   

The effects of injecting hydrogen (renewable gases)

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OF THE EUROPEAN NATURAL GAS INDUSTRY

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Secretary General

Sharp growing of renewable power generation

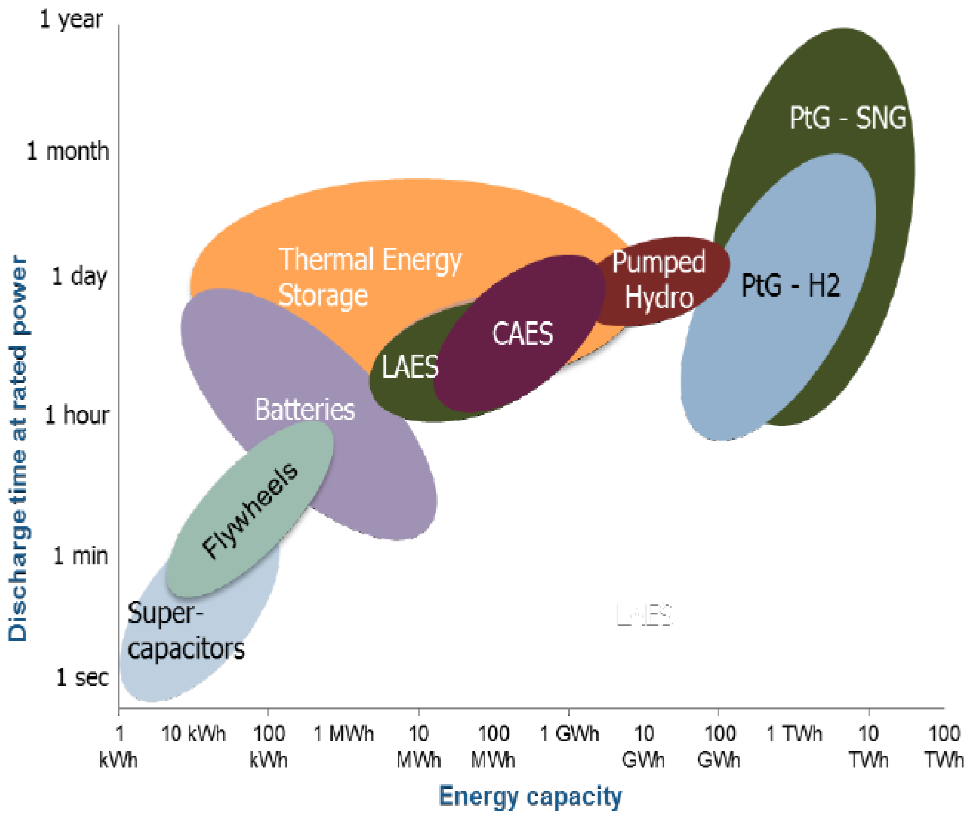
- *Peak power production generates curtailments*
- *Renewable power is intermittent*

Need for power storage

Different technologies available

- *Many of them under development*

Hydrogen is an option



Source: World Energy Council, 2016

Why hydrogen?

Allow long term storage and transport of surplus of renewable energy

Hydrogen is an energy carrier

Different utilization options:

- *Use in hydrogen application: heat, mobility, raw material, …*
- *To transform in another fuel: methane, methanol, liquid fuels*
- *Injection into the natural gas network*

Reasons behind injection of hydrogen in the natural gas grid

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Allow to use the large storage and transmission capacity of natural gas infrastructure

The natural gas infrastructures already exist and their capillarity along European territory allows connecting almost any production/utilization point

Natural gas infrastructure operators and associations are strongly committed to support the integration of renewable gases in their grids

Contribution to reduce the CO_2 footprint

Hydrogen main combustion properties vs natural gas (pipeline/LNG origin):

	Pipeline NG	LNG	H_2
Hs (MJ/m^3)	39.67	41.26	12.10
WI (MJ/m^3)	50.73	52.35	45.88
Rel. Density	0.6114	0.6211	0.0696

