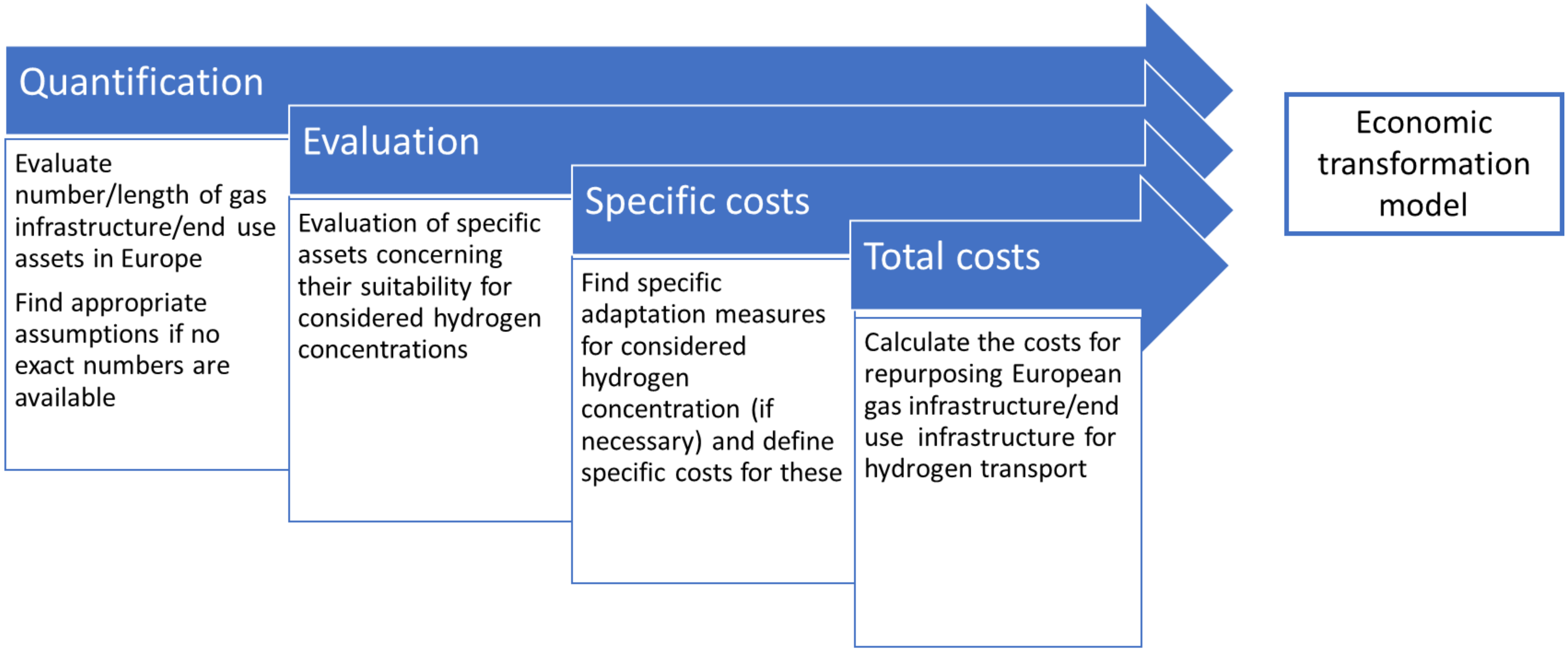
Results elaborated by Marcogaz TF H2 in cooperation with:

- WG: Gas transmission
- WG: Underground gas storage
- WG: Gas distribution
- WG: Gas utilisation and
- Eurogas and ENTSOG
- Grid operator experts

Methodology

Methodology

General approach - quantification, evaluation, cost assumption



Asset volume approximation

Asset volumes

Example for approximation of asset volumes for “gas transmission assets”

Infrastructure item	Asset volume	Additional information
Steel transmission pipelines	225,000 km	TYNDP 2018
Older pipe construction	121,000 km	before 1984 EN12732, EGIG
Younger pipe construction	104,000 km	after 1984 EN12732, EGIG
Valve stations (existing)	15,400	Extrapolated based on specific values
Valve stations (needed for pure hydrogen service)	11,250	Extrapolated based on specific values
Pigging stations	3,400	Extrapolated based on specific values
Compressor station installed power incl. drive and auxiliaries combined	12,500 MW	Extrapolated based on specific values
Metering stations	870	Extrapolated based on specific value
Pressure regulating stations	-	→ Covered in a separate section “pressure regulation”

Asset volumes

Example for approximation of asset volumes for "gas distribution pipes"

COUNTRY EU 28 + Ukraine	Total (km)	Total Plastic (km)	Total Steel (km)	Cast Iron (km)	Others (km)
Austria	43,400	30,497	11,423	2	1,478
Belgium	76,334	57,609	17,000	16	1,709
Czech Republic	74,821	43,396	31,425	0	0
Denmark	18,229	15,677	2,552	0	0
Germany	498,500	268,193	218,343	11,964	0
Ireland	11,913	11,794	119	0	0
Italy	262,360	73,329	184,872	2,948	1,211
The Netherlands	125,326	100,261	18,799	3,760	2,507
Poland	170,900	68,360	102,540	0	0
Portugal	19,022	16,721	2,283	19	0
Slovakia	33,301	14,519	18,782	0	0
Spain	74,629	63,980	9,515	1,134	0
France	208,105	146,533	54,469	5,821	1,282
Finland	1,911	1,808	83	20	0
Slovenia (1)	4,342	2,464	1,700	108	70
UK	126,335	81,657	7,242	17,362	20,074
Greece	6,080	4,663	1,281	136	0
Romania	17,218	8,958	8,260	0	0
Cyprus	0	0			
Latvia (1)	5,501	3,122	2,153	137	89
Estonia (1)	2,151	1,220	842	54	35
Lithuania (1)	8,300	4,710	3,249	207	134
Croatia (1)	18,386	10,435	7,197	458	296
Malta (1)	0	0			
Sweden (1)	2,720	1,543	1,065	68	44
Bulgaria (1)	248	141	97	6	4
Luxembourg (1)	1,962	1,113	768	49	32
Hungary (1)	83,999	47,672	32,879	2,094	1,354
RGC Ukraine	350,000	126,781	223,219	0	
TOTAL	**2,245,993**	**1,207,156**	**962,156**	**46,362**	**30,318**

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Asset volumes

Example for approximation of asset volumes “Underground Gas Storage facilities”

2) Estimation Number of UGS facilities according to type

Main Component and Type	Calculation / Assumption	Amount for representative type-UGS
Compressors • Turbo Compressors • Piston Compressors	• Calculated according to max. injection rate of UGS facility. Turbo-comp. with 150,000 Nm^3/h and Piston comp. with 50,000 Nm^3/h. 1 compressor in addition for redundancy. Calculated for each European UGS facility. • Above 200,000 Nm^3/h max. injection capacity utilization of Turbo-compressors, otherwise Piston. • 2-stages compression	• 4 turbo • 4 piston
Drive engine • Electric engine • Gas engine • Gas turbine	• One drive engine per compressor. • Numbers for different drive engines were applied from a reference project and extrapolated to the European UGS infrastructure	• 3 electrical engines • 4 gas engines • 1 gas turbine
Cooler	• One per compression stage, i.e. two per compressor.	• 16
Separator	• Calculated according to max. withdrawal rate (3 separators for 1,500,000 Nm^3/h; rule of three) + 1 for redundancy	• 2
Gas Dryer • Absorption • Adsorption • JT-Dryer	• Calculation of total number of dryers according to max. withdrawal rate (3 units for 1,500,000 Nm^3/h; rule of three) + 1 for redundancy; • Analysis of shares of absorption drying, adsorption drying and JT-drying according to IGU WGC 2018 data base and Type of UGS • Calculation of amount of units per UGS according to type and shares; formation of an average value for all European UGS facilities.	• 5 absorption • 1 adsorption • 1 JT

1) Number of UGS facilities according to type

Type	Salt Cavern	Aquifers	Depleted Fields	Total
Number	68	36	101	205

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Mitigation measures

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Mitigation measures

Example for “gas transmission pipes“

	Mitigation measures according to hydrogen concentration							
	2 vol.-%	5 vol.-%	10 vol.-%	15 vol.-%	20 vol.-%	25 vol.-%	30 vol.-%	100 vol.-%
Steel pipelines before 1984	risk assessment			ILI and subsequent repair for dynamically operated pipelines needed				
Steel pipelines after 1984	risk assessment			ILI and subsequent repair for dynamically operated pipelines needed				

Mitigation measures

Example for "underground gas storage facilities"

Main Component	Unit	Value	0 %	2 vol.-%	5 vol.-%	10 vol.-%	15 vol.-%	20 vol.-%	25 vol.-%	30 vol.-%	100 %
Cooler	EUR	1,130,000	No additional cost						20 %	20 %	20 %
Separator	EUR	2,130,000	No additional cost			20 %	20 %	20 %	20 %	20 %	20 %
Absorption Gas Dryer	EUR	9,500,000	No additional cost		20 %	20 %	20 %	20 %	20 %	20 %	20 %
Adsorption Gas Dryer	EUR	2,650,000	No additional cost		20 %	20 %	20 %	20 %	20 %	20 %	20 %
JT Gas Dryer	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Pressure regulator	EUR	105,000	No additional cost								20 %
Turbine gas meter	EUR	54,900	No additional cost								100 %
Coriolis gas meter	EUR	109,800	No additional cost			20 %	20 %	20 %	20 %	20 %	20 %
Ultrasonic gas meter	EUR	109,800	No additional cost				20 %	20 %	20 %	20 %	100 %
Diaphragm gas meter	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Process gas chromatograph	EUR	150,000	No additional cost	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %
Pipeline, 100 % H_2-compatible	EUR/m	291	No additional cost								
Pipeline, not H_2-compatible	EUR/m	291	No additional cost			20 %	20 %	20 %	20 %	20 %	20 %
Fittings, H_2-compatible	EUR	2617	No additional cost								

Main Component	Cost										
	Unit	Value	0 %	2 vol.-%	5 vol.-%	10 vol.-%	15 vol.-%	20 vol.-%	25 vol.-%	30 vol.-%	100 %
Tubing - not H_2-compatible	EUR/m	370	No additional cost		20 %	20 %	20 %	20 %	100 %	100 %	100 %
New inner Liner as secondary barrier for protection of Casing	EUR/m	370	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %
Sand filter (in case porous UGS)	N/A	N/A	No additional cost								
Wellhead, H_2-compatible	EUR	370,000	No additional cost								
Wellhead, not H_2-compatible	EUR	370,000	No additional cost		20 %	20 %	20 %	20 %	100 %	100 %	100 %
SV	EUR	290,000	No additional cost		20 %	20 %	20 %	20 %	100 %	100 %	100 %

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Cost estimation

Cost estimation

Example for approximation of “gas transmission pipes”

	Adaption costs according to the hydrogen concentration								
	0 vol.-%	**2 vol.-%**	**5 vol.-%**	**10 vol.-%**	**15 vol.-%**	**20 vol.-%**	**25 vol.-%**	**30 vol.-%**	**100 vol.-%**
Steel pipelines before 1984	0 EUR				23,000 EUR/km + 50,000 EUR/repair				274,000 EUR/km
Steel pipelines after 1984	0 EUR				23,000 EUR/km + 50,000 EUR/repair				229,000 EUR/km

