# Using natural gas grids for transport and distribution of $H_2$

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*Making use of natural gas infrastructure for $H_2$ transport*

With the increasing importance of the role of $H_2$ in the European and global energy systems (notably in Japan, United Kingdom, South Korea and Canada), there is an ongoing study and debate on the possible use of the existing natural gas grid infrastructure natural for $H_2$ transport.

**At European level the following key issues are being discussed:**

- **Technical issues** regarding the admissible and viable percentage of $H_2$ blending in the grids and at what scale the corresponding regulation will be undertaken (national or European);
- **Guarantees of origin certificates** (GO);
- **Articulation with current European legislation**, and in particular the almost absence of mentions to $H_2$ in the legislation in place

## Technical issues on the share of $H_2$ for blending

This is one of the most controversial issues on this topic and several lobbies have came forward with contradictory views. According to some groups, the maximum share of $H_2$ that is technically viable in the natural gas grids is of 5% in volume. MARCOGAZ (Technical Association of the European Natural Gas Industry) has defended that the maximum admissible share of $H_2$ in all grids in Europe is of 20% (in volume), with some exceptions for some specific situations.

### *Embrittlement*

From a technical point of view the main drawback could be the pipelines' *embrittlement*, that is, the possibility of fissure in pipelines due to the reaction of $H_2$ with the steel of which they are made of. This phenomenon is more relevant for the natural gas transport grids that are usually made of steel, while the natural gas distribution grids are mostly built on polyethylene pipes throughout Europe (with some exceptions for a few countries).

However, even for the steel pipelines, embrittlement is only a case for concern for high-end steel (as API X70 or API X80). In any case, a share of $H_2$ up to 20% in volume in viable and safe, according to MARCOGAZ.

Some of the solutions to overcome this limitation and increase the share of $H_2$ in the natural gas grid above 20% could be: (i) adding oxygen to "block" the contact of $H_2$ with the steel; (ii) relining transport pipelines with an inner lining of polyethylene, similarly to what has been done in Berlin in the 90s (note that this is a very expensive option).

### *In Portugal...*

***The Portuguese natural gas distribution grid is mostly made of polyethylene pipelines. The transport grid is made API X57 steel pipelines, which is one of the less embrittlement vulnerable steel types among the "high end" steel according to MARCOGAZ.***

## *$H_2$ Storage*

The current storage options considered by the TSOs (*transmission system operators*) and DSOs (*distribution system operators*) are the transport and distribution grids, the storage in tanks and underground storage. It should be mentioned the relevance of the embrittlement phenomenon depends o how the grids will be operated, since embrittlement is more relevant when there is a higher fluctuation of the gas pressure in the grid. When the TSO/DSO use their own pipelines to store gas there is a higher variation in pressure. Therefore, some operators are starting to ponder building more infrastructure for dedicated gas storage .

Regarding underground storage, the following options are being assessed: (i) using salt caverns, which are considered a stable and safe option; (ii) porous storage currently on-going in Austria, but where it was reported that unfortunately the $H_2$ reacted with the surrounding formations and was converted into methane; (iii) $H_2$ injection in depleted natural gas fields (on-going in Argentina).

The Portuguese plan for development of the liquified natural gas distribution grid for 2020-2029, made by REN (Portuguese TSO), has been under public consultation until March 2020. In the proposed plan $H_2$ is not mentioned. In the scoping document prepared by ERSE (Portuguese energy regulator) the following information is provided (p.27): *"The energy sector is going though a European-wide discussion and reflection regarding the role that each energy vector will have within the energy transition. ERSE will have to provide its feedback on a plan that may not be totally aligned with current guidelines for national and European energy policy, since the proposed PDIRGN 2019 was developed before the approval of the National Energy and Climate Plan 2021-2030 (PNEC 2030) within the Portuguese obligations following the Clean energy for all Europeans package."*
Decadal Indicative Development and Investment Plan in the RNTIAT (National Grid for Transport, Interconnections, International Connection Underground Storage and of the LNG Terminal)

> *"The massive deployment of grids with 100% $H_2$ in the next 10-15 years is not likely, since besides the technical and financial issues this would entail, it would be necessary to produce substantial amounts $H_2$ which do not seem feasible in such timeline."*
>
> *MARCOGAZ, March 2020*

## *End-use consumers*

One of the main barriers for increasing $H_2$ share in the natural gas grids will the requirements of the end-use consumers, such as:

- availability of a stable $H_2$/ natural gas blend in the grid, specially for industry consumers, which are substantially more demanding since they need to ensure the quality of their final products and use productive processes that can be affected by a variable blend. This is a concern mostly of the chemical industry and could lead to the need for developing and implementing "mix equalizing" infrastructures or for membranes for separating $H_2$ from naturals gas at the "gate" for some industry consumers;

- technical viability of existing natural gas appliances in residential and services buildings to consume a blend of natural gas & $H_2$ .

One of the possibilities being considered in the EU is the future co-existence of two parallel natural gas transport systems, one only for natural gas and another one with $H_2$ blending, managed by the TSOs. The DSOs could, depending on the requests made by its end-use consumers, choose one or the other, or also directly connect to the distribution grid local $H_2$ producers.

