Joint ACER/EnC $H_2$ Webinar

# Creating the Hydrogen Market:

## Hydrogen Blending into Existing Gas Networks

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entsog
european network of transmission system operators for gas
gie
Gas Infrastructure Europe
SYSTEM DEVELOPMENT MAP
Import & Transmission Capacity
Barents Sea
Pechora Sea
Blending
Retroffting
GHG
Deblending
Storage
GOs
Hydrogen networks
Electrolysers
Repurposing
Cost-efficiency
Mixtures
Resilience
Sector Coupling
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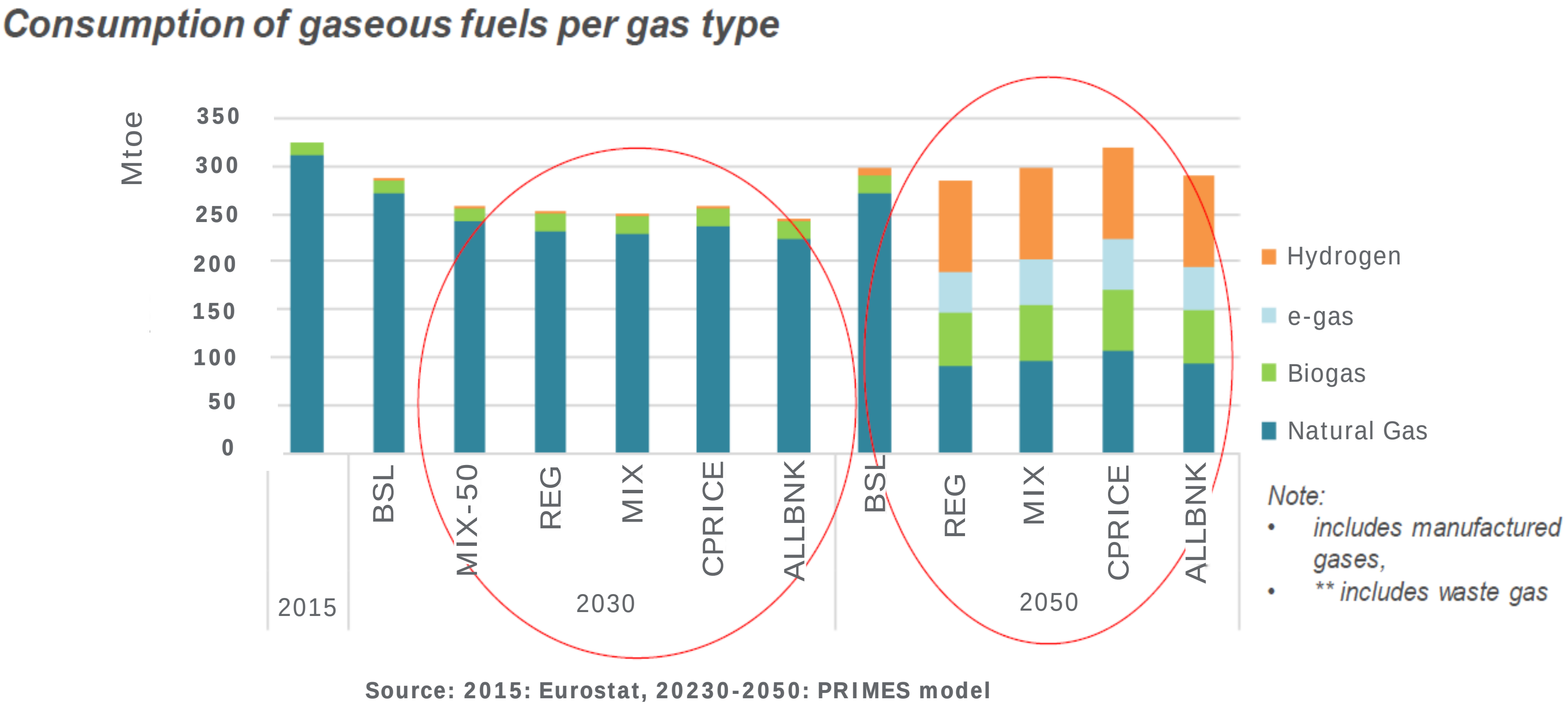
Decarbonisation
Regional approach
Flexibility
Energy System Integration
Infrastructure
EU Green Deal
Decentralised Production
Life Cycle Analisys
Separation Technologies
Interoperability
Effort Sharing
Climate Neutrality
Core Hydrogen Network