Cost assumptions

Example for approximation for Underground “Gas Storage facilities”

Main Component	Cost										
	Unit	Value	0 %	2 vol.-%	5 vol.-%	10 vol.-%	15 vol.-%	20 vol.-%	25 vol.-%	30 vol.-%	100 %
Turbo compressor	EUR	6,280,000	No additional cost				20 %	20 %	20 %	20 %	100 %
Piston compressor	EUR	6,280,000	No additional cost			20 %	20 %	20 %	20 %	20 %	20 %
Electric motor	EUR	6,280,000	No additional cost								
Gas engine	EUR	6,280,000	No additional cost					20 %	20 %	20 %	20 %
Gas turbine	EUR	6,280,000	No additional cost		20 %	20 %	20 %	20 %	20 %	20 %	100 %
Cooler	EUR	1,130,000	No additional cost						20 %	20 %	20 %
Separator	EUR	2,130,000	No additional cost			20 %	20 %	20 %	20 %	20 %	20 %
Absorption Gas Dryer	EUR	9,500,000	No additional cost		20 %	20 %	20 %	20 %	20 %	20 %	20 %
Adsorption Gas Dryer	EUR	2,650,000	No additional cost		20 %	20 %	20 %	20 %	20 %	20 %	20 %
JT Gas Dryer	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Pressure regulator	EUR	105,000	No additional cost								20 %
Turbine gas meter	EUR	54,900	No additional cost								100 %
Coriolis gas meter	EUR	109,800	No additional cost			20 %	20 %	20 %	20 %	20 %	20 %
Ultrasonic gas meter	EUR	109,800	No additional cost				20 %	20 %	20 %	20 %	100 %
Diaphragm gas meter	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Process gas chromatograph	EUR	150,000	No additional cost	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %
Pipeline, 100 % H_2-compatible	EUR/m	291	No additional cost								
Pipeline, not H_2-compatible	EUR/m	291	No additional cost			20 %	20 %	20 %	20 %	20 %	20 %
Fittings, H_2-compatible	EUR	2617	No additional cost								
Fittings, not H_2-compatible	EUR	2617	No additional cost			20 %	20 %	20 %	20 %	20 %	20 %
Field pipeline, H_2-compatible	EUR/m	500	No additional cost								
Field pipeline, not H_2-compatible	EUR/m	500	No additional cost			20 %	20 %	20 %	20 %	20 %	20 %
Glycol vessels	EUR	260,000	No additional cost			20 %	20 %	20 %	20 %	20 %	20 %
Flare	EUR	160,000	No additional cost			20 %	100 %	100 %	100 %	100 %	100 %
Burners	EUR	390,000	No additional cost			20 %	100 %	100 %	100 %	100 %	100 %
Desulfurization	EUR	530,000	No additional cost			20 %	20 %	20 %	20 %	20 %	20 %
LCCS			No additional cost								
Packer	EUR	180,000	No additional cost		20 %	20 %	20 %	20 %	100 %	100 %	100 %
Tubing - H_2-compatible	EUR/m	370	No additional cost								
Tubing - not H_2-compatible	EUR/m	370	No additional cost		20 %	20 %	20 %	20 %	100 %	100 %	100 %
New inner Liner as secondary barrier for protection of Casing	EUR/m	370	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %
Sand filter (in case porous UGS)	N/A	N/A	No additional cost								
Wellhead, H_2-compatible	EUR	370,000	No additional cost								
Wellhead, not H_2-compatible	EUR	370,000	No additional cost		20 %	20 %	20 %	20 %	100 %	100 %	100 %
SV	EUR	290,000	No additional cost		20 %	20 %	20 %	20 %	100 %	100 %	100 %

Results

Results

COST ESTIMATION OF HYDROGEN ADMISSION INTO EXISTING NATURAL GAS INFRASTRUCTURE AND END USE

		Adaption cost in % according to hydrogen concentration								
		2 vol.-%	5 vol.-%	10 vol.-%	15 vol.-%	20 vol.-%	25 vol.-%	30 vol.-%	100 vol.-%	New build H_2 infrastructure
Gas-transmission	Total adaption costs compared to new build H_2 IS in %	0.03	0.28	0.71	2.4	2.6	11.5	11.5	27.7	100
UGS	Total adaption costs compared to new build H_2 IS in %	0.1	7.1	10.8	13.4	15.5	25.8	25.8	38.3	100
GPRMS	Total adaption costs compared to new build H_2 IS in %	2.2	2.2	2.2	3.9	3.9	3.9	3.9	33.2	100
Gas-distribution	Total adaption costs compared to new build H_2 IS in %	0.07	0.07	0.07	0.07	0.07	4.8	4.8	6.4	100
End Use (domestic and commercial)	Total adaption costs compared to new build H_2 IS in %	0.0	0.0	0.0	0.0	0.0	14.8	14,8	100.0	100
Total gas-infrastructure	Total adaption costs compared to new build H_2 IS in % without end use	0.3	0.7	1.0	1.9	2.1	8.0	8.0	19.0	100
Total gas-infrastructure, domestic and commercial end use	Total adaption costs compared to new build H_2 IS in %	0.2	0.5	0.7	1.4	1.5	9.8	9.8	40.5	100

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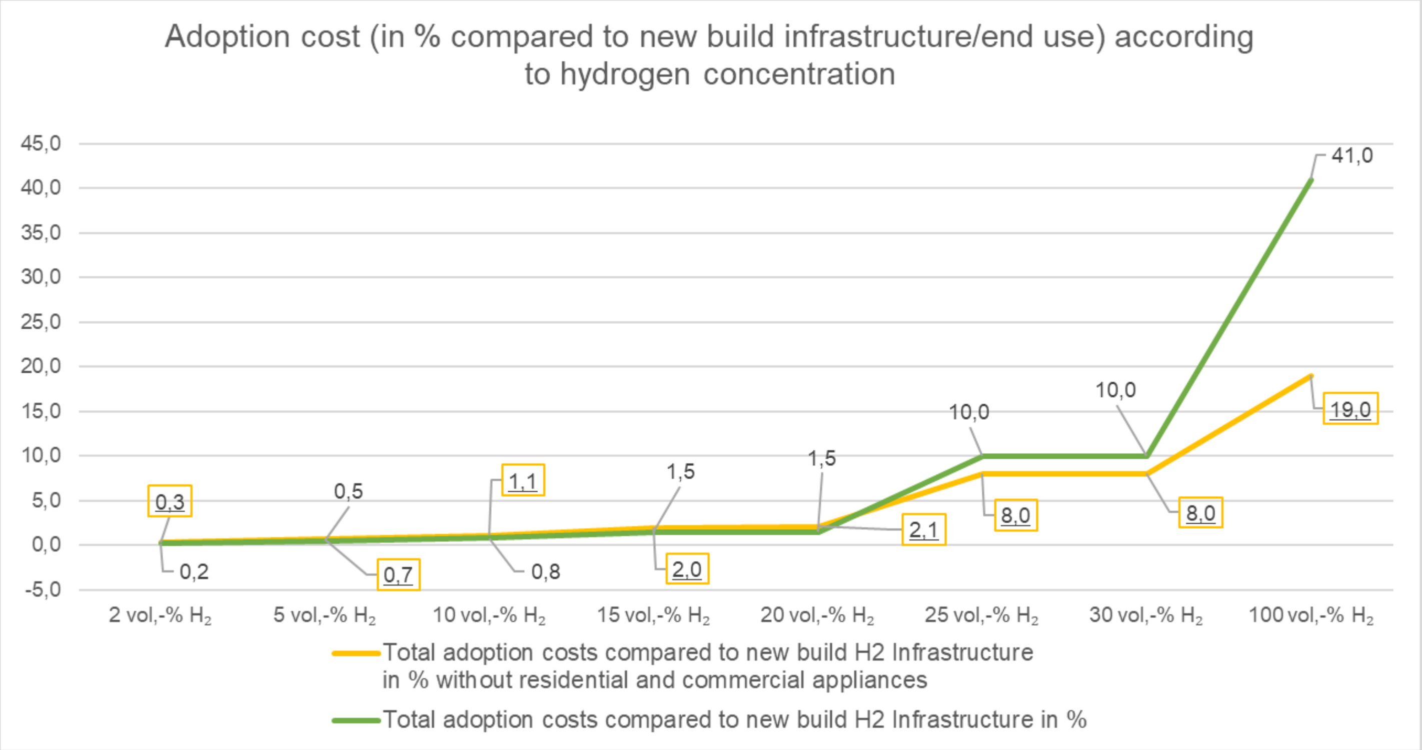
Results

Cost estimation of hydrogen admission into existing natural gas infrastructure and end use

		Adoption cost (in bn EUR and %) according to hydrogen concentration								
		2 vol,-%	5 vol,-%	10 vol,-%	15 vol,-%	20 vol,-%	25 vol,-%	30 vol,-%	100 vol,-%	New build H_2
Total gas-infrastructure	**Total adoption costs compared to new build H_2 IS in % (without residential and commercial appliances)**	**0.3**	**0.7**	**1.1**	**2.0**	**2.1**	**8.0**	**8.0**	**19.0**	**100**
total gas- infrastructure, dom,/com, End use	**Total adoption costs compared to new build H_2 IS in %**	**0.2**	**0.5**	**0.8**	**1.5**	**1.5**	**10**	**10**	**41**	**100**



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Key findings & conclusions

COST ESTIMATION OF Transformation costs in comparison to a new build infrastructure

The following results are based on an average cost approximation on European level. The situation in single countries might be different. in some cases, parts of the infrastructure might have to be modified/replaced also for low hydrogen concentrations e.g. due to capacity requirements, technical restrictions or regulatory issues. Those cases are not considered in the general results.

