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Hydrogen to become a source of cleaner power on a massive scale

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Анотація

Водень чудово зберігається, є легким, енергомістким і не виробляє прямих викидів вуглецю та парникових газів (ПГ). Такі галузі, як переробка ґрунту, виробництво аміаку, метанолу та виробництво сталі широко використовують водень. Водень, швидше за все, відіграватиме вирішальну роль у переході на чисту енергію зі збільшенням його використання в таких секторах, як транспорт, будівництво та виробництво електроенергії. Інтерес до використання водневих технологій зростає в ряді сегментів ринку ніш транспорту, крім інших застосувань. У короткостроковій та середньостроковій перспективі технологію водню можна використовувати для заміщення стисненого природного газу (СПГ) у деяких районах із незначними змінами в наявній інфраструктурі.

Ключові слова: *Водень; Чиста енергія; Відновлювальна енергія; Електричні машини; Паливні елементи.*

Abstract

Hydrogen is light, storable, energy-heavy and does not produce direct carbon emissions or greenhouse gases (GHG). Sectors such as soil refining, ammonia production, methanol production and steel production use hydrogen extensively. Hydrogen will likely play a crucial role in clean energy transition with an increase in its use in sectors such as transportation, buildings and power generation. Interest in the use of hydrogen technology is increasing in a range of niche transport market segments, besides other applications. In the short to medium term, hydrogen technology could be used to replace compressed natural gas (CNG) in some areas with minor changes to the existing infrastructure.

Keywords: Hydrogen; Clean Power; Renewable energy; Electric vehicles; Fuel-cell.

Countries worldwide strive to accelerate the development and use of hydrogen technology to tackle environmental concerns and enhance energy security. Hydrogen technology has the capability to serve as a long-term, large-scale clean energy storage medium that aids power generation from renewable sources. However, formulating a cost-effective and well-regulated transition is a complex issue, and the cost of producing hydrogen from renewable energy sources is currently expensive.

A recent report Thematic Research: Hydrogen released by GlobalData, a leading data and analytics company, reveals that hydrogen has the ability to assist in variable power output from renewable energy sources such as solar photovoltaic (PV) and wind. The availability of these sources is not always equal with the demand for power. Hydrogen serves as one of the leading alternatives for energy storage from renewables and seems to be favoured as a lowest-cost alternative for storing huge quantities of electricity over days, week and months. The storage of hydrogen fuel can take place for long periods and in quantities limited only by the size of storage facilities.

Hydrogen can be produced from a broad variety of fuels such as renewables, nuclear, natural gas, coal and oil. The transportation of hydrogen as a gas occurs via pipelines and in liquid form via ships, similar to liquefied natural gas (LNG). Once hydrogen is transformed into electricity and methane, it can be used to power homes and feed industry and turned into fuels for road transport (cars, trucks), marine (ships), railways and aviation sectors.

Hydrogen finds application in various sectors such as buildings, industry, power, transport and refining. The global building industry accounts for 30% of the final energy use, with almost three-quarters used for space heating, hot water production and cooking. The role of hydrogen as a source of energy is limited in the global building industry today. However, its use in numerous areas is under evaluation. Currently, a number of demonstration projects are assessing the blending of hydrogen into the natural gas grid.

In the UK, a groundbreaking hydrogen trial project (HyDeploy) is underway at the Keele University. The £7 million pilot project is led by Cadent in partnership with Northern Gas Networks (NGN), Keele

University, the Health and Safety Executive (HSE) Science Division, ITM-Power and Progressive Energy. The injection of zero-carbon hydrogen (20% hydrogen by volume) into Keele University's gas grid is feeding approximately 100 houses and 30 faculty buildings.

Currently, in the power industry, hydrogen plays a minimal role and accounts for less than 0.2% of electricity generation. This is associated mainly with the usage of gases from the steel sector, petrochemical plants, along with refineries. But a change is within the realm of possibility in the near future. Co-firing with a share of ammonia can decrease the impact of carbon in existing conventional coal-fired power plants, hydrogen gas turbines and combined-cycle gas turbines (CCGT), which can be a source of power system flexibility with increasing shares of variable renewable energy sources. When it comes to long-term and large-scale energy storage, hydrogen (in the form of compressed gas, ammonia (NH3) or synthetic methane has a role to play in balancing seasonal variations in electricity supply and demand from renewable energy sources.

Since a long time, hydrogen gas has been spoken about as a potential transport fuel. It serves as a low carbon substitute to natural gas and refined oil products, along with supplementing alternatives such as electricity and advanced biofuels. Hydrogen-powered fuel cell electric vehicles (FCEVs) are more efficient when compared with conventional vehicles as they involve zero tailpipe emissions and only water vapour and warm air are emitted from these vehicles. The conversion of hydrogen into hydrogen-based fuels such as synthetic methane, methanol and ammonia, and synthetic liquid fuels finds a range of applications in the transportation sector in the form of synthetic jet fuel) and for shipping (as ammonia).