(15°C/15°C conditions)

- *Higher combustion velocity*
- *Higher flame temperature in stoichiometric combustion*

Effect of adding hydrogen to natural gas

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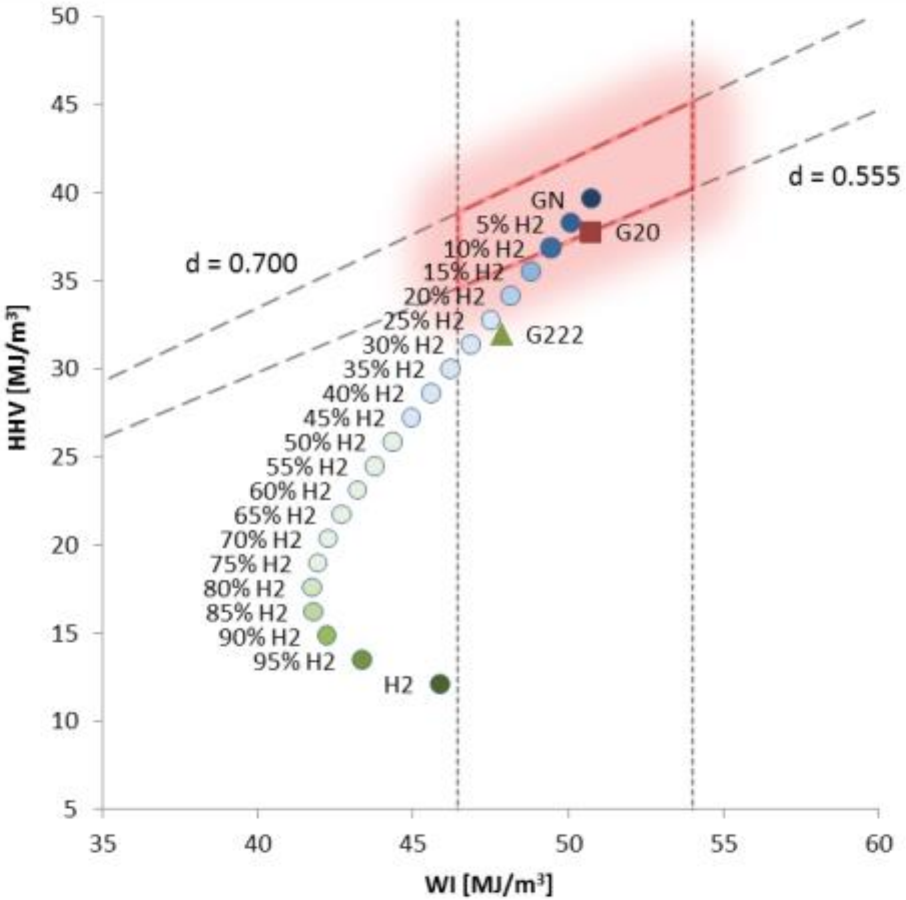
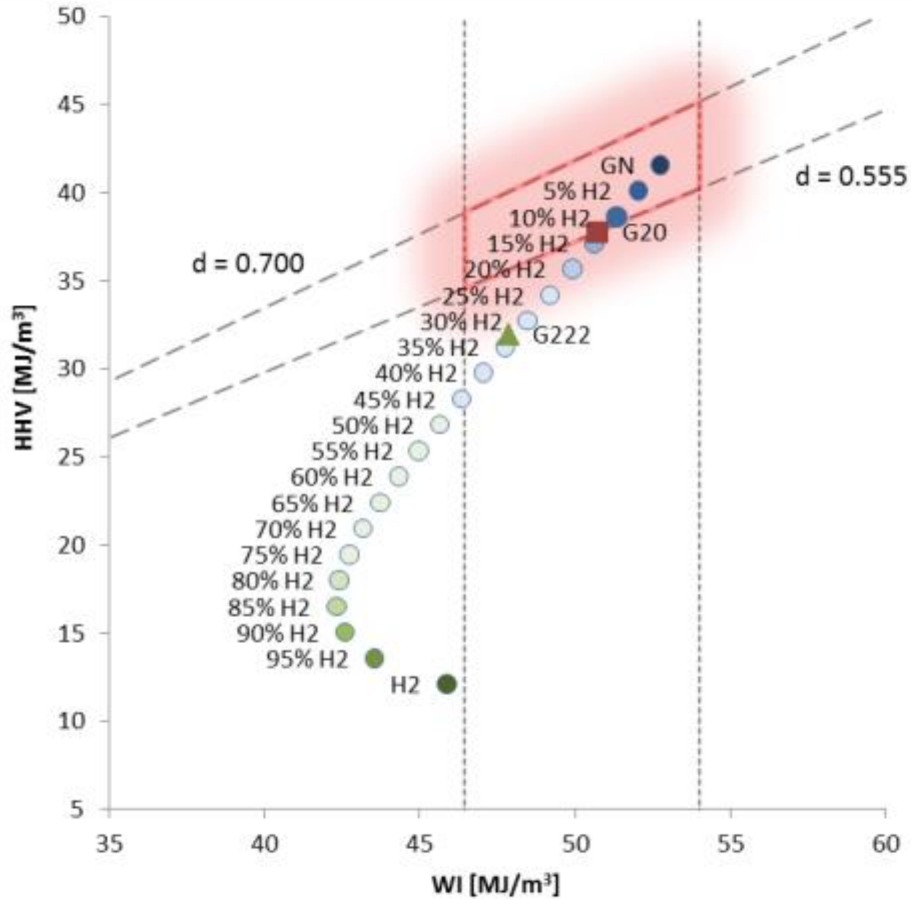
Pipeline natural gas

