Position Paper: *Hydrogen as an energy carrier for the future*
Contact: Peter Claes (Febeliec) - +32 496 59 36 20 – febeliec@febeliec.be
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Hydrogen (H, atomic number 1) is the most abundant element in the universe. As a gas, it is a diatomic molecule with the formula H_2, which is colorless, tasteless, odorless, and highly combustible. It is, however, not considered as a primary energy source because on earth it is mostly bound to other atoms and it does not occur as such in nature in significant quantities. It thus has to be produced actively while using other energy sources.

Hydrogen is widely used in several industrial applications in different sectors. Most of the hydrogen produced industrially today is through steam reforming of natural gas (SMR), but several other production methods are available and applied, such as electrolysis of water. The use of hydrogen as an energy carrier is rather limited in industry today because of its relatively high cost compared to alternatives (fossil fuels and other).

The fast development of intermittent renewable energy sources for electricity production has, however, re-opened the debate on the use of hydrogen as an energy carrier for the (climate-neutral) future. Indeed, excessive electricity generation that cannot be consumed nor stored at the moment of production, can "easily" be used (through electrolysis) to produce hydrogen for instantaneous or later use as a molecule, or for later re-conversion into electricity. The European Commission has recognized the role of hydrogen in the energy transition, and has set up a Hydrogen strategy in the framework of its Fit for 55 program (2030 climate targets) and its Green Deal (2050 climate targets)[1].

Increasing the role of hydrogen in the energy transition, however, comes with several challenges on different levels.

1. Use of hydrogen

   Currently industry already uses large amounts of hydrogen, mostly as a feedstock. Process electrification is generally seen as an important pathway to reduce greenhouse gas emissions. Molecules (low-carbon hydrogen and other molecules of non-fossil origin) will, however, remain indispensable in several applications, both as a feedstock and as an energy carrier. This will require massive volumes of low carbon hydrogen, and require an exponential growth in production.

   In transports, hydrogen has the potential to become an energy carrier in air transport, maritime transport and for on-land heavy duty transport. For cars, electric vehicles are expected to remain more energy-efficient.

   For heating in residential, commercial and administrative buildings, the potential of hydrogen as an energy carrier is still rather unclear.

   In power generation, hydrogen can be used as a fuel. Efficiency is a challenge, as energy losses in the chain are substantial.

2. Hydrogen production

   In order for hydrogen to contribute to the energy transition towards climate neutrality, production of low carbon hydrogen needs to grow exponentially in the following decades. Different types ("colors") of low carbon hydrogen are distinguished:

   - Green hydrogen is produced by electrolysis driven by renewable energy sources. As from an energy efficiency point of view, it is strongly preferable to use green power directly as electricity, green

[1] See https://ec.europa.eu/growth/industry/strategy/hydrogen_en.

hydrogen is to be produced essentially from green power produced in periods where demand and storage cannot absorb generated electricity.

- Blue hydrogen is produced by using fossil methane as a raw material (essentially natural gas through steam methane reforming) and storing the released greenhouse gases (CCS) and/or by using them in other sustainable applications (CCU).
- Turquoise hydrogen is produced by methane pyrolysis (delivering solid carbon as a waste product), a technology still in development.
- Purple, pink and red hydrogen are produced by nuclear power in different processes without greenhouse gas emissions.
- White hydrogen is obtained by the (rare) natural sources of hydrogen gas, or as hydrogen produced as an unavoidable by-product in chemical processes.

In order to distinguish low carbon hydrogen from fossil fuel based hydrogen (gray and brown hydrogen) at production level, a certification system is to be set up at international level. Once different "colors" of hydrogen are mixed into the dedicated transport chain, the distinction at consumption level becomes impossible and irrelevant.

3. Hydrogen infrastructure

Today, hydrogen is worldwide mostly transported over the road in cryogenic liquid tanker trucks or gaseous tube trailers. Where demand is substantial and guaranteed for a longer period (several decades), hydrogen pipelines are deployed.

Increasing production and consumption of hydrogen will require deploying a wider hydrogen grid of dedicated pipelines, a capital intensive investment that can only be profitable if demand is guaranteed over a very long period (several decades).

Existing natural gas grids could be refurbished to be used for hydrogen transport, generally after some investments. It is also possible, up to a certain level, to blend hydrogen into existing natural gas pipelines.

In order to guarantee a steady flow of hydrogen, storage facilities are required. Not all existing natural gas storages can be used for hydrogen, and investments in new capacity is recommendable.

4. Hydrogen imports

Belgium (and most probably the EU) will not be able to produce sufficient volumes of low carbon hydrogen to satisfy its total needs. Production of other forms of low carbon hydrogen and imports from other parts of the world would therefore be necessary. For efficiency reasons, hydrogen could also be transported in the form of transformed molecules such as ammonia, methanol or other. Imports of hydrogen require specific infrastructure (vessels, liquefaction facilities, storage facilities, …).

