OVERVIEW OF AVAILABLE TEST RESULTS* AND REGULATORY LIMITS FOR **HYDROGEN** ADMISSION INTO **EXISTING NATURAL GAS INFRASTRUCTURE AND END USE**

*ACCORDING TO THE LIST OF REFERENCES

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TECHNICAL ASSOCIATION
OF THE EUROPEAN NATURAL GAS INDUSTRY

01-10-2019 - TF_H2-427

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No significant issues in available studies*.

Mostly positive results from available studies*. Modifications/ other measures may be needed.

Technically feasible, signifcant modifications/ other measures or replacement expected.

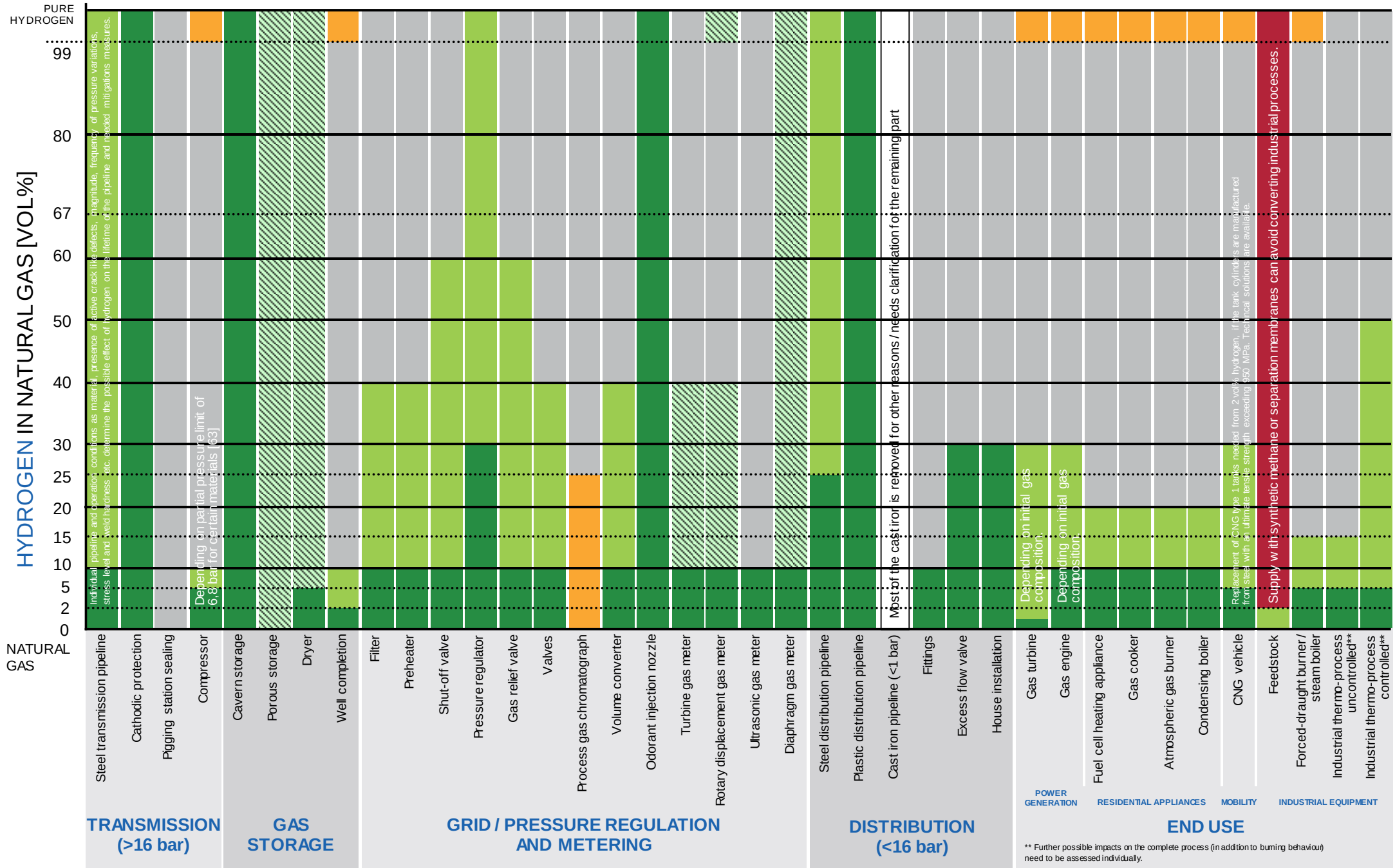
Currently not technically feasible.

Insufficient information on impact of hydrogen, R&D required.

Conflicting references were found, R&D/ clarification required.

This assessment is based on information from R&D projects, codes & standards, manufacturers and MARCOGAZ members expertise.
The assessment applies to segments in isolation. Any decision to inject hydrogen into a gas infrastructure is subject to case by case investigation and local regulatory approval.

*According to the list of references.



** Further possible impacts on the complete process (in addition to burning behaviour) need to be assessed individually.

Purpose of infographic

- The properties of Hydrogen (H_2) are different to those of natural gas. Mixtures of hydrogen and natural gas (H_2NG) have different properties than the two individual gases. This raises the question of the suitability of the existing natural gas infrastructure and end uses equipment for utilizing such mixtures.

