Securing competitive
energy for industry

IFIEC Europe position paper on hydrogen quality

IFIEC Europe, the International Federation of Industrial Energy Consumers, represents energy energy-intensive industries (EII) across sectors such as chemicals, refining, food and nutrition, paper, glass, ceramics, steel and metals and fertilizers. Our members include both current and future users of hydrogen. IFIEC sees a large role for low-carbon and renewable hydrogen in hard-to-abate sectors and to decarbonize current hydrogen use. The availability of hydrogen which meets the quality specifications of current and future users is a crucial condition to enable efficient and effective deployment. In this position paper IFIEC Europe presents the perspective of energy-intensive industries on the preferred hydrogen quality standard.

Current and future hydrogen users

Current hydrogen use deploy hydrogen as a feedstock in industrial processes. In 2024, hydrogen consumption was largely concentrated in refineries (4241 kt), ammonia production (1944 kt), and in other chemical processes (611 kt).[1] While specific hydrogen quality requirements and allowable contaminant specifications differ across these applications, feedstock users share common characteristics: they rely on hydrogen with a very high mol% hydrogen content and require strict limits on contaminants. These requirements reflect the sensitivity of industrial processes and catalysts to impurities and underline the need for a high and consistent hydrogen quality for existing feedstock applications.

Future new hydrogen users are expected to use hydrogen both as a feedstock as well as an energy carrier. The first group has similar hydrogen quality requirements as current hydrogen feedstock users. The second group, which is expected to use hydrogen as an energy carrier, has different hydrogen quality requirements. Electrification will most likely fill most of the demand for low- and high temperature processes. Hydrogen presents a technically feasible decarbonisation pathway for high temperature processes that are difficult, or impossible, to electrify. Hydrogen might also play a role in providing CO_2-free flexible generation capacity (for instance in hydrogen-ready CCGT). These applications have different sensitivities to hydrogen quality than feedstock applications. Certain high-temperature applications can suffice with a lower hydrogen mol% but can still be sensitive to concentrations of various contaminants. Therefore, these users can still benefit greatly from the use of high-quality hydrogen. How the consumption volumes of future new hydrogen users will develop is highly uncertain.

[1] Hydrogen Observatory. Excluding the United Kingdom.

IFIEC Europe
International Federation of Industrial Energy Consumers
Silver Building, Boulevard Reyers, 70 – 1030 Brussels
www.ifieceurope.org | chaput@ifieceurope.org | Mobile: +32 496 59 36 07
a.i.s.b.l. NI 436 343 513 | VAT: BE 0436.343.513 | EU Transparency Register: 1978775156-31

IFIEC Europe hydrogen quality proposal

IFIEC Europe advocates for **a hydrogen quality of ≥ 99.9 mol%** with a composition of contaminants which allows the maximum number of users to utilize the hydrogen infrastructure. The IFIEC-proposal can be found in the table below. IFIEC Europe supports the preamble of the Hydrogen and decarbonised gas market package with 'a focus on the transport and use of hydrogen in its pure form' while 'taking into account hydrogen end-users' quality requirements'.[2] In the spirit of the package, setting a high quality standard conforming to the demand of current as well as future feedstock hydrogen users provides companies with the necessary certainty to take investment decisions and thereby makes a maximum contribution to the development of a liquid hydrogen market. Arguments in favour of a high hydrogen quality standard can be found on the following pages.

Parameter	**Units**	
Wobbe-index	$MJ/m^3(n)$	
Hydrogen	mol%	≥ 99.9
Inerts (N_2, Ar, He)	mol%	≤ 0.01 (100 ppmv)
Hydrocarbons	mol%	≤ 0.001 (10 ppmv)
Hydrocarbons - dewpoint	°C	
Water	molppm	≤ 5
Oxygen	molppm	≤ 0.1
Carbon Dioxide	molppm	≤ 0.1
Total S content (incl. H_2S)	molppm	below detection limit
Halogens	molppb	below detection limit
Carbon Monoxide	molppm	≤ 0.1
Formic Acid	molppm	≤ 1
Ammonia	molppm	≤ 1
Formaldehyde	molppm	≤ 1
Dust particles (> 5µm)		no visible particles
Temperature (entry)	°C	40
Temperature (exit)	°C	40

Additional parameters		
Pressure	barg	≥ 50
Mercury	wtppm	≤ 0.05
MEA/DEA	wtppm	≤ 0.1
Oil	wtppm	≤ 1
Arsenic	molppm	below detection limit
Phosphorus	molppm	below detection limit
Hydroxides (KOH, NaOH)	molppm	below detection limit

Table: IFIEC hydrogen quality proposal.