Febeliec position

- Febeliec fully recognizes the significant role that hydrogen and hydrogen carriers can play as feedstock and as an energy carrier in the energy transition towards a climate-neutral system in 2050.
- Business models for the increased use of (low carbon) hydrogen are still to be developed and/or to be detailed down for many applications. Overall, technological choices will need to be made based on the technical and economic potential of all the available pathways towards a climate-neutral energy system by 2050, i.e.:

- Renewable energy sources completed by storage and/or power-to-X technologies
- The further use of fossil fuels combined with pyrolysis or Carbon Capture and Storage (CCS)/Carbon Capture and Usage (CCU). In some "hard-to-abate" sectors (e.g. cement, lime, …), this is the only way to reach the target, as these sectors are confronted with unavoidable process emissions.
- Nuclear technologies (new generation of fission reactors, small modular reactors, nuclear fusion).

- Febeliec is thus in favor of a no-regret, technology neutral approach, with a step-by-step development of generation of low carbon hydrogen, investments in hydrogen infrastructure and hydrogen use in industry, transport and power generation based on progress in technical feasibility and economic viability. Seeing the limited potential of renewable energy, high and continuous demand of hydrogen, high uncertainty in price evolutions and high uncertainty in technology evolutions, Febeliec is opposed to arbitrary imposed targets for the use of green hydrogen in industrial processes without accompanying carbon leakage measures. Specific quota's on green hydrogen without a supporting framework puts the Belgian industry at risk and hinders further hydrogen development instead of supporting it.
- Low carbon hydrogen production costs are today generally some 2 to 7 times higher than the cost of hydrogen produced from fossil fuels. Upscaling of low-carbon hydrogen production, further technical/technological breakthroughs and supporting measures are therefore necessary in order to avoid competitive disadvantages for existing and future Belgian industrial hydrogen consumers compared to their competitors in other countries or parts of the world. As transitionary measure, support is needed to avoid carbon leakage and competitive disadvantages for industry vis-à-vis their competitors.
- As for infrastructure development, Febeliec strongly supports the ACER/CEER recommendations on when and how to regulate pure hydrogen networks[2]:
    1. Consider a gradual approach to the regulation of hydrogen networks in line with market and infrastructure development for hydrogen
    2. Apply a dynamic regulatory approach based on periodic market analysis and monitoring
    3. Clarify the regulatory principles from the outset
    4. Foresee regulatory exemptions for existing and new hydrogen infrastructure developed as business-to-business networks
    5. Value the benefits of repurposing gas assets for hydrogen transport
    6. Apply cost-reflectivity to avoid cross-subsidisation between the gas and hydrogen networks in case of repurposing gas assets.

  Furthermore, hydrogen distribution at industrial site level requires a special regime, comparable to the "closed distribution grids" for electricity and natural gas.
- Hydrogen is also produced as an unavoidable by-product in chemical processes. Febeliec asks that this hydrogen be recognised and allowed to play a role in a low carbon economy.
- Febeliec ask for realistic conditions for H_2 produced by water electrolysis. Conditions like additionality, temporal and geographical correlation need revision as these hamper cost efficient development of renewable hydrogen.
- As for blending of hydrogen into existing natural gas pipelines, Febeliec takes the following position:

[2] See https://documents.acer.europa.eu/Media/News/Pages/ACER-and-CEER-recommend-when-and-how-to-regulate-pure-hydrogen-networks.aspx

FEBELIEC vzw/asbl
BluePoint Brussels, Bld. A. Reyerslaan 80, 1030 – Brussel/Bruxelles
Tel: +32 (0)496 59 36 20, e-mail: febeliec@febeliec.be, www.febeliec.be
RPR Brussel - TVA/BTW BE 0439 877 578

- To the extent that hydrogen is to be part of the future fuel mix in a climate-neutral Europe, mixing it up with natural gas does not seem to be a step in the right direction. Moreover, blending high-value low-carbon hydrogen with natural gas would be economically hard to justify. Febeliec recognizes the technical possibility to increase the hydrogen content of supplied natural gas, but does not see today a clear cost/benefit analysis proving it offers a positive balance for society.
- Febeliec insists on the need of a longer-term perspective of blending, and of harmonization of the process parameters with neighbouring TSOs and with greenhouse gas accounting in ETS.
- Febeliec points out the potential negative impact of higher hydrogen shares in the natural gas used for certain applications in industry and power generation.

- In order to distinguish low carbon hydrogen from fossil fuel based hydrogen (gray and brown hydrogen) and to attract investment in low carbon hydrogen, a stable framework with clear definitions and methodologies for low carbon hydrogen is needed. A certification system needs to be set up at international level and needs to include an absolute GHG savings threshold in the interest of regulatory certainty.