Many countries have plans underway to introduce hydrogen trains. In Germany, hydrogen fuel cell-powered rail has been put to greater use. In September 2018, the country rolled out the world's first hydrogen-powered train Coradia iLint in Lower Saxony, Germany. The two pre-series iLint trains built by Alstom are now operational between the German cities of Cuxhaven, Bremerhaven, Bremervörde and Buxtehude. Alstom is also planning to deliver another 14 hydrogen-powered trains to Germany by 2021.

In May 2019, Alstom announced that it would supply 27 Coradia iLint trains to German public transport network Rhein-Main-Verkehrsverbund's (RMV's) subsidiary fahma. The fuel-cell trains are expected to run on four regional train lines in Germany's Taunus region from 2022. The order also consists of hydrogen supply, maintenance and offering of reserve capacities for the next 25 years. Alstom is also testing Coradia iLint trains in the Netherlands, serving as its first pilot Coradia iLint project outside Germany. On 6 March, Alstom successfully completed ten days of tests of the Coradia iLint hydrogen fuel-cell passenger train.

The aviation sector is looking at hydrogen fuel cells as a substitute for the conventional aircraft propulsion system. These hydrogen fuel cells offer zero-emission transportation with heat and water being the only byproducts.

Oil products currently dominate the shipping industry, and hydrogen fuel cell-powered marine vessels are still in the early design phase or trial stages with their applications limited to smaller passenger ships, ferries and recreational craft. In 2019, Belgium's shipping company Compagnie Maritime Belge (CMB) was involved in a partnership with the Port of Antwerp to unveil the world's first hydrogen-powered tugboat Hydrotug. The Hydrotug will be powered by combustion engines that run on hydrogen-diesel dual fuel. Hydrotug's construction is expected to initiate shortly and it will be running within two years.

Fuel-cell electric vehicles (FCEVs) are powered by hydrogen. Cars constitute a large portion of fuel-cell-powered vehicles used in road transport. The US alone has more than 7,500 fuel-cell cars on its roads with more than 40 publicly available hydrogen refuelling stations. Most of the passenger car FCEVs are manufactured by Toyota, Hyundai and Honda. Mercedes Benz also achieved a major milestone with the launch of its GLC F-CELL vehicle, a special plug-in hybrid with fuel cell. Meanwhile, Toyota announced a target of 30,000 FCEVs annually after 2020 from approximately 3,000. Through its FCEV Vision 2030, Hyundai aims to increase its fuel-cell system production to 700,000 units annually by 2030, including 70% (500,000 units) for FCEVs.

The UK-based hydrogen car manufacturer Riversimple's two-seater hydrogen-fuelled vehicle Rasa is also undergoing trials (beta tests) on the UK streets. Some companies such as SAIC Motor, Great Wall Motors and BAIC Group have accelerated their attempts to develop and produce FCEVs, which are regarded as cleaner, emission-free solutions for the automotive sector. A Chinese start-up company Grove Hydrogen Automotive Co launched a new hydrogen fuel-cell concept car at the Shanghai Auto Show 2019. This could make fuel-cell vehicles the next big thing in China's EV market.

A number of fuel cell electric buses (FCEBs) are in the production phase or on pre-order for the next five years, largely in China. Mostly, government-supported measures directly reinforce these orders such as the

Fuel Cell and Hydrogen Joint Undertaking (FCH-JU) in Europe and the National Fuel Cell Bus Program (NFCBP) in the US. In the Republic of Korea, a public-private partnership (PPP) plans to put in place 1,000 FCEBs by 2022 on its way to achieving a target of 40,000 by 2040. In the UK, a fleet of eight hydrogen buses has been operational in the busy London streets (six years on RV1 route) until recently. The hydrogen buses now continue to be functional in London's 444 bus route. The UK's first double-decker hydrogen buses are also expected to be rolled out on the streets of Aberdeen in the next few months.

Major hydrogen-powered truck manufacturers include Hyundai, Scania, Toyota, Volkswagen, Daimler and Groupe PSA. These established manufacturers are coming up with models and so is a five-year-old electric vehicle startup Nikola Motor Company. Hyundai and Nikola are making progress in terms of their orders. In September 2019, Hyundai Hydrogen Mobility (HHM), the joint venture (JV) between Hyundai Motor Company and H2 Energy, entered a partnership with Hydrospider, a JV among H2Energy, Alpiq and Linde, to enhance green hydrogen environment in Switzerland and other countries in Europe in the future.

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