Gas Infrastructure Europe

# Regulation of Hydrogen Infrastructure

## GIE Position Paper

# Paper highlights

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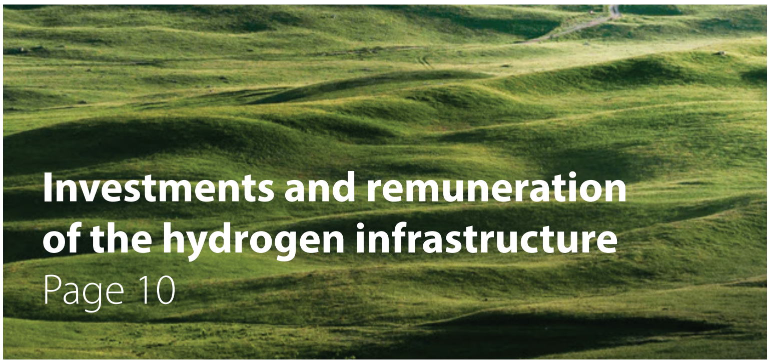




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## Executive Summary

Gas Infrastructure Europe

Hydrogen can strongly contribute to the EU's climate goal of achieving climate neutrality by 2050. This paper outlines the benefits of the gas infrastructure to integrate hydrogen.

Gas Infrastructure Europe (GIE) represents around 70 members from 27 European countries that own and operate infrastructure that is ready to be retrofitted and/or repurposed for transporting, storing and importing hydrogen.

Furthermore, they have the expertise to build and operate new dedicated hydrogen infrastructure.

Within the context of upcoming EU legislation, GIE presents policy recommendations to enable the gas infrastructure to efficiently integrate hydrogen, thereby contributing to the targets of the EU Green Deal.

# 1. Introduction

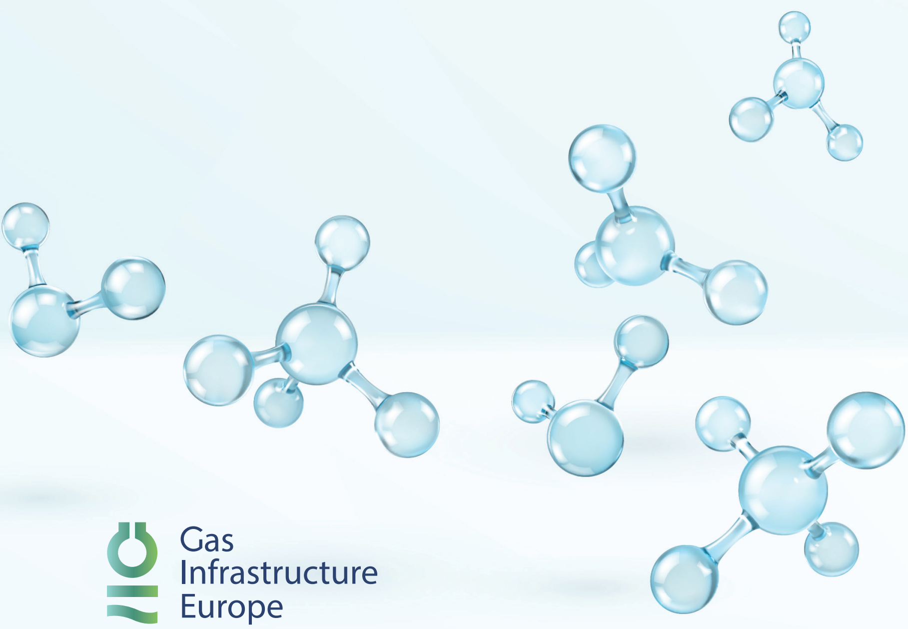
Gas Infrastructure Europe (GIE) is the association of the European gas infrastructure operators: gas transmission networks, storages, and LNG terminals. We represent around 70 members from 27 European countries. Our members own and provide services along the gas value chain, in close (commercial) cooperation with policy makers, end-users like households and industries, as well as most other energy sector stakeholders. GIE members are committed to assisting delivering the European Union (EU)'s goal in being the first continent achieving climate neutrality by 2050.

