ARTICLE

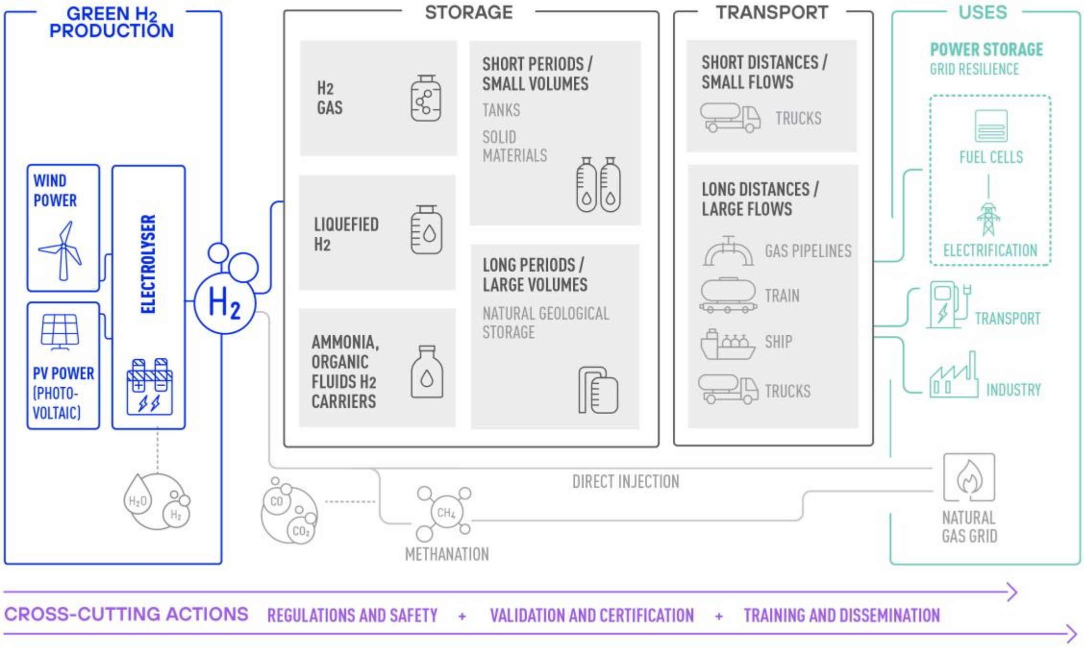
Hydrogen, a key element for decarbonisation

- *Climate change is currently one of the main challenges society must cope with to reduce carbon dioxide emissions drastically. Consequently, an energy transition is also required to replace fossil fuels with renewables. In this regard, renewable hydrogen will eventually become one of the main energy vectors needed to carry out said energy transition efficiently. With a gravimetric density higher than gasoline, renewable hydrogen is a fuel that does not generate contaminating emissions during production and when later consumed.*

Hydrogen production with renewables is based on water electrolysis, a process that splits water molecules into their components (hydrogen and oxygen) by the electricity supplied by renewables. Electrolysis allows large amounts of renewable electric power to be stored over long periods of time by transforming electric power directly into hydrogen.

This is why electrolysis systems, also known as electrolysers, must be installed at photovoltaic and wind power farms. Electrolysers, however, do not only provide electrical power storage capabilities that increase the amount of power generated by renewables, but can also deliver grid frequency control and balancing capabilities.

Renewable hydrogen generated by electrolysers can also be used as a raw material in several sectors such as transport, industry or construction to allow for the decarbonisation of these sectors and in which actions of this nature have always been difficult to carry out. Likewise, any renewable hydrogen that has been generated can be injected into the natural gas network to provide a coupling with the electricity and gas networks.



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As regards the different types of electrolysers that are currently available, those featuring polymeric membranes (PEMWE) have become increasingly relevant over the last decade as they are considered to be optimum for use with intermittent renewables thanks to features such as a rapid dynamic response, the possibility of operating at high current densities associated with high levels of efficiency, compact designs and the option of running at high pressure settings. The full potential this technology has been demonstrated in a few pilot projects such as the 2 MW Haeolus project or the 10 MW Refhyne project.

On the other hand, alkaline electrolysers (AWE) represent a mature technology that is still available on the market, although liquid electrolytes, low current densities and higher operating pressures are gradually pushing them out of the market as optimum candidates to be used at renewable energy facilities.

Lastly, and compared to other alternatives, solid oxide electrolysers (SOEC) are associated with higher efficiency levels due to high operating temperatures (~800 ºC): This also means that they require additional heat to reach said temperature levels and this poses severe stability and degradation problems as few materials are capable of withstanding system operating conditions.

Although PEM electrolysers offer numerous advantages, there are still many obstacles hindering a widespread deployment of this technology in the market for power to hydrogen solutions. Such barriers are mainly due to high capital (CAPEX) and operating (OPEX) costs, to the absence of mass manufacturing processes and because there is a dependence on certain critical materials.

Challenges and uncertainties

In addition to the technological challenges posed by the PEM electrolyser, there are many technological challenges and uncertainties associated with the rest of the value chain such as storage, transportation and use.

By incorporating electrolysers to renewables, it is nowadays possible to store surplus power in the form of hydrogen. This also means that the cost of generating electricity can be reduced by drawing on all of the electrical power generated regardless of specific grid demand requirements in what is termed adapting to a fluctuating supply that the generation of renewables offers with respect to demand.

Nowadays, commercial electrolysers are designed to produce hydrogen in a stable and constant operational manner. If, however, the aim is to use water electrolysis to make the most of generation surpluses, it will be first necessary to overcome certain difficulties associated with the intermittent and variable character of these power sources as fluctuations of this kind may give rise to a number of problems in electrolysers in the form of corrosion, explosive blends, sudden pressure drops or stack temperature variations.

The main challenge associated with PEM electrolysis is to reduce manufacturing costs for these systems. Consequently, new designs must be developed to allow electrolysis cells to incorporate cheaper materials with a view to implementing competitive serial manufacturing practices. New designs must also improve efficiency and increase system robustness by improving management actions associated with gas/water flows and thermal issues. New designs and materials should make it possible to increase operating pressure and produce more active cell surfaces.

The Tekniker contribution

It is within this particular context that Tekniker experts are currently working to develop new critical components to reduce manufacturing costs for the PEM electrolysis technology.

Based on more than 30 years of experience in developing surface coatings by means of magnetron sputtering technology, we have produced innovative coatings for bipolar plaques and porous transportation layers to replace titanium, the material currently used, with stainless steel.

Thanks to the new coatings we have been able to develop new channels on bipolar plaques to enhance gas and water distribution efficiency. One of the most critical aspects of this technology is the use of precious metals as catalysts to achieve electrolytic reactions.

We are developing new catalysts and manufacturing processes at Tekniker to minimise or even remove precious metals altogether from these units.

The development of materials and components, moreover, has given rise to a number of tools and methods that are used to monitor, diagnose and control electrolysers.

These new developments do not only focus of electrolysis systems, but also incorporate new integration and control technologies to achieve a perfect degree of coupling between electrolysers and renewable power facilities so that renewable hydrogen can be produced at competitive prices.

As hydrogen technologies must be deployed rapidly to achieve pre-established carbonisation goals, any knowledge acquired must be transferred to the industrial sector. This is why Tekniker is a member of the Basque Hydrogen Corridor (BH2C), an initiative where the expertise and efforts of a number of companies and organisations converge and whose ultimate goal is to transform renewables into a reality in the energy sector.

The expert's view: Eva Gutiérrez, coordinator of Tekniker’s hydrogen scheme