This proposed IFIEC Europe hydrogen quality standard will:

- address the needs of current hydrogen feedstock users requiring a high quality;
- address the needs of future hydrogen feedstock users requiring a high quality;
- ensure a maximum utilization rate of the hydrogen infrastructure dividing costs over the greatest number of users benefitting everyone;
- provide improved combustion efficiency and decreased environmental emissions for future hydrogen users for energetic purposes;
- prevents inefficient and costly decentralised purification;
- align with the European hydrogen framework which focuses on high purity hydrogen production through electrolysis.

[2] Directive 2024/1788 preamble (94).

An unsuitable quality standard excludes users

Current users that employ hydrogen as a feedstock impose strict requirements on hydrogen quality. In order to replace unabated fossil hydrogen use with low-carbon or RFNBO-hydrogen, current users must have access to hydrogen of a quality suitable for their specific applications. In case the hydrogen quality specification in hydrogen infrastructure does not comply with their requirements, companies may choose to install a local purification unit (Pressure Swing Adsorption, PSA), with all associated consequences (see "Decentralised purification leads to high costs"). An alternative is to install, or have a third-party, install an electrolyser on-site. Another alternative is to gain access to CO_2-storage infrastructure in order to decarbonise (existing) hydrogen production installations. The alternatives require substantial investments, the acquisition of permits (environmental, noise, spatial planning), the realisation of a connection to CO_2 infrastructure (or liquefaction facilities), a reinforced or new electricity connection, and significant space.

If these alternatives are unattractive and detrimental to the business case of decarbonising hydrogen use, companies are left without a viable course of action and may be forced to reduce or cease production, as the continued use of fossil hydrogen without carbon capture and storage will become economically unsustainable due to the expected increase of costs including ETS prices.

Electrolysis produces high-quality hydrogen

Hydrogen production through water electrolysis using renewable electricity produces high-purity RFNBO hydrogen, typically between 99.8 mol% and 99.999 mol%, depending on the type of electrolyser, water quality, gas separation and drying processes. Any remaining contaminants are generally limited to trace amounts of O_2, H_2O, H_2O_2 and N_2, and in exceptional cases ions or metals.

If an infrastructure quality standard lower than the production quality is chosen, this high-quality hydrogen would, on paper, lose significant value. End-users connected via the hydrogen network would not be guaranteed to receive hydrogen at the quality-level it was produced at. This loss in value worsens the business case for investments in RFNBO hydrogen production, as the sales price decreases while production costs remain unchanged. Such consequences are inconsistent with the European policy framework, which explicitly promotes hydrogen production through the electrolysis of water.

Existing producers already have purification installations

Conventional hydrogen producers (SMR with or without CO_2 capture) must apply purification steps before supplying hydrogen to their customers, as the produced quality is always lower than the requirements of end-users. In existing SMR installations, purification units are therefore already in place. These producers are thus already able to meet the high quality requirements of customers and the high quality standards of the hydrogen network. If the hydrogen supplied to customers did not previously meet the specifications proposed by IFIEC Europe, these producers can adjust their purification installations accordingly to comply with those specifications.