# Transformation of the “Gas” Industry

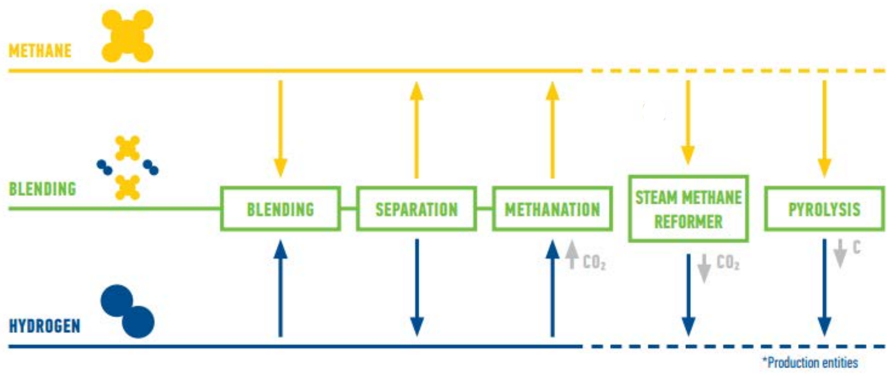



**Decarbonisation ≠ Electrification**

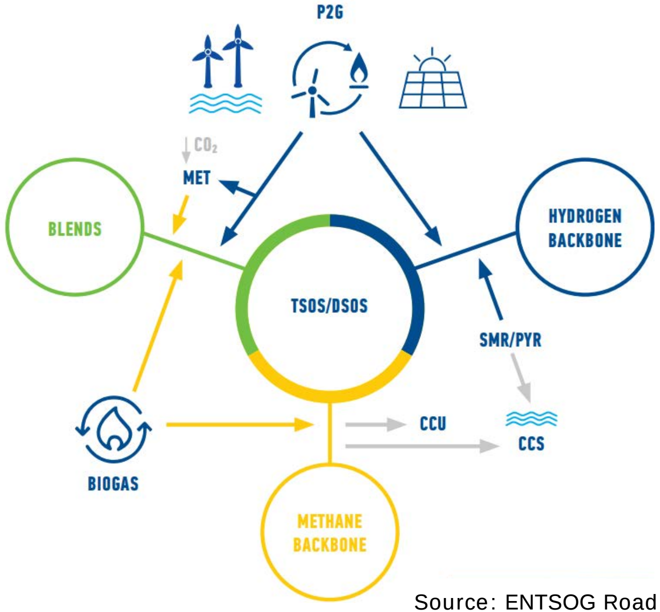
# ENTSOG Roadmap 2050

ENTSOG Roadmap 2050 identifies 3 possible, and equally important, grid configurations for achieving a carbon-neutral gas system:

1. Methane (with CCUS, biomethane, synthetic methane)
2. Blending hydrogen and methane
3. Hydrogen




Source: ENTSOG Roadmap 2050 (Dec 2019)




Source: ENTSOG Roadmap 2050 (Dec 2019)

# Blending - What for?

In essence, blending offers the following services:

1. **Gaseous Hydrogen Carrier**: facilitates transportation and storage of $H_2$, lowering the cost of linking $H_2$ demand and supply
2. **Decarbonisation Tool**: a step-by-step approach to enable more customers, in all EU countries and regions, to gain access to $H_2$ and progressively decarbonise their energy use.