Following the EU Green Deal announcement in November 2019 under the new European Commission, the EU has set out an ambitious plan to reduce net emissions to zero by 2050. In April 2021, the European Council and the European Parliament agreed on the increase of the greenhouse gas emission reduction target from 40% to 55% by 2030. Many further EU legislations are currently being revised to adapt them to the increased targets.

In order to achieve these targets and to fulfill the objectives laid out in the EU Green Deal, hydrogen will play a central role in the future energy system together with other renewable and low-carbon gases, by making full use of the well-developed existing infrastructure and markets, as well as creating new links and bringing together new customers and sectors.

The Commission acknowledges the potential of hydrogen and sees a vital role for it towards 2030 and 2050. The EU Hydrogen Strategy and the EU Energy System Integration Strategy, both published in July 2020, underline the need to scale-up hydrogen rapidly and present it as a key enabler for the integration and coupling of the electricity and gas sector, as well as a sector on its own. The strategies acknowledge the paramount role of hydrogen to balance and store renewable electricity and the contribution of hydrogen to decarbonisation.

Moreover, it is the most cost-effective solution to decarbonise hard-to-abate sectors such as industry and transport, and it also has potential to increase the share of renewable energy in other sectors such as the power sector and heating & cooling. Hydrogen has similarities with natural gas, and it has the benefit that it can be developed along several pathways like clusters, dedicated backbones or blending, reflecting national and regional starting points.



# 2. Benefits of the existing gas infrastructure

The introduction of hydrogen will need a well-developed infrastructure. The gradual hydrogen market ramp-up and demand will lead to an increasing need to transport, store, import and export large volumes of hydrogen in its various forms. Different pathways will thereby exist for each Member State: Besides newly built infrastructure for hydrogen where it is cost-effective, the existing gas infrastructure is very well-suited to integrate hydrogen by retrofitting[1] and repurposing[2] pipelines, storage facilities and LNG terminals. Large cost- and time savings for society as well as minimising the need for constructing new types of energy infrastructure will increase the social acceptance of the energy transition. The existing infrastructure will be progressively made available for hydrogen, compatible with the evolution of natural gas demand.

One possible pathway among many is blending hydrogen into the existing gas infrastructure up to a certain threshold. Besides enabling quick decarbonisation wins, hydrogen blending supports the building-up of hydrogen production capacity. Moreover, it also represents a cost-effective transitional solution in those European regions that do not have the capacity yet to immediately switch from natural gas infrastructure to hydrogen infrastructure.

The mostly well-developed pan-European gas pipeline and storage infrastructure of today allows a cost-effective transition to integrate hydrogen. It will enable the pan-European transport of hydrogen, connecting hydrogen supply and demand sites. The gas infrastructure delivers the flexibility needed to balance hydrogen supply and demand and to decarbonise the energy system. Furthermore, it should be noted that a single hydrogen pipeline can transport 10-20 times more energy than an electricity cable, based on the same level of investments[3]. This means that a high-voltage electricity line could carry 1-2 GW of power, while the transport capacity of hydrogen pipelines lies between 15-30 GW[4]. As also outlined by the European Hydrogen Backbone Initiative, the transmission network is ready to integrate hydrogen in a cost-efficient way. The study underlines that repurposing the existing gas infrastructure is possible at 10-35% of the costs that would be required for a newly built hydrogen pipeline. Moreover, it enables the connection between hydrogen supply and demand sites and thereby, a dedicated EU hydrogen infrastructure will develop gradually[5].

Hydrogen storage assets will facilitate the interlinkage between electricity and hydrogen markets and provide the flexibility needed to balance the entire energy system on short-term and seasonal timescales. Moreover, underground storage facilities can secure hydrogen supply by enabling large seasonal storage of renewable and low-carbon hydrogen. While salt caverns can be completely filled with hydrogen (no reactivity with salt rock), porous rock storage sites and aquifers can be retrofitted to blend hydrogen with natural gas. In the European Union (EU27), around 50 salt caverns are currently used for natural gas storage with a storage volume of more than 180 TWh. These salt caverns are also highly suitable for hydrogen storage, as salt is one of the best sealing rocks available in the subsurface. Salt caverns, acquifers and depleted fields can contribute to short-term flexibility needs that will increase in the coming decades and could have a theoretical storage capacity potential of 60 TWh hydrogen already today[6]. Hydrogen storage in porous rock, such as aquifers or former gas or oil fields, is subject to additional research and pilot projects currently investigated by storage operators.