This infographic aims to:

- Provide an overview of the technical readiness of the gas infrastructure and end uses equipment to handle hydrogen-natural gas mixtures at each stage of the gas chain. The infographic currently focuses on material aspects and functional principles It does not consider the effect of increasing levels of hydrogen on performance, efficiency and output.

- Identify gaps in knowledge and areas where R&D is required to remove barriers that limit hydrogen uptake in the supply chain and enabling new applications for hydrogen and H_2NG.

- Collect and assess the most up-to-date knowledge on the use of hydrogen and H_2NG based on evidence and experience from gas network & storage operators and end use experts.

- Collect and appraise the current state of knowledge of transmission, storage, distribution and use of H_2NG and hydrogen, drawing on the wide expertise and experience of network operators, storage operators and end use experts.

- Assist with the investigation into the opportunities with the existing gas infrastructure to achieve the best benefits and contribute to reaching climate goals.

Summary

- MARCOGAZ members with experience in operating gas infrastructure or involved in pertinent research have reviewed more than 60 references *(https://www.MARCOGAZ.org/publications-1/documents/hydrogen-infographic/)* on the hydrogen tolerance of the existing gas infrastructure and end use applications.

Natural gas infrastructure and residential appliances:

- Major elements of the gas transmission, storage and distribution infrastructure and residential gas appliances are expected to be able to accept 10 vol.-% H_2 without modification.

- Some networks and residential appliances are already being operated with 20 vol.-% of hydrogen [62].

- Major elements of the infrastructure and residential appliances are expected to be able to accept 20 vol.-% H_2 with modification*.

- Higher concentrations (> 20 vol.-% H_2) can be reached through R&D by further measures or replacement.

Industrial processes:

- Many industrial processes (except feedstock) are expected to be able to accept 5 vol.-% H_2 without modification.

- Current power plant gas turbines, industries using natural gas as feedstock and also CNG steel tanks are assessed to be sensitive to even small quantities of hydrogen and need further R&D/mitigation measures when planning to convey higher hydrogen concentrations.

- Thermoprocessing equipment (such as furnaces and burners) are expected to be able to accept 15 vol.-% H_2 with modifications*.

- Higher concentrations (> 15 vol.-% H_2) can be tolerated through R&D, further measures or replacement.

* According to the studies listed in the references.

Next steps

- To enable hydrogen concentrations in the range of 5 to 10 vol.% H_2, R&D is recommended to understand the effect on underground gas storage, gas turbines, process equipment in the chemical industry using natural gas feedstock and steel tanks for CNG vehicles.

- To exceed hydrogen concentrations of 10 vol.-% H_2 in addition to the topics mentioned before, special R&D focus is required on gas transmission issues including pipelines and compressors. Underground gas storages (including well completion and the suitability of porous rock structures) should also be investigated. In addition, metering devices and industrial gas use need to be addressed.

- R&D for residential appliances is especially recommended for hydrogen concentrations above 20 vol.% H_2 as well as to understand the impact of varying hydrogen concentrations in general. A few cases are expected where R&D will be recommended for hydrogen concentrations above 10 vol.% H_2.

- Further focus should be put on the development of retrofit solutions for existing installed appliances to allow them to handle hydrogen / natural gas mixtures.

- Mitigation technologies, such as membranes and methanation, used to reduce hydrogen concentration in gas grids exist. They are considered to be very important to protect sensitive equipment and processes and can be installed beforehand Further R&D is recommended in such cases.

- Further R&D does not mean that the equipment is not suitable for use with hydrogen / natural gas mixtures or that no modification measures are currently available. Rather, it reflects the need for innovation to develop new opportunities with the aim of obtaining the maximum benefit from the existing infrastructure.

Additional Explanation

- Equipment in the gas infrastructure, underground gas storages and end use are diverse and have different life/usage times. Nevertheless, all equipment needs to be renewed at the end of its useful economic life.
  This is a continuous process that naturally offers the opportunity to install optimised and more future-proof equipment. Hence renewal cycles should be used to increase the tolerance of the gas infrastructure and end uses to higher hydrogen concentrations.

- For many current installed end-use applications, the presence of hydrogen in natural gas is a relatively new topic. Given the wide variety of end-uses across all sectors (residential, commercial, industry, power generation and mobility), R&D activities are required to investigate the impact of higher levels of hydrogen and to develop technology solutions for “hydrogen readiness”. The aim is to maintain highest levels of performance in terms of efficiency, fitness for purpose, flexibility and low-pollutant emissions that these appliances and applications have achieved over the last decades.

- Sensitive end use equipment could require the use of digital reproduction systems, local gas quality measurement and appropriate control technology.

References

The assessment is based on is based on public and non-public information R&D projects, Codes & Standards as well as manufacturer and MARCOGAZ member expertise. Due to the large number of references, these are summarised in a digital bibliography in the link below.

You can call up the bibliography using the QR code as follows:

1. Download a QR code scanner app onto your smartphone or tablet.
2. Use the camera or download the QR code below.
3. The digital bibliography opens.

You can also access the digital bibliography via the following link:

www.marcogaz.org/publications-1/documents/hydrogen-infographic/

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