$H_2$ blending, underpinned by a **GO/certificates** scheme,

- ✓ supports **higher-shares** of renewable/low-carbon $H_2$
- ✓ is a **tool to scale-up offer and demand** for renewable/low-carbon $H_2$

# Advantages of Hydrogen Blending in Summary

**Costs**

**Sector Coupling**

**GHG emissions reduction in all sectors**

**Effort Sharing among all sectors**

**Faster GHG Reduction**

**Quick $H_2$ Roll-out and Scale-up**

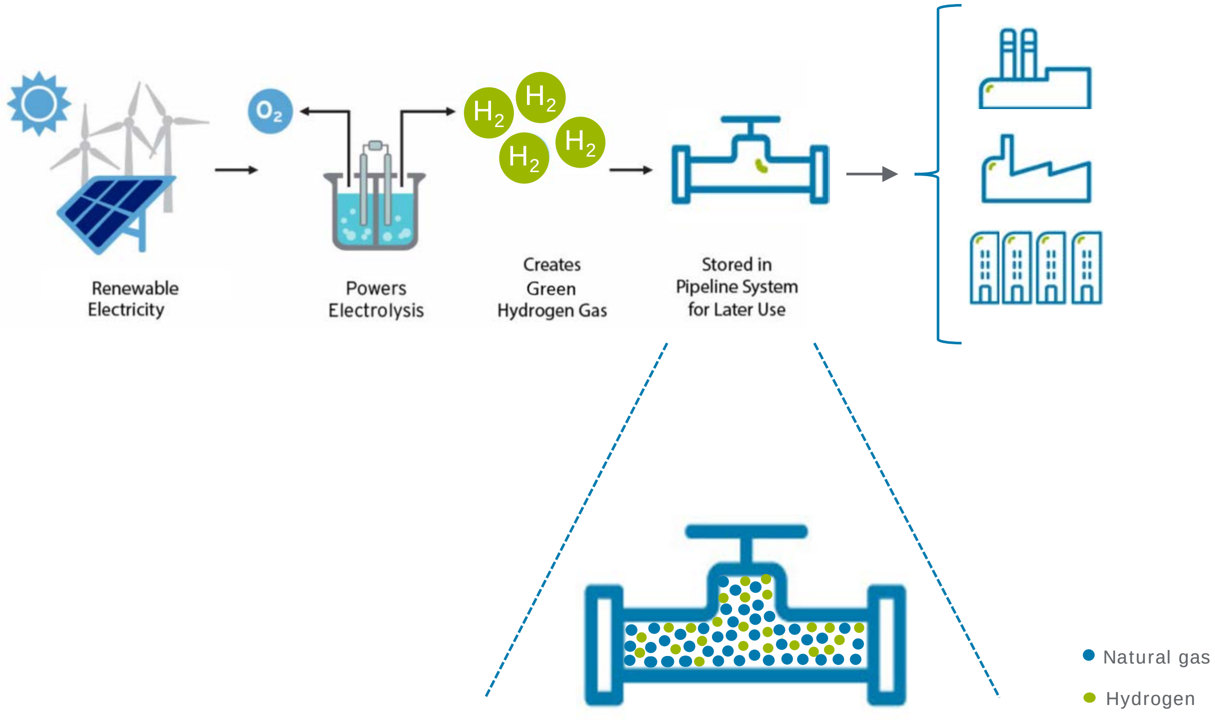
**Efficiency (thermal use)**

**De-blending**

1. Enabling faster decarbonisation
2. Covering all gas sectors and everywhere in the EU
3. Decentralised – Flexible location for injection, not linked to clusters
4. Allows for a higher load factor in electrolysers
5. Cheaper than building dedicated $H_2$ infrastructure
6. Compatible and complementary with other $H_2$ infrastructure deployment

# Blending

**Example:**



# Advantages of Blending (1/5)

**Costs**

- Integration of large amounts of renewable/low-carbon hydrogen **without large investments** (only affordable adaptation of existing network)
    - ✓ Upcoming CEN gas quality standard to allow different percentages of $H_2$ blending
- **Using the existing network** to transport hydrogen is **much cheaper than** building **new $H_2$ pipelines**
- Storing and transporting hydrogen would have very **low marginal cost**, when using existing infrastructure between 2% - 10% $H_2$ admixtures.
- **More flexible use of the electrolyser** (vs. industrial cluster processes with constant demand) taking advantage from lower electricity costs
    - ✓ lower costs for GHG emissions reductions
- **Reduction of logistic and productions costs** as consequence of flexible location, almost anywhere within the country
    - ✓ lower land acquisition costs
    - ✓ better access to competitive RES production places

# Advantages of Blending (2/5)

**GHG Reduction**

- **Faster** and **cost-efficient** GHG emissions **reduction** at the end-use sectors and processes (e.g. heating, high temperature industrial processes, etc.)