1 Retrofitting refers to small modifications/adaptations of the gas infrastructure that allow injection of certain amounts of hydrogen up to a technically-sound threshold of H2/CH4 mixture (i.e. blending)

2 Repurposing implies converting an existing gas infrastructure into a dedicated hydrogen infrastructure.

3 https://static1.squarespace.com/static/5d3f0387728026000121b2a2/t/5e85aa53179bb450f86a4efb/1585818266517/2020-04-01_Dii_Hydrogen_Studie2020_v13_SP.pdf

4 https://www.europeanfiles.eu/energy/the-best-of-both-worlds-efficient-decarbonisation-through-energy-systems-integration
https://static1.squarespace.com/static/5d3f0387728026000121b2a2/t/5e85aa53179bb450f86a4efb/1585818266517/2020-04-01_Dii_Hydrogen_Studie2020_v13_SP.pdf

5 https://gasforclimate2050.eu/sdm_downloads/european-hydrogen-backbone/

6 https://gie.eu/index.php/gie-publications/databases/storage-database

Storing hydrogen in underground gas storage sites is significantly cheaper than electricity storage. For example, hydrogen storage unit costs in salt caverns are at least a factor 100 cheaper than electricity storage cost in batteries[7]. It is therefore an efficient solution for large scale renewable energy storage.

LNG terminals are well positioned to develop new services and contribute to the energy transition: they can be retrofitted and repurposed at lower costs compared to investments into new systems that enable both intra-EU and non-EU hydrogen imports and exports. This underlines the EU Hydrogen strategy expectations of installing at least 40 GW of renewable hydrogen electrolysers by 2030 within the EU, and the industry expectations of building additional 40 GW renewable hydrogen electrolysers outside the EU, in the Eastern and Southern Neighbourhood, ensuring a sustained cross-border trade with the EU. Adapted terminals will have the capacity to receive different hydrogen-based energy carriers in liquid form from any origin in the world. Therefore, they facilitate the import of renewable and low-carbon hydrogen that is produced outside Europe and then shipped to Europe as liquid hydrogen or as other hydrogen carriers like synthetic methane, ammonia or LOHC (Liquid Organic Hydrogen Carrier). Hydrogen shipment within Europe will also be needed.

As the hydrogen market matures, policy should ensure that hydrogen users can be supplied from a diverse supplier portfolio. This could involve supporting imports of hydrogen via LNG terminals and import pipelines from non-EU countries in addition to domestic production.

The benefits of the entire existing gas infrastructure show a complete picture where synergies exist due to the interconnections between pipeline, storage, and LNG infrastructure. Therefore, this well-developed and intertwined infrastructure system will guarantee the safe transport, storage and import of hydrogen.

[7] In a typical salt cavern, a pressure of about 200 bar is required to store hydrogen, which equals a storage capacity of about 240 GWh. The total amount of installation costs is about € 100 million for piping, compressors, and gas treatment. For comparison, if this amount of energy would be stored in batteries, with costs of 100 €/kWh, the total investment cost would amount to € 24 billion. Storing energy in form of hydrogen in salt caverns is therefore at least 100 times cheaper than battery storage.

