Hydrogen: Realistic Game Changer? ^(A) Nexant

Hydrogen has many potential applications but can it be supplied economically and in sufficient quantities?

Background

Traditionally, hydrogen is used in the chemical industry for the production of several important products such as ammonia, methanol, cyclohexane, hydrogen peroxide, aniline, oxo alcohols and TDI, amongst others. Hydrogen is also used in the refining sector to decrease the sulfur content of certain fuel streams as well as in many other industries including in food production, electronics, polysilicon, vegetable oil processing, float glass, steel processing, and power generation, among other applications.

Adopting hydrogen as an energy carrier in fuel cell applications would open up a potentially huge new market. This leads to the question: where should the hydrogen be sourced from?

Global production of hydrogen is ca. 60 million tons per year (2017). Currently, most hydrogen globally is produced from conventional hydrocarbon sources, (e.g., natural gas, oil, and coal) through the use of thermocatalytic and gasification processes. More than 90 percent of all hydrogen is derived from fossil fuels, with natural gas being by far the most frequently used, followed by liquid hydrocarbons, coal, electrolysis and other by product sources of hydrogen.



Historic H2 Production and Capacity, by Source

Hydrogen to date is not consumed in large quantities as an end-use product (energy carrier)

As such, almost all hydrogen is produced on-demand depending on downstream requirements. There is a healthy margin of "spare capacity" available on a global scale. Historically, operating rates have been around 77 to 83 percent. The merchant market for hydrogen is small with trade on an industrial scale limited to some refineries and power plants sourcing hydrogen from near-by suppliers. Hence, unlike in other chemical markets, operating rates are not necessarily a good indicator on how tight a regional hydrogen market is. Regional and global operating rates for ammonia for example provide a good insight on how supply is developing relative to demand which provides a basis for analyzing pricing developments. In the case of hydrogen there is only very limited local trade and hence limited option to take advantage of arbitrage opportunities within regions and especially inter-regionally. As long as hydrogen production and trade is focused on local markets, hydrogen pricing mechanisms will also differ intra- and inter-regionally.

A wide range of hydrogen supply sources as well as different distribution methods will require case-by-case economic feasibility evaluations

Hydrogen production methods include reforming, gasification, electrolysis, photocatalytic water splitting, and biological processes to name a few. Production can furthermore be centralized or decentralized. Storage and transportation can include cryogenic as well as pressurized systems, trailers, and pipelines. The viability of each system is furthermore dependent on each specific location, raw material and or utilities supply situation which can vary significantly from region to region and even locally. Individual systems thus need to be analyzed on a case-by-case basis.

Given the size of the transport industry, using hydrogen as an energy carrier in this sector could significantly impact the global demand for hydrogen.

Via fuel cells, hydrogen has been trialled in cars, military vehicles, trucks, buses, boats, trains, forklifts, drones and other applications. Even a modest uptake of hydrogen fuel cell technology would put significant pressure on hydrogen production. The speed with which this technology will be adopted will vary regionally with some Leader and Followers. Currently, the US (especially California), Western Europe, Japan, South Korea and China are some of the Leaders. There is also growing interest of some nations to develop inter-regional trade of hydrogen especially from hydrocarbon rich regions such as Australia and the Middle East.



Potential hydrogen demand split in 2035 under different "Adoption" scenarios

While the interest in hydrogen is growing, a significant amount of research and development still has to be undertaken, both on the technological and commercial sides, in order to move hydrogen as an energy carrier closer to reality.

Summary

For further information, please refer to Nexant's report "Hydrogen: Realistic Game Changer?". This report provides regional and global analysis and forecasts under three market scenarios to 2035. The scenarios have been developed to analyze different levels and speeds of adopting hydrogen as an energy carrier in the transportation sector. This analysis identifies "new" and conventional applications for hydrogen as well as "new" and conventional supply sources. An analysis of different hydrogen supply / logistics chains is included, as well as a cost analysis to illustrate economic viability of certain production and distribution routes.

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