**Higher Potential for GHG emissions reduction**

- **Larger potential** to decarbonise and reduce emissions in **all gas-consuming sectors** (not only those consuming pure hydrogen).

**Effort Sharing**

- **Financing** and **decarbonisation efforts** to be **shared among different sectors**
- Consumers/sectors willing to pay more for renewable/low-carbon hydrogen will buy **GOs**, reducing the need for public support.
  - ✓ With a GO market value comparable to biomethane, the cost of Renewable $H_2$ would come closer to the price of Grey $H_2$

# Advantages of Blending (3/5)

**Sector Coupling**

- Enables **widespread sector coupling** between **gas and electricity**:
  - ✓ flexibility, **resilience**, dealing with **surplus** of variable renewable electricity, avoiding power **congestions**, **energy conversion**, (seasonal) **storage**, etc.
- Allows **integration of P2G, beyond** hydrogen demand **clusters**:
  - ✓ Taking into account electricity network constraints, P2G facilities to be located where most convenient
  - ✓ In the short-term, dedicated $H_2$ infrastructure to service all these remotely located electrolysers will not be justified
- Blending as ideal solution to complement other flexibility and energy storage options (batteries and pumped hydro storage)

# Advantages of Blending (4/5)

## For thermal use, blending is not less efficient

- For **thermal applications / uses**, **$H_2$ does not lose value** when being blended into the gas grid
  - ✓ Burning hydrogen in thermal applications releases no less useful energy than producing electricity with a Fuel Cell

## Accelerates $H_2$ Roll-out

- Allow **hydrogen to start arriving at sectors and regions**, until $H_2$ (and/or biomethane) can totally replace natural gas
  - ✓ This is particularly relevant for **regions where there are not parallel / redundant gas pipelines**, easy to dedicate to $H_2$
  - ✓ Not all potential $H_2$ consumers are located in industrial clusters
  - ✓ Remotely located consuming plants might not merit a dedicated $H_2$ supply; individual Member States' geography influences this aspect
  - ✓ Blending underpinned by GOs system, as a first step

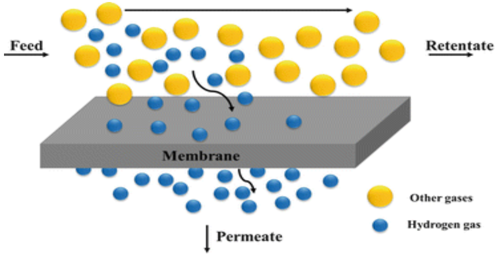
# Advantages of Blending (5/5)

## Quick $H_2$ Scale-up

- **Quick scale up** of electrolysers and P2G by taking advantage of existing and reliable natural gas demand.
- **Building-up $H_2$ volumes** and developing **economies of scale** until dedicated $H_2$ pipeline business case is mature enough.
- Provides **learnings** for moving quicker towards 100% $H_2$ grid.
- **Linking supply and demand cheaply and efficiently**, facilitating the **rapid development of the market**
  - ✓ Not feasible to physically link all suppliers and consumers in a cost-effective manner, at least at the early stages of $H_2$ market.

## De-blending

- **Separation technologies** could be an option for consumers which
  - ✓ need $H_2$ stream to be used as feedstock
  - ✓ are not tolerating certain levels of $H_2$ blending



# The Role of Hydrogen in meeting EU Objectives


## The role of hydrogen in meeting the EU objectives

January 2021 | SPECIAL REPORT: ENERGY & UTILITIES

Financier Worldwide Magazine


January 2021 Issue

BY

Luis Ignacio Parada and Abel Enriquez

Enagas

Energy & utilities

The European Green Deal has put the European Union (EU) on a path to become the first climate neutral continent by 2050. This goal will be achieved through the deep decarbonisation of all sectors of our economy. An intermediate 55 percent greenhouse gas emissions (GHG) reduction target by 2030 is a clear indicator of this ambition and imposes the need to implement concrete and bold measures at EU level as soon as possible. Europe's energy future will rely on an ever growing share of renewable energies, flexibly integrated through different energy carriers, on the avoidance of pollution and on a resource-efficient management via a circular economy approach.