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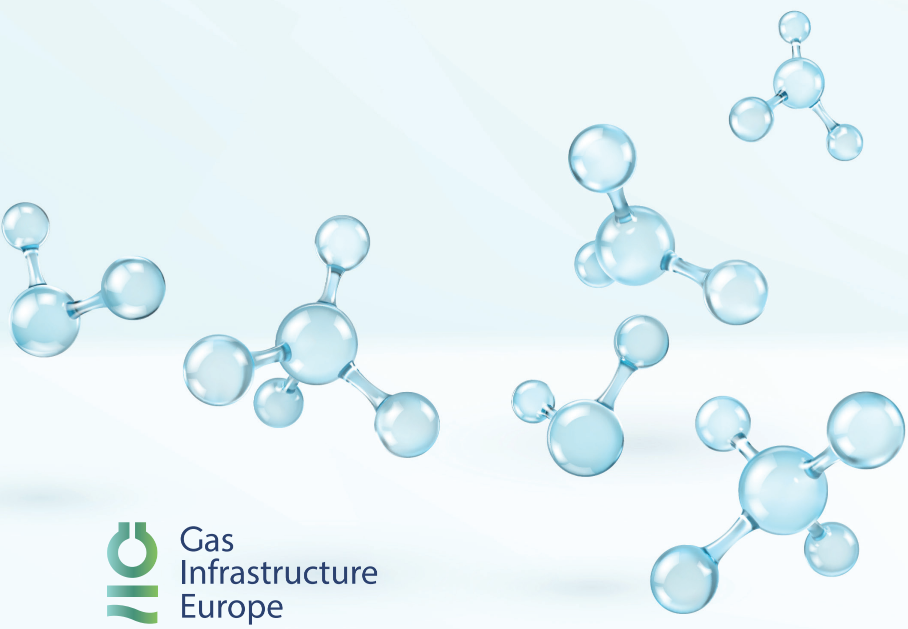


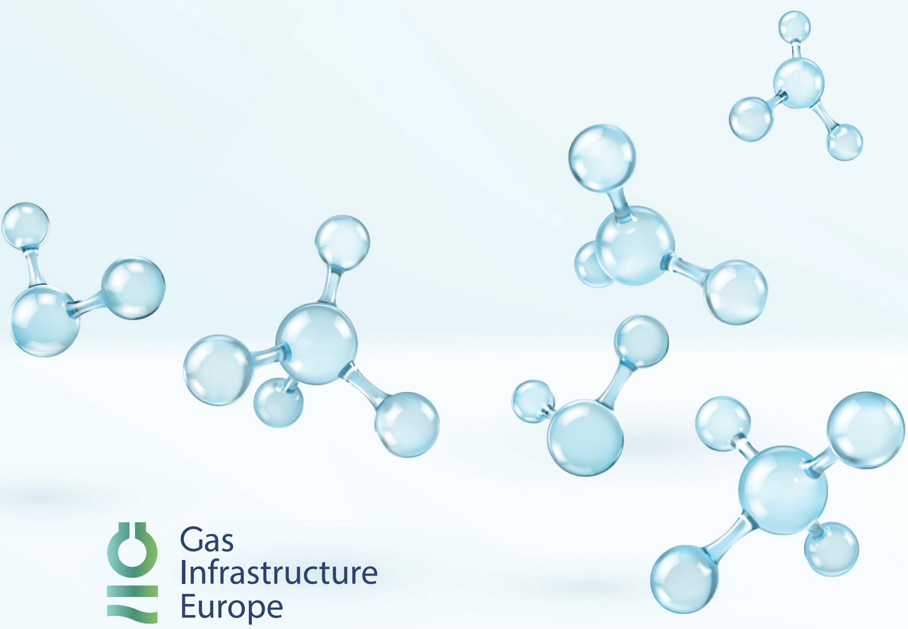
# 3. Key elements for the regulation of hydrogen infrastructure

The hydrogen economy will need to develop gradually: some initial clusters already exist and more clusters will emerge, creating local demand which will lead to the development of a dedicated European core hydrogen infrastructure (backbone) that will facilitate the connection between supply, storage and demand. Therefore, hydrogen-ready infrastructure will (need to) emerge in parallel with increasing supply and demand and will lead to an increasing need to transport, store and import large-scale hydrogen volumes. This infrastructure is expected to progressively show the characteristics of a natural monopoly and hence, the appropriate regulatory framework should be derived from a regular dynamic assessment of the natural monopoly conditions of a specific market situation.

The regulation of the electricity and the natural gas market was put in place when the large part of the gas market and infrastructure were already at a mature stage. This introduction, starting in the 1990s, aimed at providing a fair and non-discriminatory market environment to develop liquid wholesale markets. The expected liquid hydrogen market is still in a very early phase. The development of a functioning hydrogen market must happen in parallel to the construction of sufficient hydrogen infrastructure. The main focus in this starting period should be on appropriate incentives for investments in building-up the hydrogen infrastructure. A dynamic regulation will contribute to the acceleration of the hydrogen market ramp-up and the gradual creation of a liquid hydrogen wholesale market in Europe.