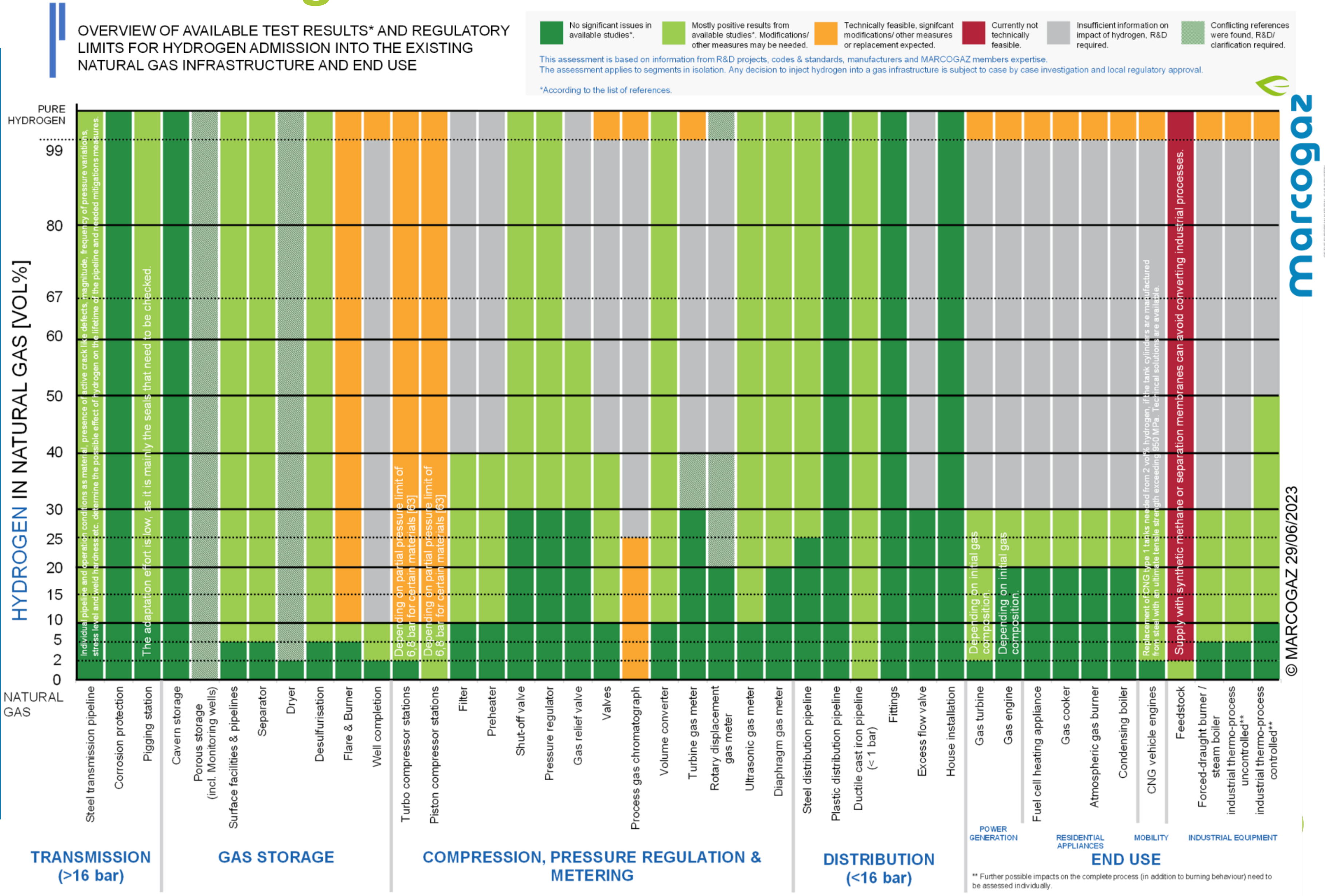
1. Up to 10 vol.-% H_2 the transformation cost is less than 1% of CAPEX for a new build infrastructure*.
2. Up to 30 vol.-% H_2 the transformation cost is equal to 10% of CAPEX for a new build infrastructure*.
3. For pure hydrogen service the transformation cost is less than 20% of CAPEX for a new build infrastructure.
4. Next to the shown financial advantages of transforming the existing infrastructure* this will also lead to a faster establishing of a H2ready infrastructure with less negative effects on the environment and lower carbon footprint.

* incl. residential and commercial applications

Infografic on H_2 tolerance of gas infrastructure and end use 2023

This infographic aims at providing an overview of the technical readiness of the gas infrastructure and end use (domestic and commercial appliances) equipment to handle hydrogen-natural gas mixtures.

The infographic focuses on material aspects and functional principles. It does not consider the effect of increasing levels of hydrogen on performance. efficiency and output.



Key steps of study development

- 4th of April: Distributing the draft version to:
  - WG Gas transmission
  - WG Storage
  - WG Distribution
  - End use
  - TF H2
  - ENTSOG
  - Eurogas
  - In total 130 recipients

- Based on the feedback and the remarks received in the SCGI meeting (April) the final draft report was developed and has been distributed on the 3rd of July
- Additional feedback was received and in total more than 500 remarks have been processed
- There was an intensive and good exchange with ENTSOG and the remarks of ENTSOG have been processed in a separate report version to be as transparent as possible

What have we learnt?

Using existing infrastructure for hydrogen supports the energy transition!

Many thanks to all who have supported

If you need support for transforming your infrastructure – please visit: https://www.verifhy.de/

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Technical Association of the European Gas Industry

Thank you!

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Case: Transmission systems operators decarbonizing the gas grid

Steven van Caekenberghe

Head of Technical Management at Nextgrid, Fluxys

Transmission system operators decarbonizing the gas grid

MARCOGAZ Tech Forum Webinar

23 November 2023

Steven Van Caekenberghe

fluxys
nextgrid

Who we are?

4 facts about Fluxys, a midstream infrastructure company not involved in energy production or supply

1. Fully independent energy infrastructure partner headquartered in Belgium

2. Strong European presence with associated companies across Europe and entities in LatAm

3. A growing group of 1 300 employees

4. Purpose-driven company committed to building a greener energy future for the generations to come

shaping together a bright energy future

Terminalling

380 TWh/y of
LNG regasification capacity with terminals in Belgium, France, Greece & Chile

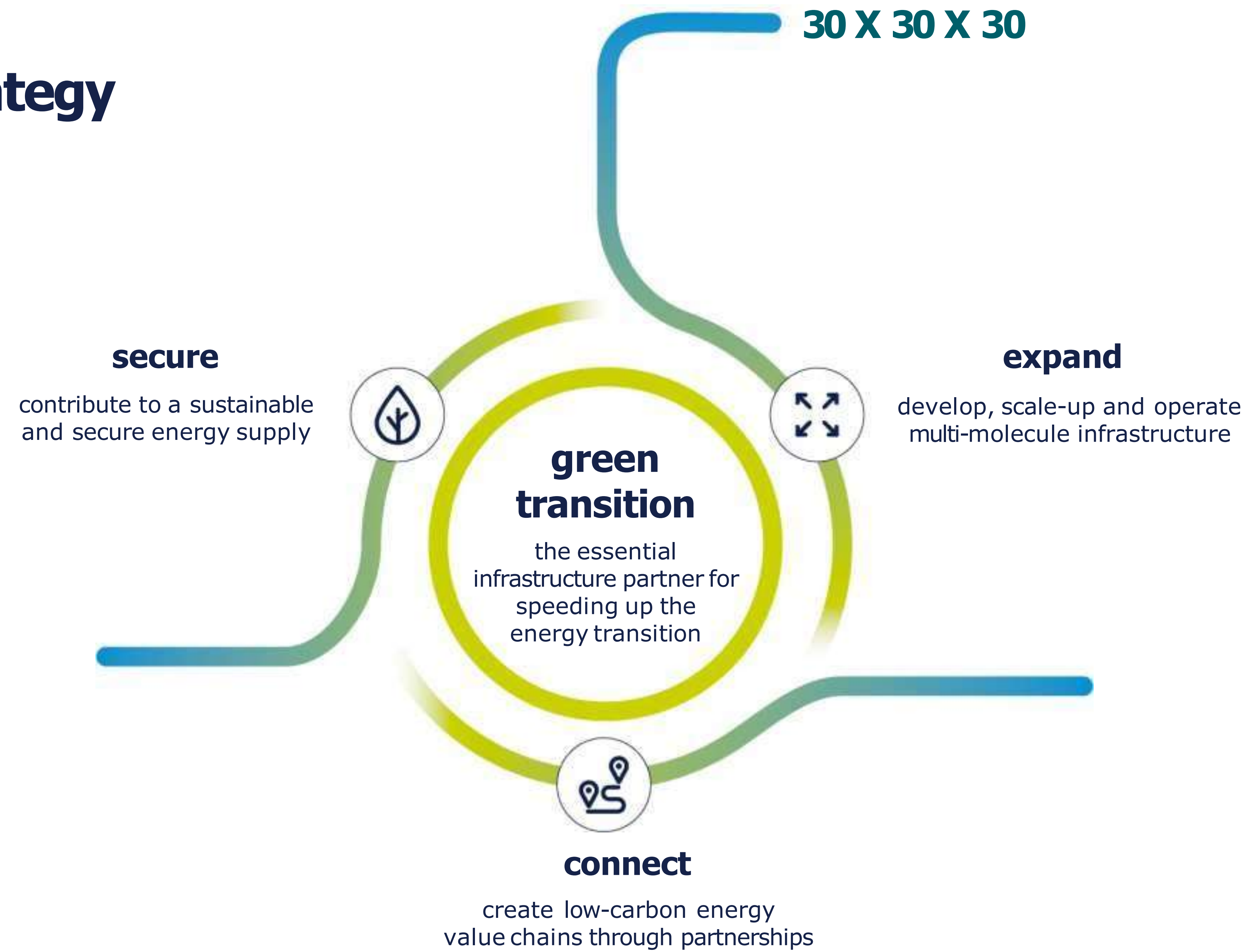
Transmission

24 000 km
gas pipelines in operation

Storage

7610 GWh
underground gas storage in Belgium

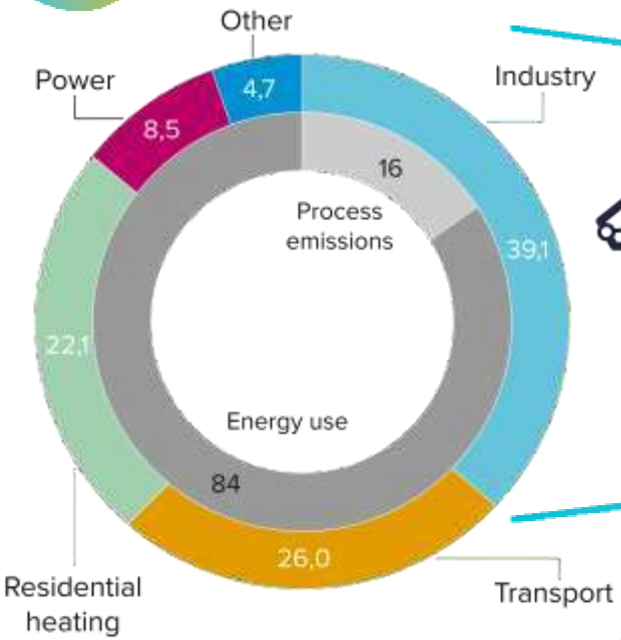
Our strategy

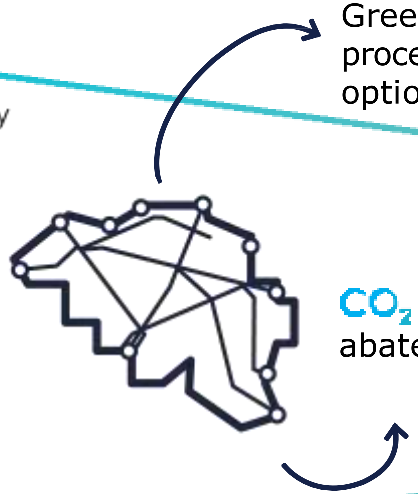


With our infrastructure we can contribute to the decarbonisation

Today

CO_2 emissions: 100 million tonnes/year (2018)