In this context, hydrogen is enjoying a renewed and rapidly growing attention in Europe and around the world. The rapid cost decline of renewable energy, technological developments and the urgency to drastically reduce GHG, are indicating that we are now close to a tipping point.

Hydrogen can be used as a feedstock, a fuel or an energy carrier and storage. It has many possible applications across different sectors (industry, transport, power and buildings sectors, etc.) and, most importantly, it does not emit either carbon dioxide nor pollutants when used. It is therefore an important part of the solution to meet the 2050 climate neutrality goal enshrined in the European Green Deal.

However, today hydrogen represents a modest fraction of the global and EU energy mix, and is still largely produced from fossil fuels, notably from natural gas or from coal. For hydrogen to contribute to climate neutrality, it needs to achieve a far larger scale and its production must become either renewable or low-carbon.

While renewable electricity is expected to decarbonise an important share of the EU's energy consumption by 2050, it will not be possible to electrify the whole economy. Renewable and low-carbon molecules, in gaseous or liquid form, will be an essential part of the future EU's energy mix. According to EU projections, it could well be that by 2050, around 50 percent of its energy consumption would take place in the form of electrons, while the remaining 50 percent would be based on molecules (known as the '50/50/50 rule').

More concretely, hydrogen has a strong potential to be used in those hard-to-abate sectors and end-use applications where electrification is either not possible (e.g., a lack of infrastructure or feasible technological solutions) or not economically competitive. In those cases, hydrogen can act as an energy vector, with high energy density, easy to be transported and stored in large quantities and for long periods of time (seasonality) connecting production and demand centres. In the EU's strategic long-term vision for a climate-neutral economy, the share of hydrogen in Europe's energy mix is projected to grow from the current less than 2 percent, to 13-14 percent by 2050.

A condition for widespread use of hydrogen as an energy carrier across the EU is the availability of infrastructure for connecting supply and demand. Hydrogen may be transported via pipelines, but also via non-network based transport options, e.g., trucks or ships docking at adapted liquefied natural gas (LNG) terminals, insofar as technically feasible. Transport can happen as pure gaseous or liquid hydrogen or bound in bigger molecules that are easier to transport (e.g., liquid organic hydrogen carriers or ammonia).

The 'EU Hydrogen Strategy' foresees a stepwise approach, according to which the initial hydrogen demand may initially be met by production on site in industrial clusters and coastal areas through 'point to point' connections between production and demand.

In the second phase, local hydrogen networks would emerge to cater for additional industrial demand. With increasing demand, the optimisation of the production, use and transport of hydrogen will have to be secured and is likely to require longer-range transportation to ensure that the entire system is efficient.

**Hydrogen/methane mixtures as an essential pillar of hydrogen take-off**

Elements of the existing European gas infrastructure could be retrofitted or repurposed at a limited cost to provide the necessary infrastructure for large-scale cross-border hydrogen transport. These two options could be additionally combined with the construction of (limited) newly built hydrogen dedicated infrastructure.

As recognised in the 'European Network of Transmission System Operators for Gas (ENTSOG) Roadmap 2050', the prioritisation of these three equally important options (retrofitted, repurposed and newly built infrastructure) will depend on national and regional circumstances. It thus requires careful consideration in terms of their contribution to the decarbonisation of the energy system as well as to the economic and technical implications.

The repurposing option, understood as the full conversion of an existing natural gas pipeline into 100 percent hydrogen lines, might be an immediate attractive alternative for concrete regions and countries with very particular situations, such as abundant and well-meshed gas networks (including parallel pipelines and low calorific gas systems subject to imminent phase-out), fast declining gas demand and gas production, and high industrial density with short distances between industrial clusters.

However, in many other EU regions with different conditions, retrofitting (i.e., the adaptation of the existing gas pipelines to transport and store certain percentages of hydrogen blends) provides an excellent transitional opportunity to build-up hydrogen volumes, develop economies of scale, and learn more quickly about hydrogen asset readiness until a clear business case for dedicated hydrogen pipelines emerges in the medium to long term. By increasing the hydrogen readiness of the existing gas grid, decentralised hydrogen production will be enabled, allowing power-to-hydrogen facilities to be located at optimal productions sites, rather than in proximity to industrial demand.