In view of the preparation of the Gas/Hydrogen Decarbonisation Package, GIE believes that the future hydrogen regulatory framework, being inspired itself from the principles underpinning the Internal Energy Market for gas and electricity, should also take into account the development stages and particularities of the hydrogen market. Experience from natural gas underlines the need for several regulatory principles at EU-level from the outset, such as: Third-Party Access, unbundling from vertically integrated activities, non-discrimination and transparency rules as a reference to develop a functioning hydrogen market in Europe. Minimum principles should guarantee a fair and open competition among all market users in a market that is still emerging and that will gradually integrate gas, hydrogen and electricity. In order to set the right regulatory incentives for investments into building-up the hydrogen infrastructure, a system of regulated tariffs for hydrogen transmission and storage infrastructure could also develop according to hydrogen market developments.

At the moment, the hydrogen market in the EU is very heterogeneous and characterised by different paces and different stages of its development across Member States. With the emergence of national hydrogen strategies, reflecting the starting point and local synergies, different priorities and diverse approaches come to the fore. In all, it demonstrates that there is no "one-size-fits-all" solution that can be applied across the EU, but rather requires a dynamic framework that considers the specific stage of development of the hydrogen market and infrastructure



as well as other national specificities - taking into account the speed of energy transition, and the synergies when reaching a regional and EU-wide market. Therefore, there needs to be a flexible regulatory framework in the beginning and overregulation should be avoided, otherwise market ramp-up will stall or fail to materialise. It is necessary to both set the appropriate level of regulation in order to ensure investor confidence and to support the market ramp-up in a short timeframe. This regulatory flexibility for hydrogen infrastructure is required, until the market has matured to a certain level, also taking into account the system users (i.e. household consumers or only businesses).

A regulatory framework for hydrogen should also include a common terminology via clear, accurate and science-based definitions of renewable and low-carbon hydrogen. There are no clear definitions embedded in EU legislation yet. Having such clear definitions would also strengthen the framework for Guarantees of Origin (GOs). The Renewable Energy Directive 2018/2001 (RED II) currently defines an obligation for Member States to issue GOs for renewable energy, including biomethane and renewable hydrogen. However, it does not include low-carbon hydrogen. Making GOs obligatory for both renewable and low-carbon hydrogen would accelerate the market development of hydrogen. Furthermore, it would facilitate the cross-border trade of all kinds of hydrogen, thereby ensuring pan-European and global trade and flow of hydrogen, provided GOs issued in one Member State can be redeemed in another Member State. The GO must be transferable across time, energy carriers, and borders. Thus, shorter term granularity and options for long term storage are needed, as well as a simple conversion from renewable electricity to renewable hydrogen, be it stored, being consumed or methanised, etc. Moreover, a coherent certification system will also help facilitate intra-EU competition, encouraging investments by mitigating demand risks.

Gas Infrastructure Europe

# 4. Role of infrastructure operators

Over the last decades, infrastructure operators along the entire gas infrastructure value chain have always guaranteed secure and efficient transport, storage and import of natural gas, while working as well on innovative pilot projects for the integration of renewable and low-carbon gases into their systems[8]. GIE members are well-equipped to integrate hydrogen into their infrastructure assets and services, and will guarantee safe and cost-efficient transport, storage and import of hydrogen, thereby contributing to the EU climate targets.

Therefore, our members i.e. Transmission System Operators (TSOs), Storage System Operators (SSOs) and LNG terminal operators (LSOs), must be allowed to retrofit and repurpose their infrastructure, as well as building new hydrogen infrastructure, giving them the flexibility to own and operate the hydrogen infrastructure. There are a number of existing or possible structures that depend on national circumstances, including combined operation of both gas and hydrogen infrastructure which should be accommodated at European level.

The regulation of hydrogen should recognise the advantages that the existing infrastructure has for developing the hydrogen infrastructure in a timely, cost-efficient and socially acceptable way. This would facilitate the efficient planning, financing, operation and maintenance of the infrastructure. It would also ensure that the technical expertise of gas infrastructure owners – nationally and across borders – can be effectively used for the reliable and secure operation of the transport, storage and terminal infrastructure of hydrogen.

