China's Hydrogen Industrial Strategy

Photo: iLab/CSIS

Commentary by **Jane Nakano**
Published February 3, 2022

This commentary is part of Energy Rewired, a project from the CSIS Energy Security and Climate Change Program studying the industrial strategies of major economies for the energy transition. The project examines countries' big bets on emerging energy technologies and how these will rewire the world's energy map.

Key Points

- Despite the absence of a national strategy for hydrogen development, provincial governments and commercial enterprises in China have launched hydrogen projects to support fuel cell vehicle (FCV) deployment and produce renewable-based hydrogen.

- China is already the largest hydrogen producer (mostly from unabated fossil fuels) and the third-largest market for FCVs in the world.

- A massive renewable power generation capacity in China could help underpin the rapid expansion of renewable-based hydrogen.

- The vast potential for renewable-based hydrogen production and the significant energy consumption profile may mean that China would become neither an exporter nor an importer of hydrogen.

- The transportation sector, particularly trucks and buses, may remain China's focus for hydrogen application, although hydrogen use in industrial sectors seems to be emerging.

Analysis

Vision

China is the largest producer of hydrogen today, at about 25 million tons (Mt), or roughly a quarter of the global total. Most of the volume is produced from fossil fuels (60 percent from coal, and 25 percent from natural gas) as feedstocks in refineries or chemical facilities. However, China is increasingly exploring cultivating the production and consumption of lower-emission hydrogen to help meet energy needs and spur industrial development while also addressing climate concerns. In particular, China's 2060 carbon neutrality commitment made in 2020 is a major policy-oriented development that could aid the shift in hydrogen production away from fossil fuels to renewables, greater deployment of FCVs, and the use of hydrogen in harder-to-abate sectors.

While China has not yet announced a national hydrogen strategy, hydrogen demand outlook suggests strong growth. The China Hydrogen Alliance, a government-supported industry group launched in 2018, forecasts China's hydrogen demand to reach 35 Mt in 2030 (at least 5 percent of the Chinese energy supply) and 60 Mt in 2050 (10 percent). Meanwhile, the same organization also projects that renewable-

based hydrogen production could reach 100 Mt by 2060, accounting for 20 percent of the country's final energy consumption.

China's interest in hydrogen development began with its use in the transportation sector in the early 2000s as policymakers saw the growing auto sector and the attendant rise in fuel imports as a source of strategic vulnerability and an aggravator to air pollution in cities. At the end of 2020, there were 8,400 FCVs deployed in China, making the country the third-largest FCV market and the first for fuel cell trucks and buses in the world. Under the Hydrogen Fuel Cell Vehicle Technology Roadmap, released in 2016, China sought a national fleet of over 50,000 FCVs and 300 hydrogen refueling stations (HRSs) by 2025, and 1 million FCVs and 1,000 HRSs by 2030. The outlook for HRS deployment is stronger today. According to the New Energy Vehicle Industry Development Plan, published in October 2020, HRS capacity could grow from 72 units as of mid-2020 to 2,000 units by 2035, suggesting an accelerated pace for infrastructure rollout.

The cost of hydrogen production from coal remains very low in China: producing coal-based hydrogen costs roughly half as much as renewable-based hydrogen. The cost disadvantage hampers green hydrogen development, which currently accounts for 1.5 percent of the total national hydrogen supply. Yet, China's central government appears increasingly focused on the prospect for green hydrogen development, illuminating a potential combination of energy storage and hydrogen technologies in the context of expanding renewable energy supplies.

Home to the largest installed renewable power generation capacity in the world today, China plans to double its solar and wind generation capacity from nearly 600 gigawatts (GW) in 2020 to 1,200 GW by 2030. Insofar as the capacity of installed renewables is not an obstacle in China, it warrants close attention as to how quickly the cost falls for electrolysis, whereby electrolyzers use electricity to split water into hydrogen and oxygen. For example, a report by the Hydrogen Council notes that electrolysis at the current levelized cost of electricity in China is already competitive with low-carbon production technology, such as coal gasification with the capture and storage of carbon emissions, and suggests that electrolysis would become the lowest-cost low-carbon production technology in all Chinese locations by 2030.

Even in the absence of a national strategy, Chinese companies have begun investing in and manufacturing electrolyzers. As of 2020, China accounted for 8 percent of the global stock of electrolyzers of 290 MW and for 35 percent of the global manufacturing capacity of electrolyzer equipment and components. China is fast emerging as a major home to installed electrolysis capacity. In 2022, the Chinese capacity is expected to be five times greater than in 2021, accounting for more than 60 percent of the global total in 2022. The China Hydrogen Alliance is calling for 100 GW electrolyzer capacity by 2030 to produce green hydrogen. Moreover, although Europe is the top electrolyzer manufacturer (at 60 percent), vastly cheaper Chinese electrolyzers have made China the top electrolyzer supplier in the world .

Strategy

Hydrogen emerged in prominence following its mention in China's 14th Five-Year Plan (2021–2025) as a "frontier" area and one of the six industries for focused advancement. Many subnational governments and central government authorities—such as the National Energy Administration (NEA) as well as the Ministries of Industry and Information Technology (MIIT), Finance (MOF), and Science and Technology (MOST)—published policies to support the development of the hydrogen economy, including FCV-standard development and hydrogen production, storage, and transportation.