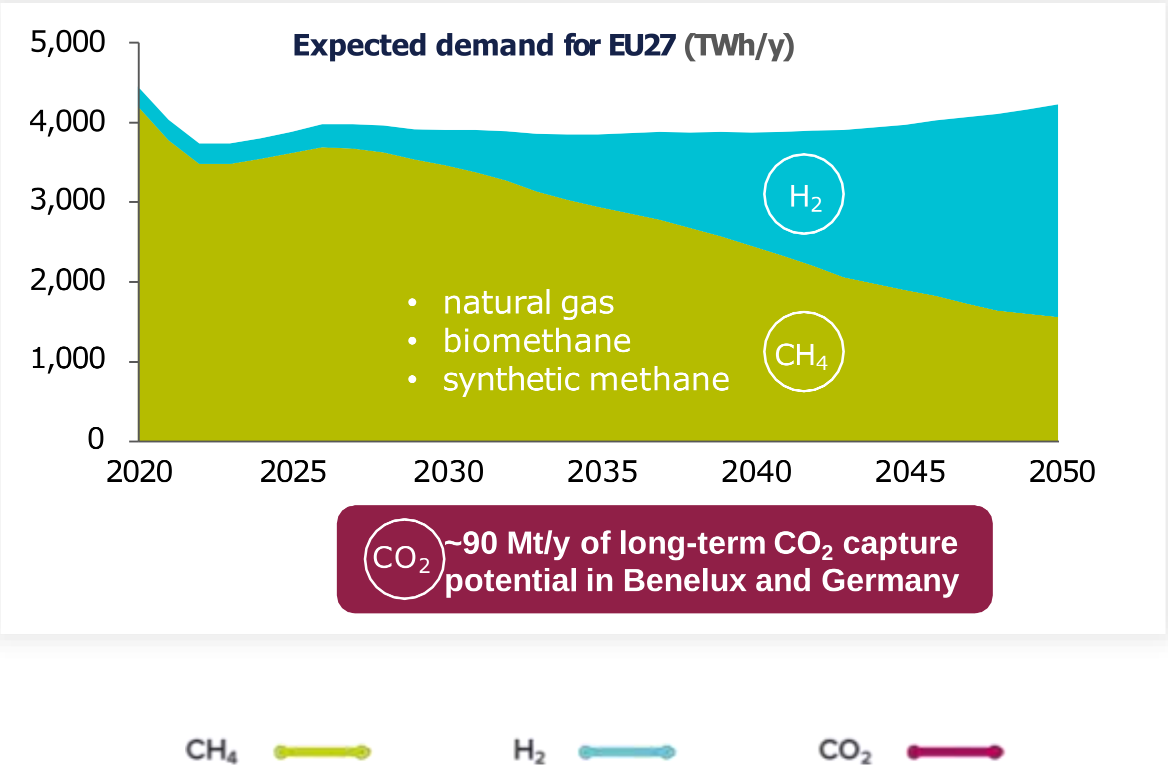
Carbon-neutral energy carriers progressively replace natural gas in our infrastructure
Green molecules are the preferred option for industrial processes with high temperature heat and the sole option for those using gas as a feedstock

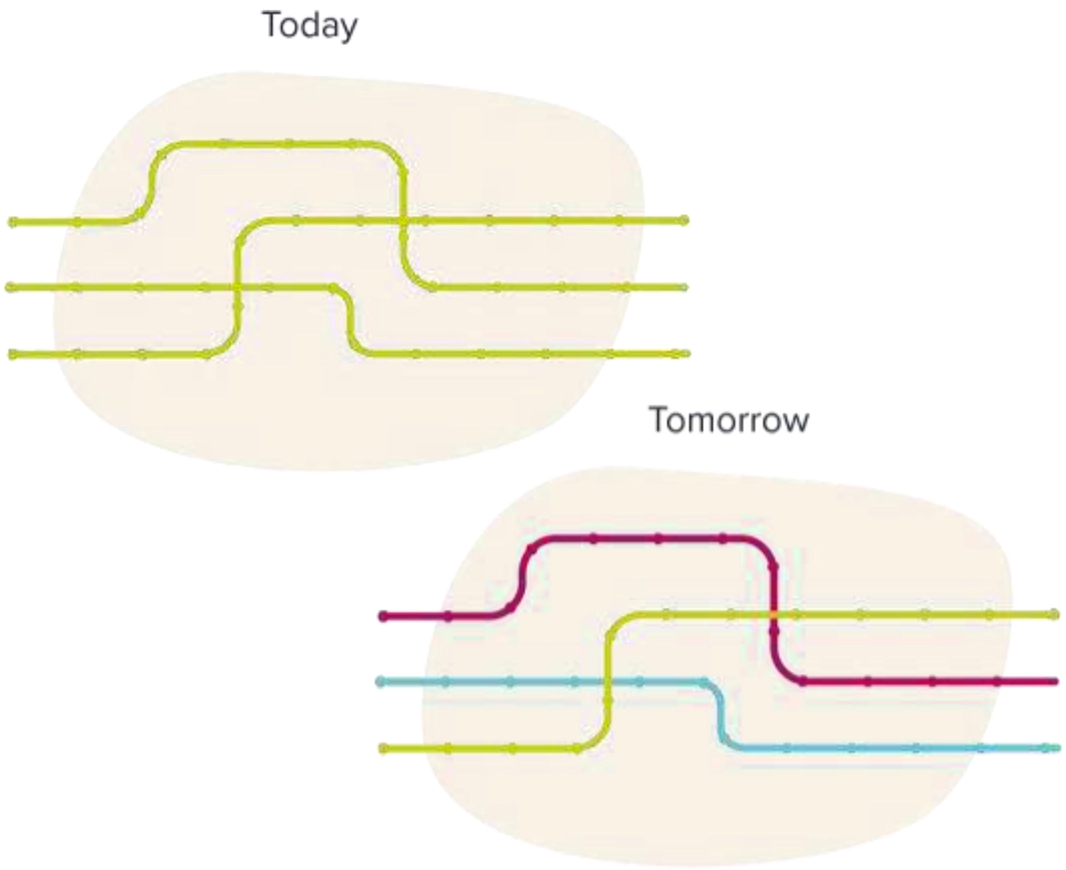
CO_2 transport and storage for hard-to-abate industries

2050

0 net CO_2

Fluxys in full swing to develop and re-use our infrastructure into a multi-molecule system supporting industries' decarbonisation path





Sources for expected demand: S&P Global (IHS) base case, ETS database, Fluxys analysis

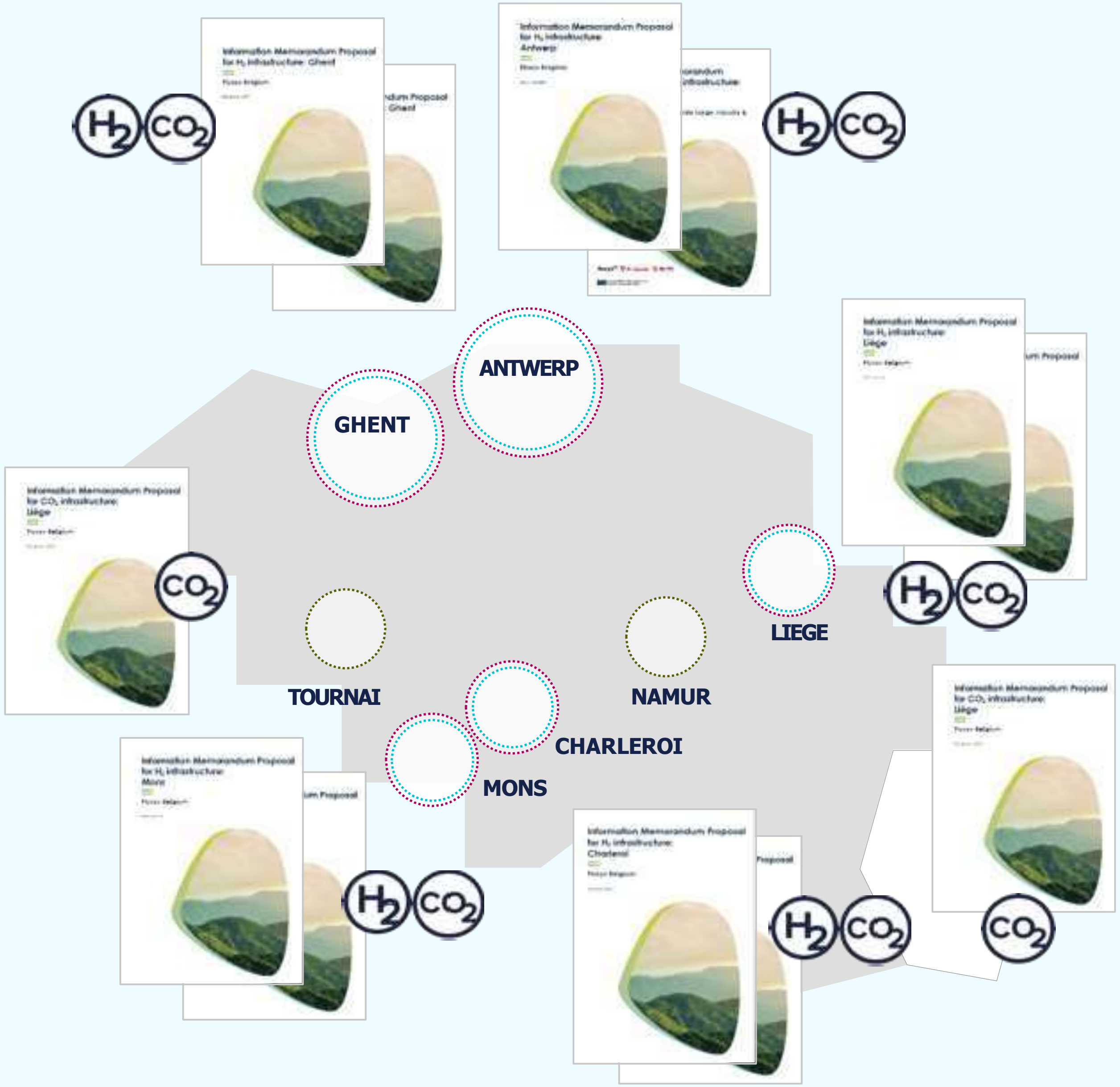
Almost 100% of pipelines repurposable

CO_2

- Plug and play
- Pressure reduction

H_2

- Valve replacement
- Rebuild compressor units
- Pressure configuration pipe per pipe



first infrastructure in 2026
length 150 km

Belgian Hydrogen Strategy has four key pillars

Hydrogen anchored within an overall Federal strategy to enable 100% renewable, competitive and secured supply, with an adequate mix of energy carriers

Belgium as import & transit hub

Entry gate into Western EU market, leveraging central position, with **existing ports** and **interconnected transport grid** (import of 20 TWh expected by 2030, 200-350 TWh by 2050)

Belgium as leader in H2 technologies

Pioneer position and strengthened innovation from private companies & public research institutions, supported by new federal funding mechanisms