Blending hydrogen into natural gas flows is an efficient solution to enable quick decarbonisation wins in some European countries. In order to facilitate intra-EU cross-border trade of gas blends, besides an EU GOs system, a certain level of harmonisation is required to guarantee interoperability, taking into account temporary regional differences and characteristics. Many studies and pilot projects are currently being conducted to improve the technical feasibilities of hydrogen blends in pipelines and storage facilities that should be taken into account in the implementation of any blending regime[9]. It is therefore of utmost importance to allow infrastructure operators to retrofit their infrastructure for adjusting it for higher blending shares and guaranteeing the technical interoperability to enable the free flow of gas across borders. A harmonised scheme for blending rates taking into consideration regional specificities to guarantee cross-border flows is needed.

To ensure the scale-up of the hydrogen market, it is crucial that infrastructure operators will be allowed to participate in decarbonisation activities, supporting the development of innovative technology facilities, thereby enabling their scaling-up as well as the transport, storage and import of hydrogen.

Furthermore, the revised legislation through a dynamic regulatory approach should allow for more flexibility for infrastructure operators to participate in and contribute to the hydrogen development. The development of an EU framework for regulatory sandboxes in the revised legislation may represent a first application to support such innovative initiatives at national level, allowing all subjects to start-up, cooperate, mature and scale-up new technologies and services supporting the energy transition.

Finally, a supportive framework is needed to reassure investors that there will be efficient integration across the value chain. This would also help reduce the perception of investment risks. Furthermore, the development of regulatory frameworks would ensure access to and investment in hydrogen and CO2 infrastructure, including clarity of roles of different entities with no unnecessary barriers.

[8] https://www.gie.eu/download/brochure/HYDROGEN_037.pdf

[9] The effects of hydrogen injection in natural gas networks for the Dutch underground storages.pdf (rvo.nl)
Marcogaz: Injection of Hydrogen/natural gas admixtures in Underground Gas Storage (UGS), 08 May 2017.
Source: https://www.marcogaz.org/publications-1/documents/

# 5. Investments and remuneration of the hydrogen infrastructure

The establishment of an internal market for hydrogen requires investments in infrastructure that will be used and refinanced over decades. Thus, an appropriate investment framework for infrastructure operators is crucial to the successful build-up of a European hydrogen market. Economic barriers could exist that pose a risk to the development of hydrogen infrastructure, especially in the initial phases where costs are high and demand projections are unclear. Securing investments is crucial for infrastructure owners. Especially for initial hydrogen projects, network and storage charges may either be prohibitively high for consumers, thus imposing a barrier from the consumption and production side, or the revenues realised could be too low to recover the investment costs. The result of which is a lack in investments. Support mechanisms via European or national funds can be one option to mitigate the resulting gap in financing. Infrastructure investments are usually depreciated within the (regulatory) asset base over a long-term period (ranging from 15-55 years depending on the asset and/or regulatory conditions) and also entail operational costs.

Therefore, it is essential that appropriate remuneration arrangements are established for infrastructure operators, aligned with market developments as mentioned earlier, that ensure the guaranteed recovery of investment costs within the appropriate framework. Especially in the phase of scaling up a hydrogen infrastructure, it is necessary that system charges can be carried by system users. Cost-mutualisation between the different parts of the wider energy system should be one option to guarantee stable investments in hydrogen infrastructure, as well as to avoid high initial costs for only a few users in the starting phase of the market. The reasoning behind this is that accounting rules for gas and hydrogen infrastructure should allow a transparent mutualisation of costs between the different parts of the wider energy system – including gas and hydrogen infrastructure – to ensure cost-reflective and stable tariffs for using the gas and hydrogen infrastructure in the long run for the benefit of all energy users. Especially when scaling up hydrogen infrastructure, a coordinated energy system and network planning between electricity, gas and hydrogen infrastructure should be the central mode for identifying the necessary infrastructure needs, allowing for Member States to choose on the right remuneration model at national level aligned with concrete EU principles. Therefore, the full extent of the benefit cannot be supported by hydrogen or natural gas system users only but should be extended to the whole energy system.