Decentralised purification leads to high costs

If a user does not obtain hydrogen of the required application-specific quality via the backbone, it may install an on-site PSA unit to upgrade the supplied hydrogen. However, the use of PSA installations entails significant disadvantages for industrial users:

Contact: I.Chaput

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- losses of approximately 10% to 15% of hydrogen during the purification process (depending on inlet quality), and increased consumption of electricity;
- significant space requirements while space is often scarce at industrial sites;
- noise emissions, depending on the design and installation of the purification installation;
- high investment costs, often amounting to several million euros per installation;
- the need to apply for permits (environmental, noise, spatial planning);
- the need for a reinforced (or new) electricity connection;
- the need to find a useful application for so-called tail gas (e.g. for heat production) in order to avoid flaring and additional emissions.

One or a combination of these factors may be sufficient reason for an industrial user to refrain from establishing a connection to national hydrogen infrastructure. This results in suboptimal utilisation of infrastructure and the absence of a viable decarbonisation pathway for industry.

Natural gas pipelines are suitable for high-quality hydrogen

Various technical studies and pilot projects demonstrate that existing natural gas pipelines, provided they are properly prepared, can be made suitable for the transport and delivery of high-purity hydrogen. Through cleaning, pigging, purging and drying, residual contaminants in natural gas pipelines can be sufficiently removed. The adoption of a lower quality standard for hydrogen infrastructure therefore does not appear to be driven by technical limitations, but rather by a desire to limit operational and liability risks for hydrogen network operators.

While such concerns are understandable from an operational perspective, they must be weighed against broader system costs and the interests of end-users. Lowering the infrastructure quality shifts risks and costs to users, who are then required to invest in decentralised purification installations or are effectively excluded from connection to the backbone.

A low quality standard contaminates newly constructed pipelines

Choosing a low quality standard entails the risk that newly constructed hydrogen pipelines become contaminated. Contaminants such as hydrocarbons (CxHy) and sulphur compounds may remain in the infrastructure. Without cleaning the pipelines, these contaminants can have significant long-term impacts. If a higher quality standard is implemented at a later stage, part or all of the infrastructure may need to be cleaned again.

The quality standard has a major impact on investments

The choice for a hydrogen quality standard has major implications for decisions made by network users. Users must adapt or align their capital-intensive installations to the applicable standard, with financial consequences over long periods (10–25 years). If users take a final investment decision (FID), for example for a PSA installation, and the quality standard is later raised, they risk stranded assets, which should be avoided from a business perspective.

Benefits for future energy users

Replacing natural gas with hydrogen leads to different combustion characteristics, such as higher flame temperatures, increased NO_x emissions due to chemical reactions with nitrogen in the air, and potential

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emissions of contaminants present in hydrogen-containing gas when a lower network quality standard is chosen.

Future users require a learning period to gain experience with hydrogen combustion and to optimise their processes. This will require modifications to installations, such as adapting or replacing burners to make them suitable for hydrogen use. Additional investments may also be required to mitigate or eliminate secondary effects such as NO_x emissions.

Users that primarily intend to use hydrogen as an energy carrier have different requirements from those that use hydrogen as a feedstock. While some high-temperature applications may technically operate with hydrogen concentrations of, for example, 96 mol% and a broad range of contaminants, these future users also benefit from a high hydrogen quality standard. Technically, a high quality standard limits environmental emissions during combustion by preventing certain contaminants from being present in the gas. Economically—and more importantly—future hydrogen energy users ultimately benefit most from an infrastructure with a high utilisation rate and a liquid hydrogen market, which can only be achieved with a high hydrogen quality standard.

Conclusion

The Hydrogen and decarbonised gas market package clearly recognises that a well-functioning hydrogen market must be built around high-purity hydrogen, stable quality for end-users, and harmonised standards that enable cross-border trade, interoperability and market integration. By explicitly prioritising pure hydrogen transport, end-user quality requirements, and coordinated hydrogen quality management by network operators, the EU framework aligns closely with the needs of energy-intensive industries. IFIEC Europe's proposal for a ≥ 99.9 mol% hydrogen quality standard – with a contaminant specification which aligns with all users – is fully consistent with these objectives and provides the necessary investment certainty for both current and future hydrogen users. A high, uniform quality standard avoids costly decentralised purification, maximises infrastructure utilisation, safeguards industrial competitiveness, and supports the gradual development of an integrated, liquid and efficient European hydrogen market.

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