A robust H2 market

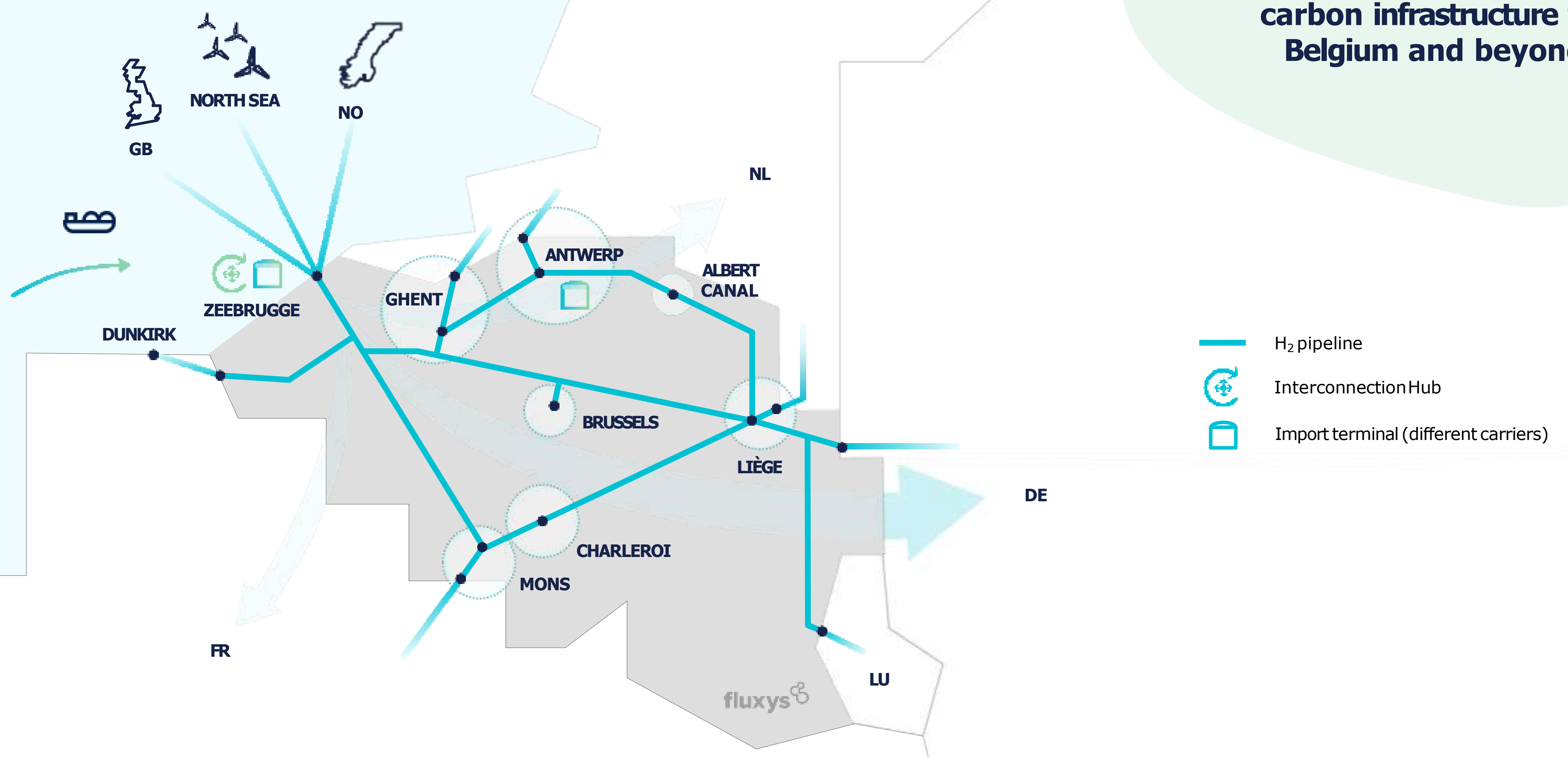
Unified, competitive H2 market, with healthy deployment of a safe, reliable, dedicated and **open-access H2 backbone**.

Cooperation as key success factor

Strengthened collaboration with national bodies and foreign players, including setting up Belgian Hydrogen Council as sectoral organisation

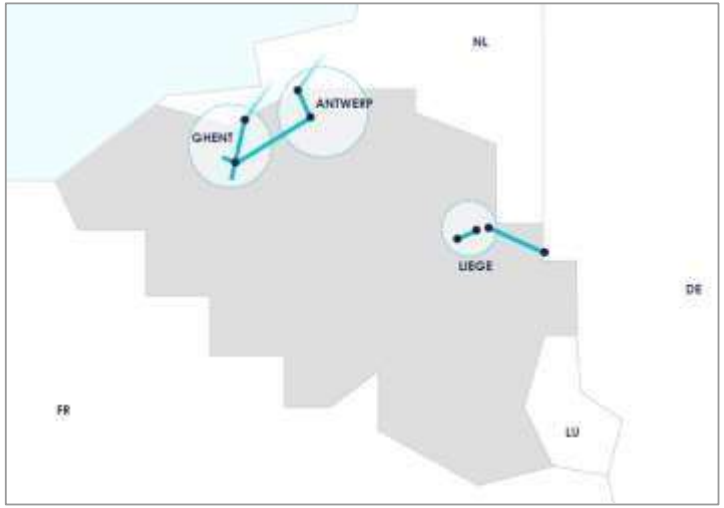
Fluxys Hydrogen network

Shaping the hydrogen and carbon infrastructure for Belgium and beyond

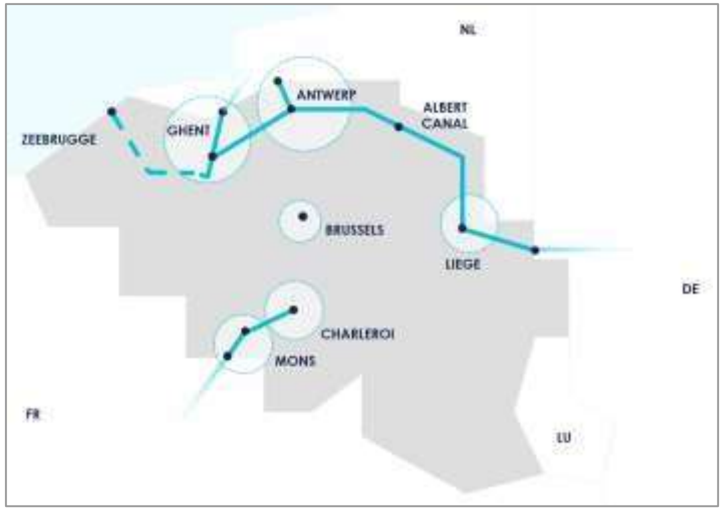


Fluxys' network development enables a cost-efficient future build-out towards mature backbone in next phases

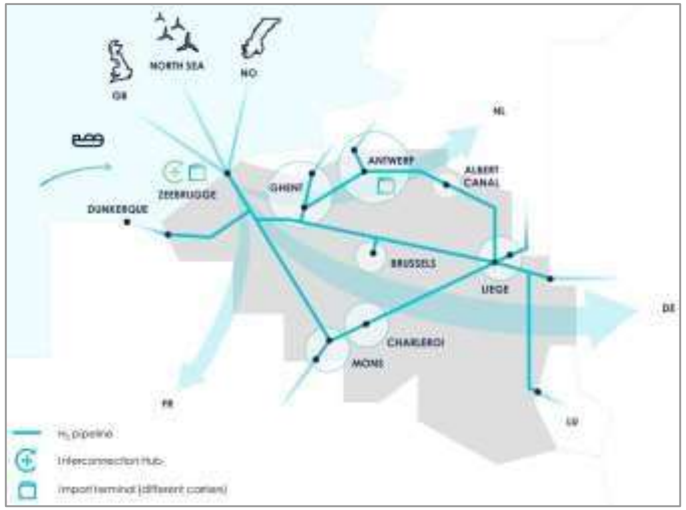
Phase 1: By 2026



Phase 2: 2028 - 2030

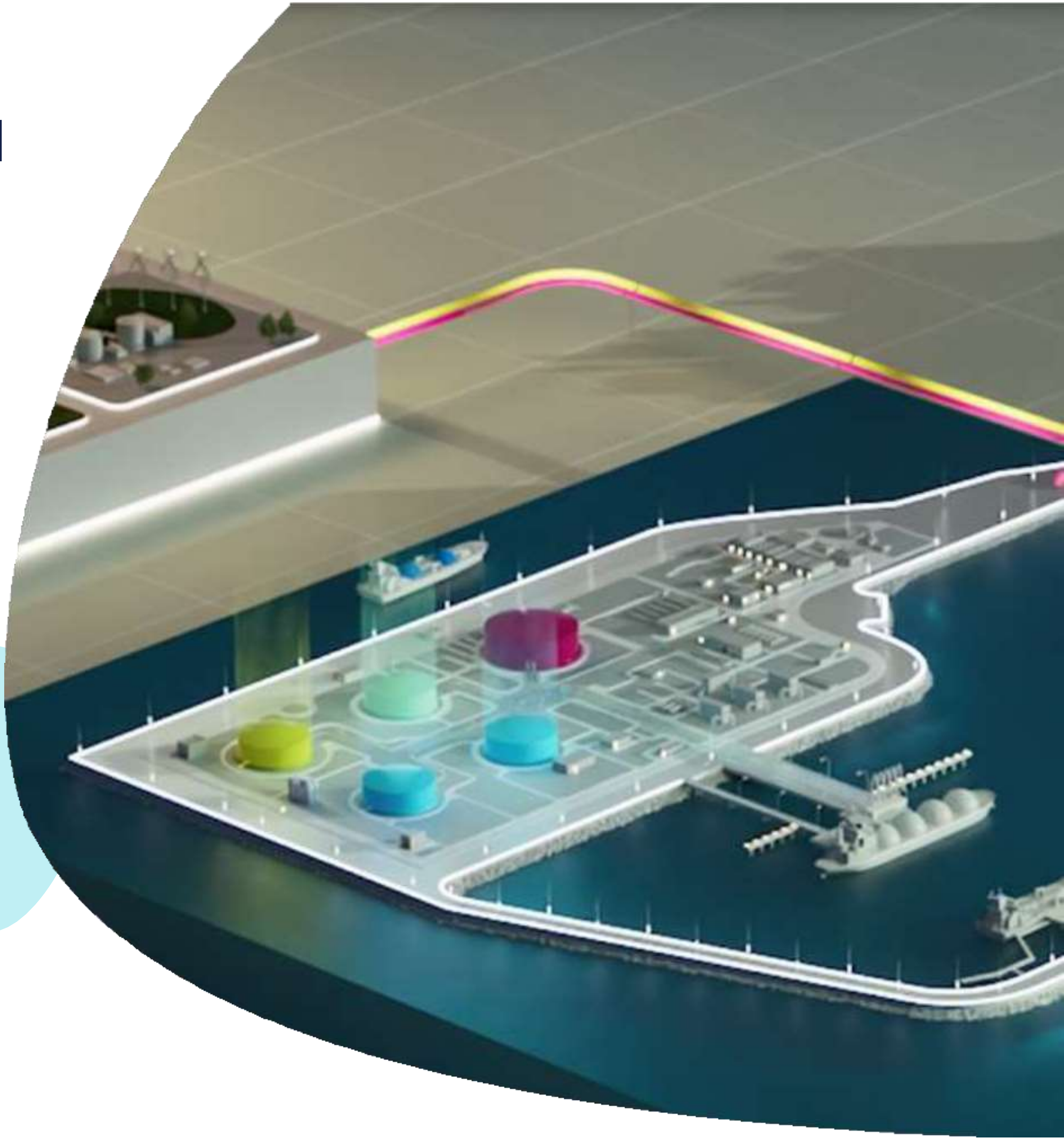


Phase 3: Beyond 2030



Development Zeebrugge LNG terminal into multi-molecule hub

- NH_3 import terminal
- Export CO_2 terminal



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Case: Distribution systems operators decarbonizing the gas grid

Jose Catela Pequeno

Head of Special Projects at Floene

FLOENE

DISTRIBUÍMOS ENERGIAS DE FUTURO

GREEN PIPELINE PROJECT

The Natural Energy of Hydrogen.