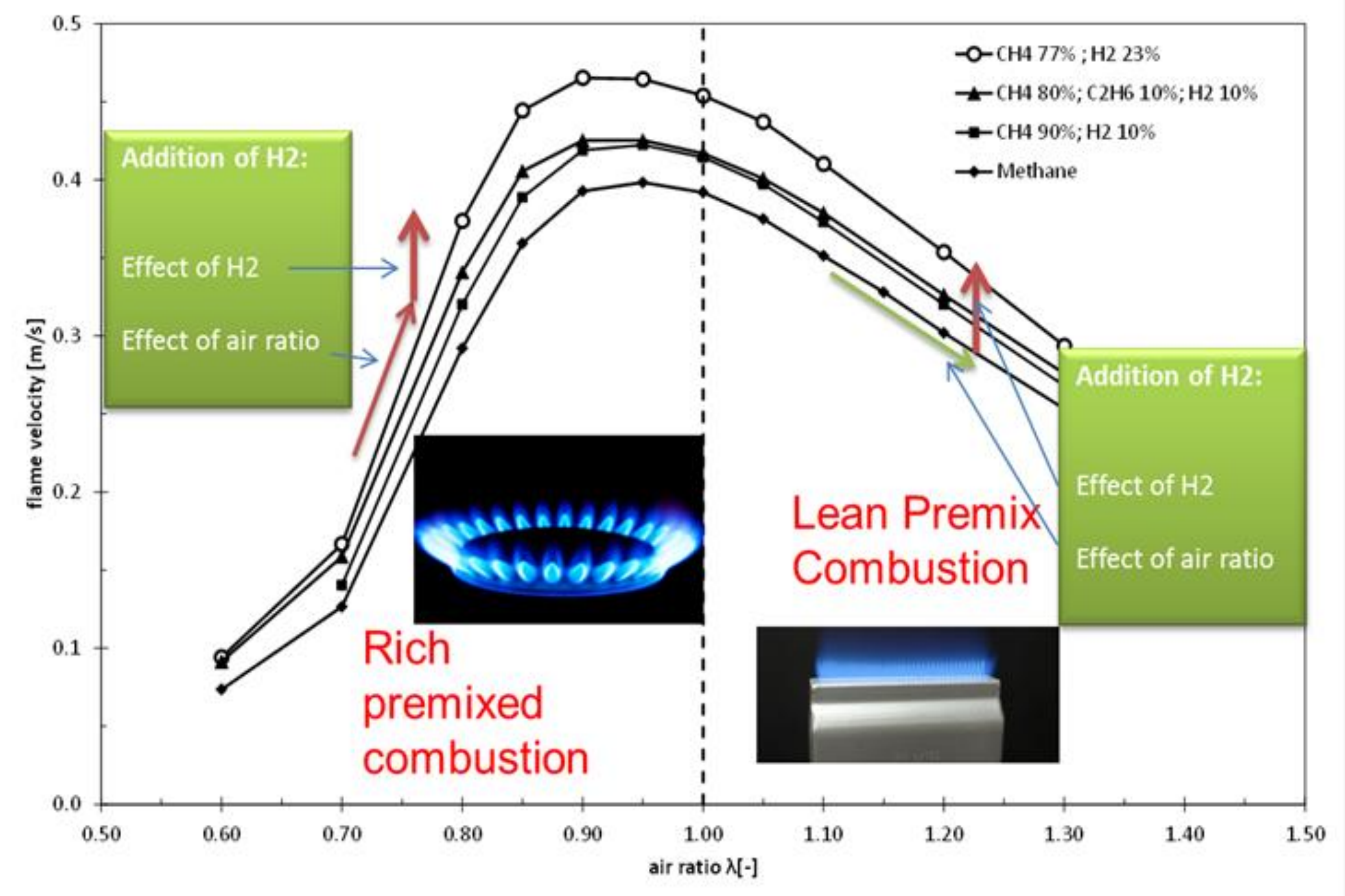


LNG



Red area: CBP natural gas specification limits as reference

Effect on gas velocity of mixtures



Source: K. Altfeld & D. Pinchbeck (GERG),

Admissible Hydrogen Concentrations in Natural Gas Systems (HIPS The paper), 2013.

What is already known - appliances

Many gas applications are able to handle mixtures of natural gas and hydrogen without significant problems

Research has demonstrate that many residential and commercial appliances can handle up to 30 % hydrogen without safety concerns

Industrial application could handle up to 50 % hydrogen without negative impact if proper measurement and control technologies are applied

Gas turbines and gas engines are probably the most sensitive applications

- *Manufacturers and researchers are investigating new technologies to address this*

Conclusions – Applications

Hydrogen reduces Wobbe index and calorific value of natural gas when mixed with it

- *Reduction depends on natural gas composition*
- *Not only WI/GCV is affected*

Acceptable concentrations of hydrogen are different today for different end uses

Many consequences of hydrogen admixtures are qualitatively rather similar to gas natural fluctuations

Report MARCOGAZ - UTIL-GQ-17-29 (http://www.marcogaz.be/index.php/gas-utilization)

Distribution network – Renewable gases

H_2 networks

- *Leeds project (CCS)*

Mixtures NG/H_2

- *Note: city gas between 40 – 60% H_2*
- *Rather stable WI/GCV needed for the appliances*
- *Depending on the materials/network structure*

Synthetic gases & biomethane

- *Equivalent to Natural Gas*

Acceptable concentrations of hydrogen depending on the local situation

- *Adaption of the network management*
- *Control/measurement*

If produced volume renewable gases (mixtures) > average Summer consumption:

- *Cut-off (decrease injection)*
- *Storage (local, via transmission pipelines, UGS…)*

Investigation ongoing (MARCOGAZ/WELMEC/FARECOGAZ/CEN) on the use of conventional meters for the measurement of non conventional gases (including H_2 and H_2 mixtures)

- *First conclusions:*
  - *No problems expected for < 10% H_2 in NG*
  - *> 10% H2 : gas characteristics are progressively changed*