Considering the mentioned issues it currently seems consensual that the $H_2$ share in the natural gas grids in EU will by firstly of circa 25-35% in volume and at a later stage of 100% $H_2$. Considering the technical complexity of adapting existing infrastructure, the gradual increase of the $H_2$ % in the grid up to 100% does not seem viable. With the current information available it seems that the integration of 100% hydrogen in the grid is possible already in some cases and it should be considered from the start to be economically viable.

In any case it will be necessary to develop technology, techniques and procedures for measuring and monitoring $H_2$ content in the grids, the calorific value of the blend and existence of $H_2$ leakage. The currently available sensors are not yet economically viable for grid operators.

Similarly to what is on-going for electricity, gas grid will have to become smart and responsive, with end-use equipment capable to adapt to variable $H_2$ content.

## ON-GOING PROJECTS

The following projects with $H_2$ blending in the natural gas grids are in operation:

- $H_2$ produced via electrolysis in the area of **Hamburg** in Germany injecting 2% $H_2$ (volume) in the natural gas grid, with on-going expansion up to 15% $H_2$;
- Natural gas grid of **Dunkirk** in France currently with 20% $H_2$;

In the north of **United Kingdom** an innovative and ambitious projecting is rapidly being implemented aiming for an 100% "blue" $H_2$ grid where $H_2$ is produced via natural gas steam reforming with CCS. This grid could supply up to 3,5 million consumers. The main driver for this project is the creation of jobs through a technological cluster:

https://www.h21.green/

## *Key-players in Europe*

**MARCOGAZ** Technical Association of the European Natural Gas Industry www.marcogaz.org

**ERGAR** The European Renewable Gas Registry www.ergar.org

**ENTSO-E** European Network of Transmission System Operators www.entsoe.eu

**E.DSO** European Distribution System Operators www.edsoforsmartgrids.eu

**ENTSOG** European Network of Transmission System Operators for Gas www.entsog.eu

**GRUPO THÜGA** Largest municipal energy supplier in Germany www.thuega.de

**What will be the future of natural gas grid in Europe's decarbonisation? What are the implications for the investments foreseen by companies till 2030?**

## Articulation with current European legislation

Regarding articulation with current European legislation in place, presently $H_2$ is only briefly mentioned in the RES Directive (Directive 2018/2001/EU).
The main topics being debated are:
- Should $H_2$ in gas grids be addressed in new dedicated pices of law or should existing legislation/regulation be adapted?
- Should blending of "blue" $H_2$ (produced from natural gas with CCS-carbon capture and storage) be accepted or only "green" $H_2$ from renewable sources will be allowed? The main question is if "blue" $H_2$ "may or not be considered to comply with climate policy targets.

Still within this topic, the articulation with the EU ETS - European Trading Scheme for $CO_2$ emission permits should be addressed, but so far there is no information on the matter.

## Guarantees of Origin (GO)

The figure of Guarantees of Origin is presented in the RES Directive and currently is implemented in Portugal for renewable electricity. For renewable gases the RES Directive requests two elements not not needed for renewable electricity: (i) proof on how the gases were produced and (ii) information on which final energy vectors these gases will replace in the end-use consumer.
This information is rather difficult to obtain (especially the last item).
The main issue regarding the introduction of a $H_2$ share in the natural gas grid as in the RES Directive has to do with the so far still unclear features for implementing the GO considering the needs and characteristics of the producers and end-use consumers.

Currently there are two relevant certification platforms in the EU:
(i) CertifHy for $H_2$ GO which is very complex and cumbersome to use for producers as it was not designed for the free trade of $H_2$, and
(ii) platform for biomethane that uses a separate system.
The compatibilization of the two platforms is not straightforward.

## *More information*

**Plataform CertifHy**
https://www.certifhy.eu/

**The Bridge Beyond 2025 Conclusions Paper** of the ACER Agency for the Cooperation of Energy Regulators and CEER Council of European Energy Regulators
https://www.acer.europa.eu/en

**Overview of available test results and regulatory limits for hydrogen admissio into existing natural gas infrastructures and end use**
MARCOGAZ
https://ec.europa.eu/info/sites/info/files/energy_climate_change_environment/events/documents/02.c.03_mf33_background_-_marcogaz_-_infographic_hydrogen_admission_-_j_dehaeseleer_g_linke.pdf

**Development plan for the liwuified natural gas distribution grid in Portugal within 2020-2029 (in portuguese)**
https://www.erse.pt/atividade/consultas-publicas/consulta-p%C3%BAblica-n-%C2%BA-85/

**Development of Business Cases for Fuel Cells and Hydrogen Applications for Regions and Cities / Hydrogen injection into the natural gas grid**
https://www.fch.europa.eu/

**HyDeploy: UK Gas Grid Injection of Hydrogen in Full Operation**
https://www.itm-power.com/news/hydeploy-uk-gas-grid-injection-of-hydrogen-in-full-operation

**ENTSOG Road Map 2050 for gas grids**
https://www.entsog.eu/entsog-roadmap-2050