INSTITUTIONAL PARTNERS

FUNDO AMBIENTAL · seixal câmara municipal

TECHNICAL PARTNERS

Gestene · PRF Gas Solutions · ISQ · TÉCNICO LISBOA · BOSCH · catim · AP2H2

Floene is the largest gas distributor in Portugal with approx. 72% market share(1)

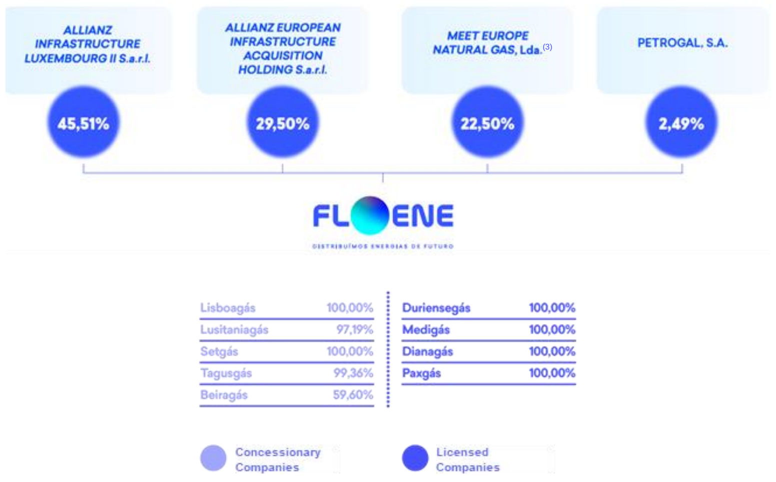
Overview

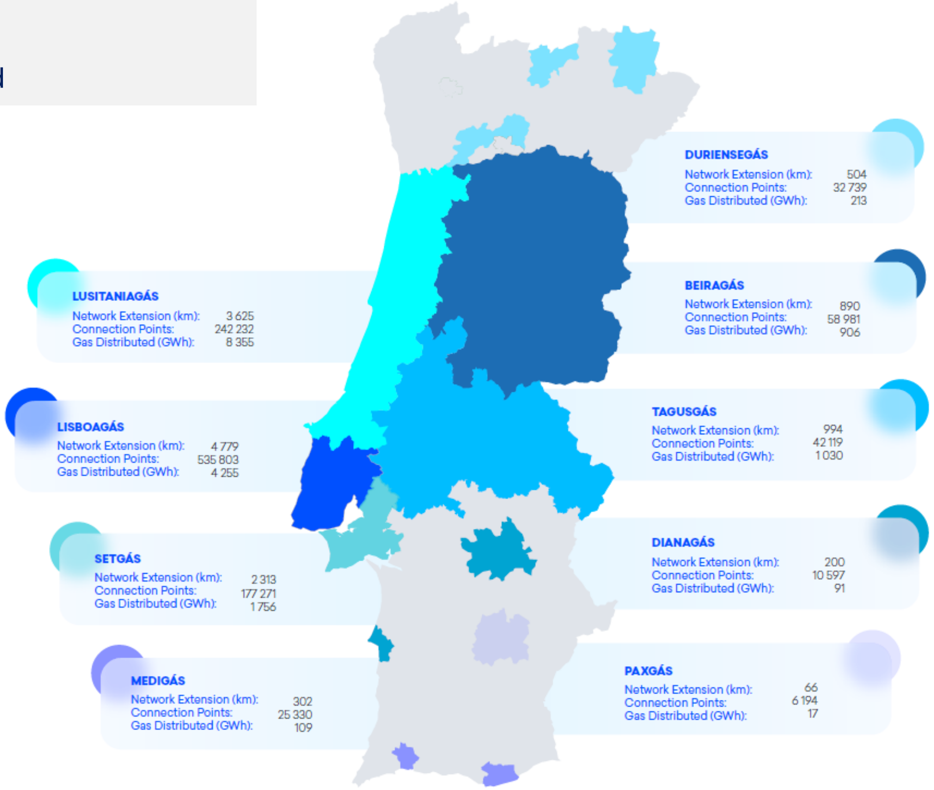
- Floene is the **leading gas distributor in Portugal:**
  - Manages **nine Regional Gas Distribution Operators ("DSO"),** which account for **c. 72%(1) of the gas distribution network** under the public service regime.
  - Operates **one of the most modern and efficient gas infrastructures in Europe,** mostly made up of polyethylene pipelines (94%), with an average age of c. 16 years.

Selected Technical Indicators(2)

- **1,131k** connection points
- **106** municipalities
- **13,673 km** network length
- **16,733 GWh** of gas distributed

Shareholder structure





Notes: (1) In terms of connection points. (2) Per Annual Report 2022, as of 31 December 2022. (3) Meet Europe Natural Gas, Lda. (consortium formed by the Japanese companies Marubeni Corporation and Toho Gas Co.Ltd.)

2 Portuguese Landscape: Growing Focus On Renewable Gases

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Positive momentum in the energy sector in Portugal, with current policies and legal framework supportive of decarbonization

PNEC 2030 PLANO NACIONAL ENERGIA E CLIMA

National Energy & Climate Plan 2030
December 2019

- The current gas infrastructure will play a key role in the distribution of renewable gases

H_2 HIDROGÉNIO

National Hydrogen Strategy
August 2020

- 10% – 15% injection H_2 into gas grids by 2030.
- 2 – 2.5 GW in electrolyser capacity.
- € 500 – 550m power-to-gas projects.

PRR Plano de Recuperação e Resiliência

National Recovery & Resilience 2030
October 2020

- € 186m to **H_2 and renewable gases** to support the investment, mostly private, in the increase of the installed capacity in electrolysers.
- € 715m towards **decarbonizing the industrial sector.**

Ordinance nº15/2023

Competitive procedure for the injection of renewable gases into the gas grid:

- **H_2**: **120 GWh/year** (max. support of **127 €/MWh**)
- **Biomethane**: **150 GWh/year** (max. support of **62 €/MWh**)

145
Biomethane - 14
Green Hydrogen - 131

INJECTION REQUESTS

to the networks operated by **FLOENE**

Source. Company information, Plano Nacional Energia e Clima 2030 (PNEC 2030), Estratégia Nacional para o Hidrogénio from Direção Geral de Energia e Geologia, Plano de Recuperação e Resiliência 2030.

3 Small scale Green Hydrogen injection into the gas grid

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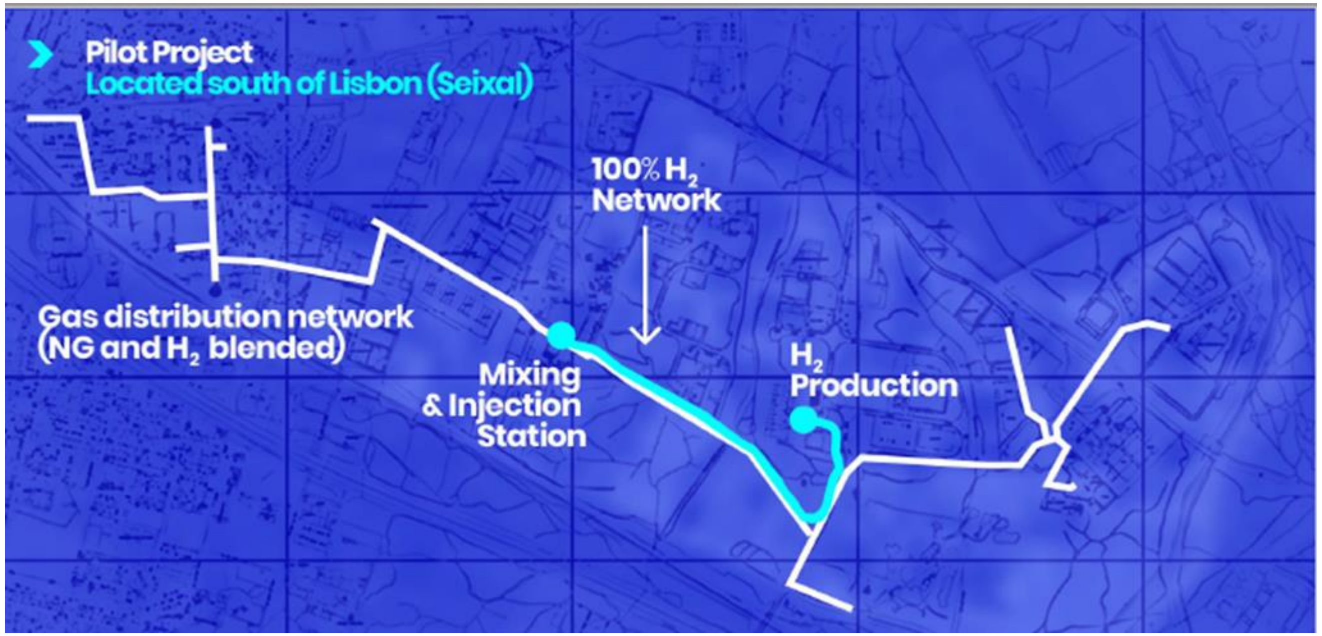
H_2 Producer	Gestene Electricidade Industrial, Lda.
Customers	~ 80 Mainly Residential
Project duration (years)	2
H_2 to be injected (Nm^3/2 years)	131,400 (45% from solar cells; 55% from the grid)



- Hydrogen is produced by GESTENE, using a 57 kW Mc Phy electrolyser, capable of producing 10 Nm^3/h of 99.999% pure H_2 at 10 bar.
- Power supplied by solar panels and public grid.
- Solar panels capacity: 25 kW
- A suitable H_2 injection point was identified, downstream to a Pressure Reduction Station (PRS 50) where a H_2/NG Mixing Station was installed
- A 4 bar, 100% H_2, PE connection line was built between GESTENE premises and the Mixing Station.
- A small area of the natural gas grid, supplied by the PRS 50, with about 80 customers, was isolated from neighbouring grid, becoming the object of the Project.
- H_2 blending up to 20% in 2% increments (currently 12%)
- Injection started in July 2022
- Project fully funded by the Environmental Fund

2 Project Concerns and Solutions

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2 Project Concerns and Solutions

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SAFETY

Utilization

Operations

Communication with Customers

- Leaflets
- Dedicated phone line
- Technical verification and repair follow-up by specialized customer service team
- Municipality support

seixal
câmara municipal

SERVICE

Fair Billing

Continuity of supply

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2 Project Concerns and Solutions

SAFETY

Utilization

Operations

Household safety inspection

ISQ

BOSCH

- Inspections previous to H2 injection
- All safety issues were cleard
- No appliances were substituted