It is important to highlight the importance of recognising the value and costs of existing system components by the National Regulatory Authorities (NRAs). This refers to the additional costs incurred to retrofit the gas network, storage sites and LNG terminals to be able to transport, store and import a given percentage of hydrogen (blending), to repurpose gas infrastructure or to realise newly built 100% dedicated hydrogen infrastructure.

Appropriate remuneration is also indispensable in the context of upholding the social acceptance for the energy transition. Hydrogen will play a central role in our future energy system. Many users will benefit from its consumption, both directly and indirectly by the benefits of its deployment to curb climate change. A cost-effective and just price scheme for hydrogen end-users must be established, which also includes acceptable system costs. Seeking the most cost-efficient scheme for the development of hydrogen infrastructure is therefore not only an economic, but also a social question.

# 6. Role of European and national regulators

GIE believes that TSOs already have the tools and competences in hand which enables them to provide integrated energy system planning including for hydrogen, based on emerging supply and demand routes and storage locations. The existing ENTSOG-led TYNDP process has proven to be efficient and contributed to the development of the internal gas market and will be needed to ensure that investments in hydrogen are done within a long-term perspective in terms of future demand (sizing/dimensioning, location, timing). Such an exercise should be carried out jointly with ENTSO-E to ensure maximum energy system benefits. Scenario planning for hydrogen transmission and storage infrastructure should therefore be integrated into the TYNDP process, building on national and/or regionals plans and based on the different maturity levels of hydrogen markets.

This ensures the most cost- and time-efficient planning, as gas infrastructure operators are best positioned to determine which existing gas infrastructure has to be repurposed/retrofitted and where new, dedicated infrastructure has to be built.

The existing structures for developing cross-border related market rules should also be applied to the respective issues of the hydrogen market. Additional burden should be avoided. On EU level, the regulatory oversight and involvement would be beneficial if focused on cross-border related aspects of a hydrogen infrastructure development.

# 7. GIE policy recommendations

1. GIE calls for a coherent legislative framework with the existing EU Gas Legislation to avoid inconsistent roles and responsibilities and definitions of regulatory principles to be set for the hydrogen market, leaving Member States flexibility to apply the appropriate regulatory environment to scale-up national and regional hydrogen markets depending on market developments.

2. GIE calls for a legislative framework that recognises the crucial role of infrastructure operators to contribute to the EU climate targets by being allowed to retrofit, repurpose and construct new infrastructure which they can own and operate.

3. GIE calls for a dynamic regulation evolving with the market and infrastructure development stages, considering basic principles like unbundling, non-discriminatory Third-Party access rules and transparency from the outset, while taking into account the specifics of the hydrogen market.

4. GIE calls for a coordinated energy system and network planning between electricity, gas and hydrogen infrastructure via a wider integration of flexibility options, based on the emerging supply and demand routes and storage locations.

5. GIE calls for a financial framework that guarantees support for infrastructure conversion and construction of new infrastructure, as well as Research & Development funding for less mature technologies, including support to facilities supporting securing of hydrogen supply via imports.

6. GIE calls for allowing a transparent mutualisation of costs between the different parts of the wider energy system – including gas and hydrogen infrastructure – to ensure cost-reflective and stable tariffs for using the gas and hydrogen infrastructure in the long run for the benefit of all energy users.

7. GIE calls for gas infrastructure operators, including TSOs, to be allowed to participate in decarbonisation activities, supporting the development of innovative technology facilities (including power-to-gas-facilities), in fulfilling the current EU legislation.

8. GIE calls for the implementation of regulatory sandboxes at national level in the revised legislation, which may represent a first application to support innovative initiatives. Regulatory sandboxes could serve as a way to foster innovative projects, by means of using a technology-neutral approach.

9. GIE calls for a harmonised scheme for blending rates to guarantee cross-border flows, thereby strengthening technical interoperability and the liquidity of wholesale markets.

10. GIE calls for a common terminology via clear and accurate definitions of renewable and low-carbon hydrogen.

11. GIE calls for an extension of the obligation to issue Guarantees of Origin for renewable and low-carbon hydrogen to establish an EU-wide credible documentation of the green value of renewable and low-carbon hydrogen, including the harmonisation of technical standards on international level.

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