Injecting hydrogen into existing gas pipelines (commonly known as blending) offers two advantages. On one side, natural gas acts as a gaseous hydrogen carrier facilitating the transportation and storage of hydrogen to link demand and supply. On the other side, it provides access to hydrogen for customers located in all EU countries and regions, progressively decarbonising their energy use as well as the gas networks.

From a cost perspective, blending allows for integration of large amounts of renewable and low-carbon hydrogen without the need for large investments (only affordable adaptation of the existing network). By using existing gas grids for hydrogen-methane mixtures, it is possible to make a more flexible use of the electrolyser and take advantage of lower electricity costs, especially in comparison to electrolysers supplying industrial consumption with constant demand. It also allows for cost reduction from a logistic and production perspective, as a consequence of the flexible location (almost everywhere with a nearby gas pipeline) which grants lower land acquisition costs and better access to competitive renewable energy production sites.

This aspect is relevant given that, at least in the early stages of a hydrogen market, dedicated hydrogen infrastructure to physically link all decentralised hydrogen suppliers and consumers via pure hydrogen pipelines would imply a very high economic cost. In this situation, hydrogen and natural gas mixtures are well-placed to accelerate the hydrogen roll-out by allowing hydrogen to start arriving at all sectors and regions where, in the long term, they can progressively substitute natural gas. In addition, the latest analysis shows that, by using gas-hydrogen blends, a larger GHG reduction is obtained at lower cost compared to building dedicated hydrogen infrastructure.

In terms of energy system integration, hydrogen admixtures enable widespread sector coupling between gas and electricity. Due to its particularities, it offers flexibility, resilience and the integration of surplus of variable renewable electricity. It avoids power congestion, enables energy conversion and (seasonal) storage, and allows for the integration of power-to-gas beyond hydrogen demand clusters. Besides, blending is an ideal solution to complement other flexibility and energy storage options, such as batteries and pumped hydro storage.

Regarding energy efficiency, and when thinking about thermal uses, the mixtures of hydrogen and natural gas into existing gas networks do not represent a loss of value. Burning hydrogen in thermal applications releases no less useful energy than producing electricity with a fuel cell. When hydrogen is to be used as a feedstock, as a fuel, or in case of gas quality constraints on the end-user side (not tolerating certain levels of hydrogen mixtures), then different separation technologies currently being studied, such as membranes, could become a feasible option in the future.

Injecting hydrogen into the existing gas network enables faster decarbonisation for all sectors and across borders. This implies that financing and decarbonisation efforts can be shared among multiple end-users. Hydrogen admixtures in the gas network should be accompanied by a robust system of guarantees of origin (GOs) which allows monetisation of the renewable and low-carbon value of the hydrogen injected into the gas grids. Those consumers willing to pay more for renewable and low-carbon hydrogen will buy GOs certificates, reducing the need for public support. This system would also incentivise higher shares of renewable and low-carbon hydrogen, acting as a tool to scale-up offer and demand. To properly manage the cross-border aspect, concrete interoperability measures would be advisable to ensure market integration, seamless cross-border hydrogen flows and end-user acceptance.

From the point of view of deciding on the configuration of the future energy system, hydrogen-gas mixtures are identified as a relevant option, especially because it provides a simpler and faster energy transition for consumers and the gas industry. Moreover, it does not exclude other options and can be perfectly compatible and complementary with other hydrogen infrastructure developments, such as repurposed and newly built infrastructure.

Adding mixtures of hydrogen and natural gas into existing gas pipelines is, without doubt, a quick and cost-efficient transitional enabler for a hydrogen economy, while keeping a pan-European integrated gas market.

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Article available at https://www.financierworldwide.com/the-role-of-hydrogen-in-meeting-the-eu-objectives

# Cost efficient decarbonization ….step by step


# The Vision

***"Blending as a Quick and Cost-Efficient Enabler for Decentralised Hydrogen Production while Keeping a Pan-European Integrated Gas Market"***

Thank you for your attention