Fair Billing

Continuity of supply

SERVICE

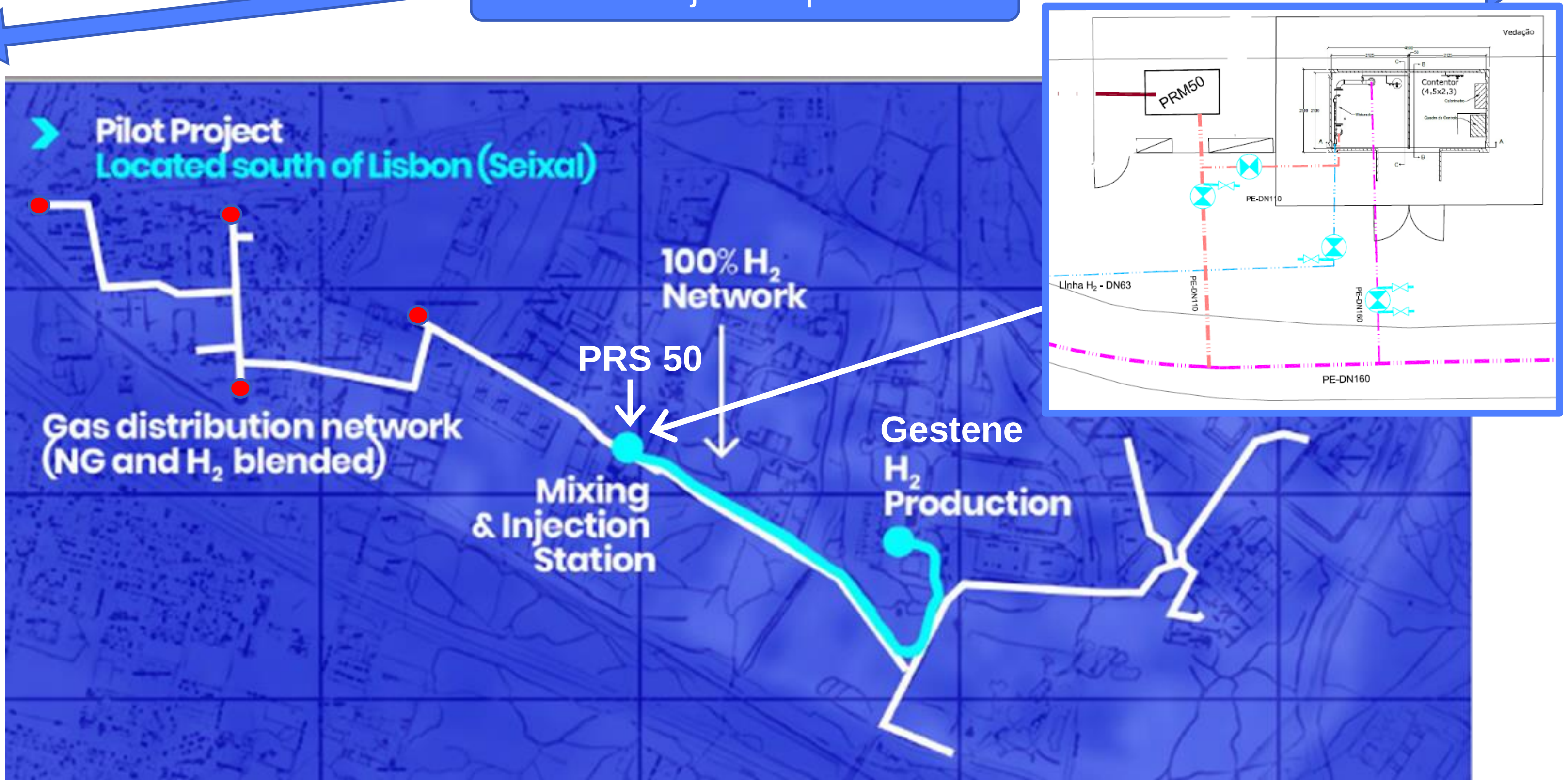
2 Project Concerns and Solutions

SAFETY

Utilization

Operations

H2 injection point



SERVICE

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Continuity of supply

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2 Project Concerns and Solutions

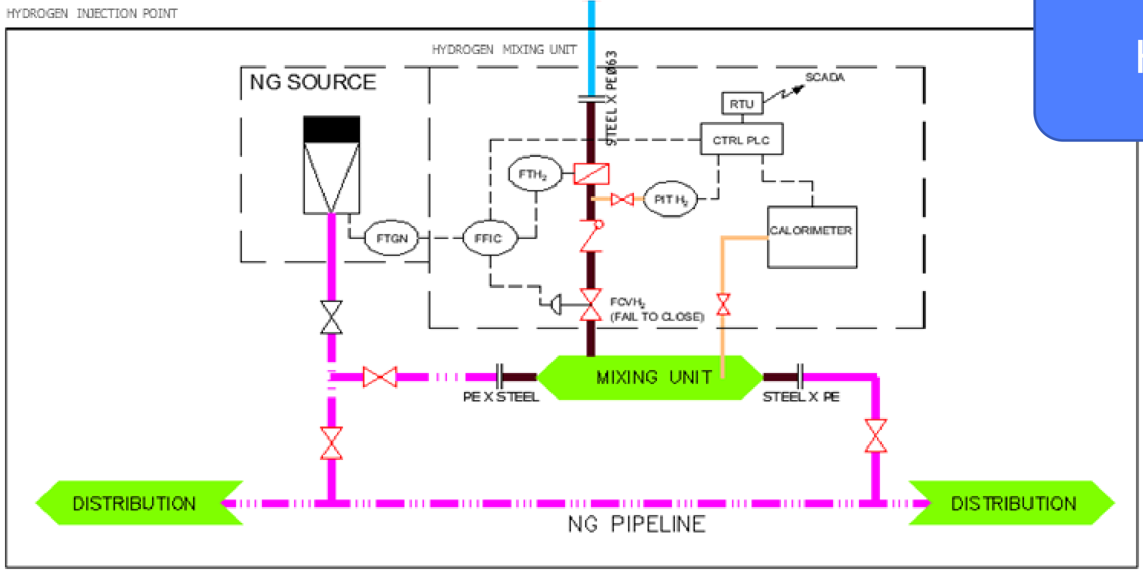
SAFETY

Utilization

Operations

- Mixture Wobbe control
- H2% control
- Ratio control (Vol H2/(Vol H2+Vol NG) <= chosen solution

H2 % effective control



HAZOP

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Continuity of supply

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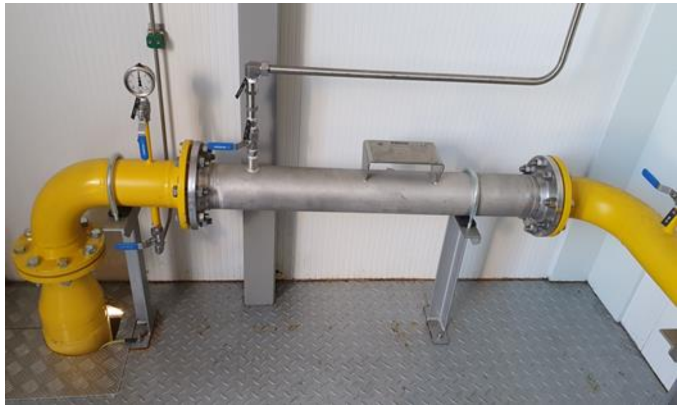
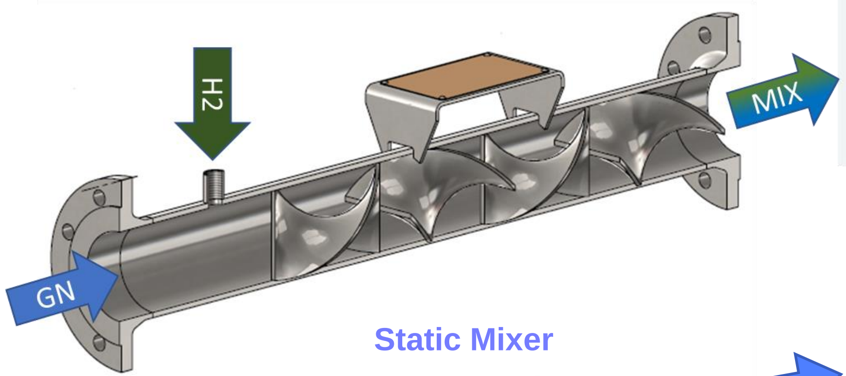
2 Project Concerns and Solutions

SAFETY

Utilization

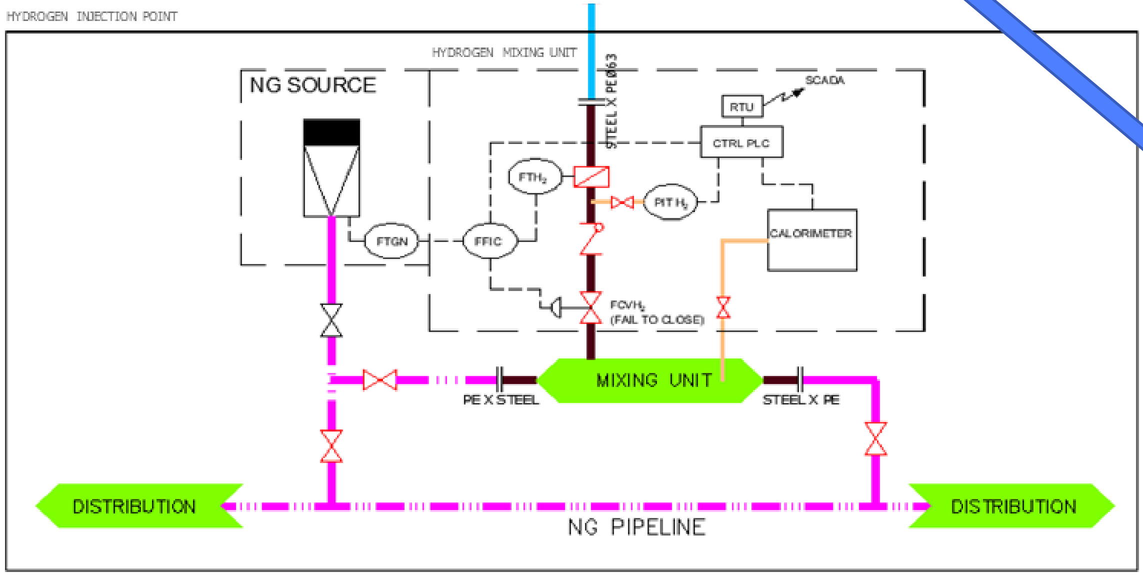
Operations





Static Mixer

NG/ H2 effective blending



SERVICE

Fair Billing

Continuity of supply

2 Project Concerns and Solutions

SAFETY

Utilization

Operations

GCV mesurement

SERVICE

Fair Billing

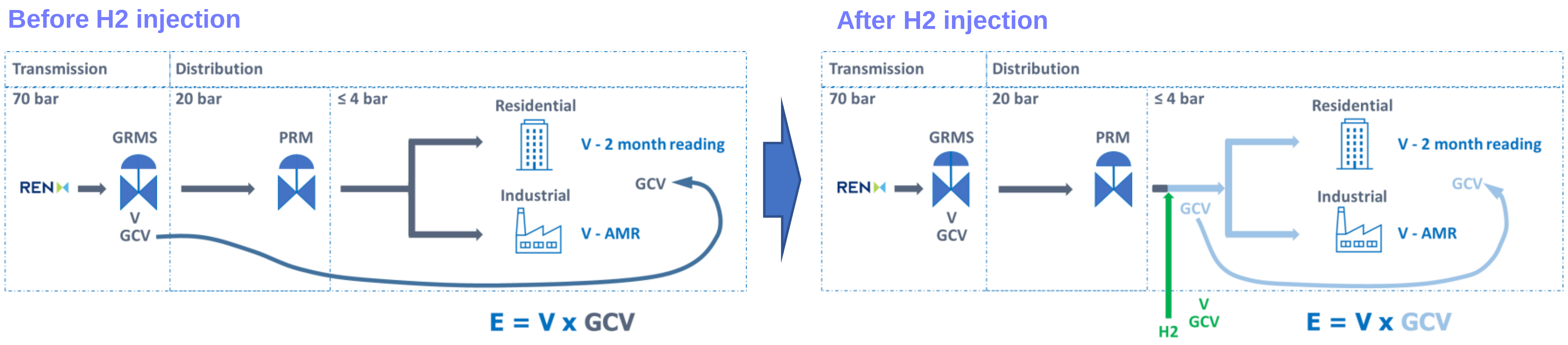
Continuity of supply

2 Project Concerns and Solutions

SAFETY

Utilization

Operations



GVD utilization for Billing

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Continuity of supply

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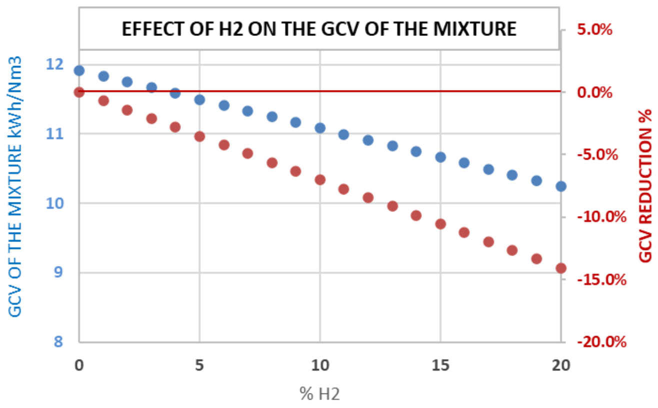
2 Project Concerns and Solutions