    Depending on the measuring principle investigation needed:

    → *Recalibration?*

    → *Modification of the metrological model approvals*

    → *The construction specifications of the pressurized parts, all gaskets/sealing and some components (sensors…) of the meters will need to be assessed for suitability, safety (tightness, embrittlement) and durability*

    → *Static meters (US, Thermal mass, …)*

    → *Influence of the density, speed of sound, specific heat capacity…*

Conversion of m³ in kWh (billing purposes)

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Existing document : GI-EM-06-05

http://www.marcogaz.be/index.php/gas-infrastructure2

New MARCOGAZ study started

- *describe and compare different methods that could be used to determine the attributed calorific value at each metering point when gases of different qualities and sources are entering at multiple points in the gas network (depending on the percentage of injection)*
  - *Assign a conventional CV (eventually after treating and/or blending)*
  - *Use tracking devices to monitor CV*
  - *Use of calculation methods*
  - *Measure CV at metering points*
  - *Examine the effects on the compressibility factor*
  - *…*
  - *Taking into account the different types of metering points used, residential, commercial, light industrial and industrial*

Transmission network

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Component	Knowledge is available	Gaps, needs further investigation
Pipeline	Degradation mechanisms Material and construction Process condition Effect H2% on crack propagation	For older pipelines a condition evaluation will be required. Existing defects should be evaluated because they can lead to lower percentages allowable H2.
Welds	Spec's for new to build 100%-H2 pipeline specify a hardness limit of ~250 Vickers (this is conservative in our opinion)	100%-Hydrogen cracking susceptibility at hardness > 250 Vickers (e,g, at 350 Vickers) Max allowable hardness for existing pipelines for 100% H2
Compressor	For reciprocating compressor: the gas used is only of limited importance Centrifugal compressors: performance depends on the density of the gas.	Compressor design should be in accordance with the gas composition.
Gas turbines	<1 % hydrogen addition is acceptable. Some new or upgraded types will be able to cope with concentrations up to 15 %	>1% Consequences for individual engines in installed base shall be investigated
Valves	Some parts might be not suitable for H2 Differential pressures Degradation non-metallic parts (e.g. gaskets)	Assess degradation non-metallic parts Investigate possible problems at differential pressures
Safety pressure device	No adverse effects expected, some parts might be not suitable for H2	Assess degradation non-metallic parts

Storage (UGS)

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INSTALLATION	PHENOMENA	TO CHECK
Surface facility	Corrosion	Integrity (idem for gas transport grid)
Compression units	Physical properties of H_2	Efficiency and integrity (idem for gas transport grid)
Dehydration and desulfurization units	Physical properties of H_2	Efficiency and integrity
Metering and gas quality monitoring	Physical properties of H_2	For high % H_2 content (idem for gas transport grid)
Wells	Corrosion of steel, impact on elastomer sealing elements	Well integrity and containment
Reservoirs/caverns	Containment	Not different than Natural Gas
Reservoirs/caverns	Physical behaviour (dissolution, fingering)	Not drastically different than for Natural Gas
Reservoirs	Bio-chemical reaction	Potential reactions specific for each reservoir

Document WG-STO-16-08 (D085) http://www.marcogaz.be/index.php/gas-infrastructure2

Safety

Health of workers / end-users

- No known toxicological effects of H_2 on health (Source: SDS of H_2)

Gas detection

- Detectors to be recalibrated, adapted or replaced depending on the % of H_2 and depending of the type of detection system currently in place.

ATEX Directive / zoning of installations

- Modification of current ATEX zones depending on the % of H_2.
- Electrical installations could need adaptations or replacement above 15% of H_2. (EN60079-10)

Odorisation

- Impact of H_2 on the smell of the mixture to be assessed.

Auto-ignition temperature

- Natural Gas (575…640°C) +/- the same as pure H_2 (560 ºC).

Combustion/Flame

- Different for H_2

Thank you !

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