

THE ROLE OF HYDROGEN IN ACHIEVING CARBON NEUTRALITY

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Overview

These days almost among all energy analysts, this notion is accepted that hydrogen will play an essential and unique role in the future of the energy systems and the route through to carbon neutrality. However, hydrogen is not the sole solution towards carbon neutrality. In other words, hydrogen is not a primary pathway to help humanity reach a zero-carbon energy society, but it is a complementary route to enabling carbon-neutrality.

In order to investigate the role of hydrogen and the level of its penetration into the energy system, an updated Hydrogen Scenario has been modelled and developed within the framework of GECF Global Gas Outlook. In the new version of the GECF Hydrogen Scenario, an extended supply chain of hydrogen, including the trade of hydrogen, is covered. This paper presents some results of the scenario that models the entire supply chain of hydrogen to assess the level of possible hydrogen penetration. This paper also investigates the associated necessities and challenges, such as the hydrogen trade that requires vast infrastructure development and investment.

The most optimistic analysis on the future role of hydrogen estimated only a share of 10% to 20% in the global energy mix for hydrogen by 2050. Therefore the majority of energy needs will yet to be met by other clean energy sources such as renewable power. Electrification, digitalisation, direct or indirect carbon-capturing, as well as efficiency advancement are among the fundamentally required evolutions towards zero or negative carbon energy society.

Methods

A combination of methods has been employed to develop this study and this version of the GECF Hydrogen Scenario. The modelling tool is the GECF Global Gas Model (GGM). The GECF GGM is a sophisticated, hybrid modelling tool that is used for projections in the GECF Global Gas Outlook (GGO). The GGM employs a variety of modelling methods, including econometrics and optimisation, to holistically forecast all market trends, with a special focus on natural gas and its derivatives. The modelling time horizon is set to be from 2020 (the base year) through 2050.

The demand for all fuels, including hydrogen, is projected through macroeconomic time-series and then fed into the supply model. The model is solved by running a chain of iterations until the appropriate convergence is gained. Assumptions of the modelling are based on the announced policies and strategies as well as the potential of hydrogen production and trade in each region.

Results

The results of the scenario modelling suggest that hydrogen demand will reach more than 620 Mt of H₂ per year by 2050, contributing to more than 10% of the global energy mix to play a fundamental role in decarbonising so-called hard-to-abate sectors. Nevertheless, the hydrogen share in some regions is forecast to be much higher. For instance, in Europe, the share of hydrogen is projected at around 20%

Transport emerges as the primary driver of hydrogen demand, accounting for more than one-third of the total market. Hydrogen is assumed to substitute for petroleum products in hard-to-electrify subsectors such as heavy and long-haul road transports, trains, shipping and aviation. The industry is forecast to appear as the second-largest hydrogen consumer among the energy sectors.

Blue and green hydrogen production arise as the two dominate technology in the Hydrogen Scenario. The scenario results suggest that almost 46% of total hydrogen production will be sourced through blue hydrogen production.

However, the share of whole natural gas-based hydrogen generation, including other clean pathways such as turquoise hydrogen, is almost half of the total output. The other half is forecast to be met by electrolysis powered by clean electricity such as renewable (green hydrogen).

Hydrogen evolution will not materialise unless the hydrogen trade is developed. The HS suggests that around 23% of the total hydrogen supply (or 145 Mt of H₂) will be traded annually by 2050. Europe and the Asia Pacific will import the majority of the hydrogen while almost all regions will export this clean fuel.

The hydrogen evolution cannot solely solve the climate issues, as emission reductions resulting from clean hydrogen deployment are estimated at around 4 Gt of CO₂ p.a. and is not very significant.

Conclusions

Hydrogen is not a game-changer in global energy decarbonisation, but hydrogen will complement other measures in decarbonising the hard-to-decarbonise sectors. That means the supremacy of hydrogen is not the result of a very significant emissions abatement but is more to do with the decarbonisation of sectors for which other pathways are impossible or highly challenged. Hydrogen will be a stand-alone contributor to carbon neutrality in some sectors that can not be easily substituted with other decarbonisation pathways.

Demand creation through policy adoption and technology advancement, and infrastructure development to facilitate the transport and trade of hydrogen are vital for the future of hydrogen. Technology advancement can positively impact all levels of the hydrogen supply chain, including production, transportation, and consumption. The hydrogen evolution will hardly materialise in scale unless the appropriate trade platforms are developed.

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