SAFETY

Utilization

Operations



H2 effect in the GCV & Calorimeter

H2% limits safety

HAZOP

iSQ

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Continuity of supply

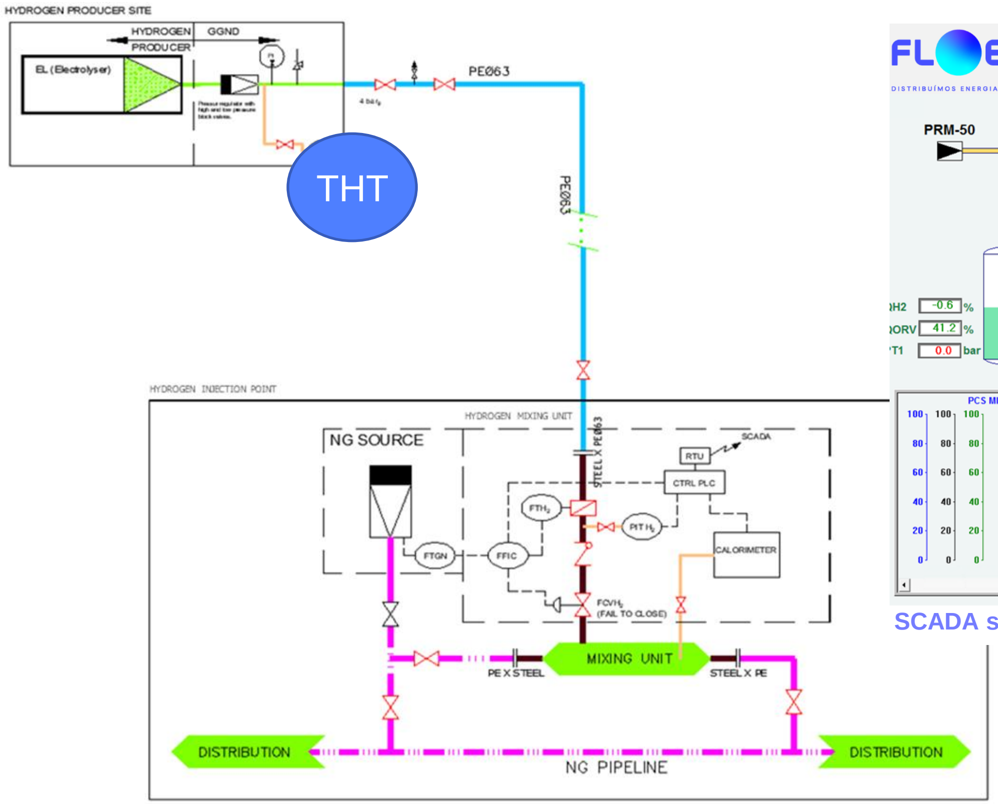
SERVICE

2 Project Concerns and Solutions

SAFETY

Utilization

Operations

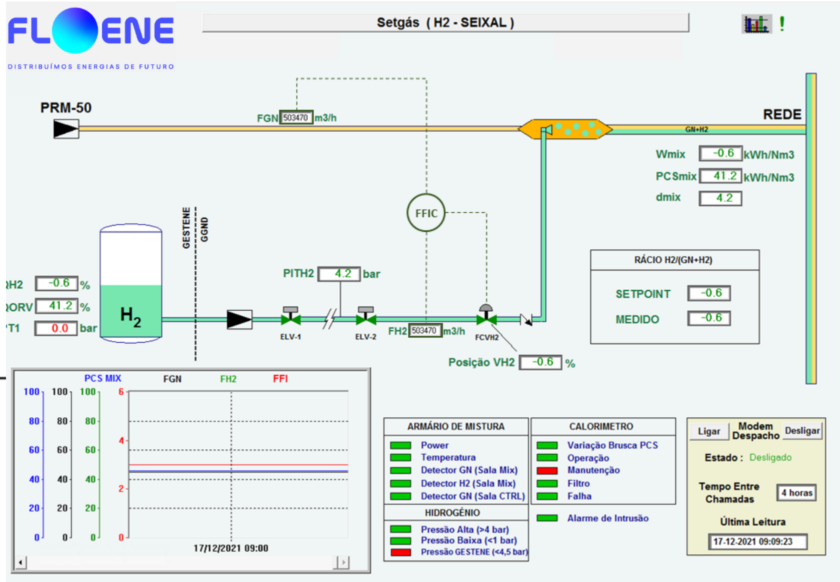


THT

Mixing station and H2 line safety

HAZOP

ATEX



SCADA screen

H2 pressure regulation and odorization at Gestene

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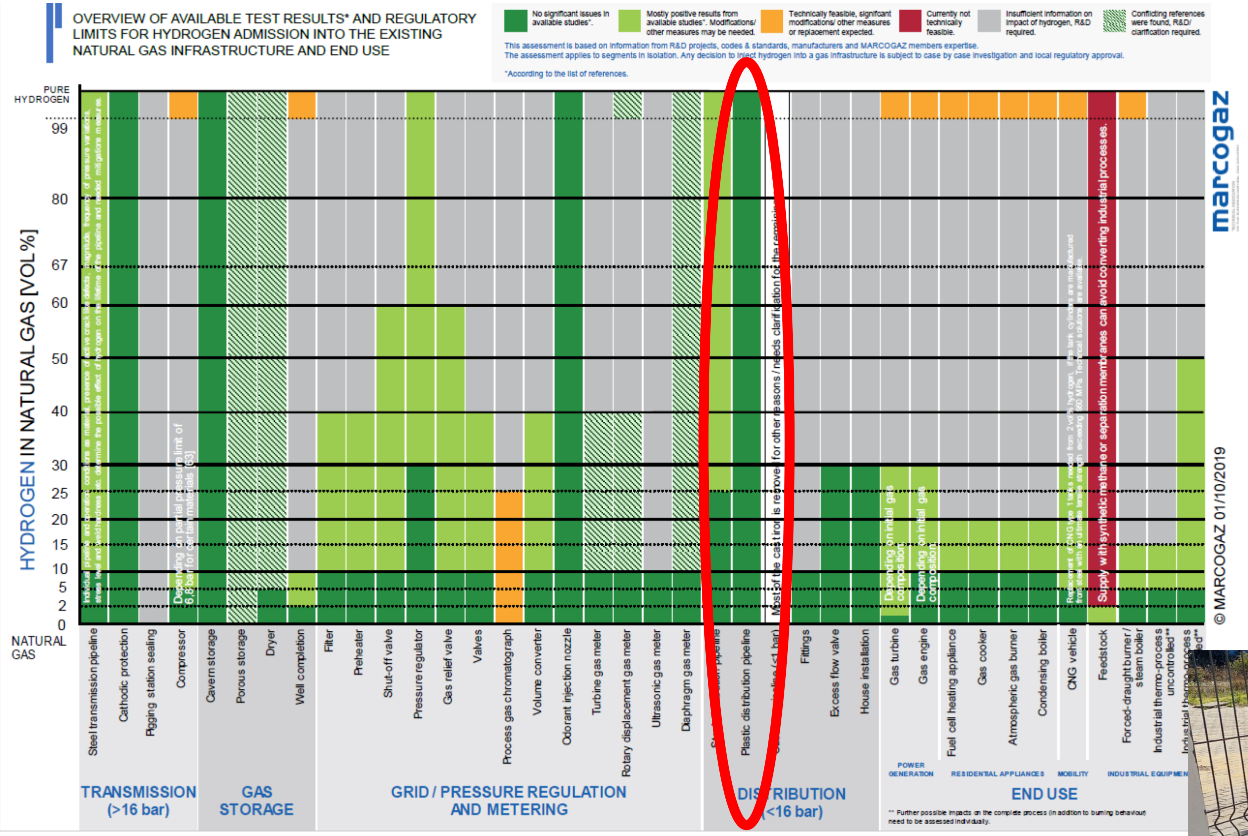
Continuity of supply

2 Project Concerns and Solutions

SAFETY

Utilization

Operations



H2 line material and odorization

Small lapping type H2 odorization at Gestene

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2 Project Concerns and Solutions

SAFETY
Utilization
Operations

Network operation procedures
- Leakage survey
- Pipeline commissioning and decommissioning
- Emergency response
- ATEX manual review

Customer Field Service procedures
- Appliance operation control
- Leakage survey
- Emergency response

Internal standards review

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Continuity of supply
SERVICE

3 Project Status and Results

Current H2 % = 12%

No issues with customers

Mixing station controls H2/NG percentage accurately

Billing system performs well

- Calorimeter very easy to operate and accurate
- Modifications made are suitable for future commercial projects

Station design should be improved

- Three rooms instead of two – the calorimeter is temperature sensitive and should be isolated

Floene is ready to cope with commercial H2 blending projects

The first of which is expected to go on-stream in the 2^{nd} Q 2024

3 Our Partners in the project

Gestene
Electricidade Industrial, Lda.

H2 production

PRF – Gas Solutions

Mixing Station Construction

seixal
câmara municipal

Municipality Support

Instituto de Soldadura e Qualidade

HAZOP, ATEX, Safety Inspections

BOSCH

GAS Appliance Supplier

4 Hydrogen Production and Storage

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Electrolyser at Gestene

H2 Storage at Gestene

H2 pressure regulation and odorization at Gestene

5 Mixing Station

Mixing station

Local Control Panel outside and inside

Calorimeter

Static Mixer

The future is coming

With the power of The Natural Energy of Hydrogen.

FLOENE

DISTRIBUÍMOS ENERGIAS DE FUTURO

For further questions and clarifications:
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marcogaz

Opening, Q&A Session and closing remarks available in the full video of the webinar, published on the Communications Hub/Videos section of our website