The Chinese government has been a key spender on hydrogen development, including research and development (R&D). Toward the end of the 13th Five-Year Plan (2016–2020), China's hydrogen technology R&D spending increased sixfold, to a little over $600 million in 2019 . Also, the statewide subsidy program is available to support the development of fuel cell batteries .

Moreover, a number of funds have been set up for investment in the development and application of hydrogen, including the Shanxi Hydrogen Energy Industrial Fund in 2021. Participants in these funds have included state-owned enterprises (SOEs), research institutions, universities, local governments, and commercial entities. While less common, hydrogen projects have also received bank loans, bonds, and equity investments. Lastly, while Europe leads in hydrogen start-ups, China is emerging as a source of hydrogen technology start-ups and venture capital for scale-up.

Specific to the transportation sector, hydrogen/fuel cell use lags that of electric vehicles (EVs) in China, although Made in China 2025—a 10-year industrial plan to upgrade China's manufacturing industry, released in 2015—included hydrogen as a key technology in the new energy vehicle (NEV) sector development. The Chinese government classifies FCVs as one type of NEV, which also includes battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs). In fact, China's primary focus has been on the development and deployment of EVs such as BEVs and PHEVs. By the first half of 2020, China had an EV fleet of over 4 million units, compared to an FCV fleet of 7,000 units. A combination of generous subsidies for production and sales led EV sales in China to grow 160 percent in 2021 alone, to about 2.91 million units.

There are some indications that China's NEV support is becoming more technology neutral than before. Under the New Energy Vehicle Industrial Development Plan for 2021 to 2035, released in 2020, the government calls for raising the market goals for the entire fleet of NEVs—a departure from the earlier focus on BEVs and PHEVs only. The plan targets 1 million FCVs and 2,000 HRSs, although the share of EVs in all NEVs is to reach about 95 percent by 2035.

NEVs have been a specific focus of public spending support. For example, the national government has provided tax reduction and subsidies for FCVs, ranging from RMB 20,000 to RMB 50,000 (about $3,200 to $7,900) depending on the type of the vehicles and the capacity of fuel cells. Notably, the NEV support is beginning to shift away from direct subsidies, which are being phased out between 2020 and 2022 at an annual reduction rate of 10 percent and withdrawn altogether by the end of 2022. Instead of direct subsidies, public financial support will take the forms of tax exemptions (e.g., no vehicle purchase tax), charging subsidies, parking incentives, and incentives for R&D investment from SOEs.

Decarbonization and carbon neutrality considerations are beginning to propel China to begin demonstrating hydrogen use in sectors beyond transportation where greenhouse gas emissions have proven harder to abate. For example, the world's largest electrolysis plant dedicated to producing hydrogen for use in the chemical sector is being built in Ningxia Province. Also, a small yet commercial-scale steelmaking project that uses hydrogen is being developed in Hebei.

In fact, SOEs are emerging as a key driving force. According to China's State-Owned Assets Supervision and Administration Commission, over one-third of SOEs are making plans for hydrogen production, storage, distribution, and utilization. For example, Sinopec—one of China's top national oil companies—has built 31 HRSs in 17 provinces and cities . The energy SOE is active in green hydrogen development as well. Sinopec is pursuing its goal of becoming the largest national hydrogen producer, with initial planned investment s of about $4.6 billion in the next five years covering projects such as a photovoltaic hydrogen production project in Xinjiang, a wind and optical power hydrogen plant in Inner Mongolia, and offshore wind power hydrogen production in Fujian Province. Also, State Power Investment Corp.—the largest renewable asset owner in the world—is not only involved in the HRS business but also aiming to build 10 GW of electrolyzer manufacturing capacity by 2027. While non-SOEs are present in the hydrogen sector, they appear to be limiting their activities to electrolyzer development for now.

Geography

Notwithstanding the absence of a national hydrogen strategy, by April 2021, 23 of China's provinces and municipalities had identified hydrogen as a key economic priority or formulated hydrogen development plans, including in their own five-year plans . Plans by Beijing and Jiangsu Province include accelerating the planning and construction of HRSs, while Zhejiang Province aims to use hydrogen in combined power and heating, use FCVs in public and port logistics transportation, and combine hydrogen production with offshore wind capacity.

The growing number of hydrogen projects in China span the geography of the country. For example, in the coastal province of Shandong, which is among the richest provinces, hydrogen is expected to play a key role in energy supply and for economic development. Sinopec has built a large fuel cell supply demonstration project in the province, with a total investment of $7.35 million. Its annual hydrogen production capacity of 22.5 Mt would meet the hydrogen demand for the entire province.

Another example is Inner Mongolia, where the provincial energy-planning ministry plans to develop seven wind and solar power projects in the cities of Ordos and

Baotou that could produce nearly 67,000 tons of low-carbon hydrogen a year. The second-largest coal-producing province in China, Inner Mongolia has also become the largest renewable power producer province. Inner Mongolia targets 100,000 tons a year of green hydrogen capacity by 2023, including 60 HRSs and over 3,800 FCVs operating in the mining, logistics, and public transportation sectors.

Furthermore, under the four-year program to advance hydrogen technology research and supply chain development, the national government has selected five city groups –the Beijing-Tianjin-Hebei cluster, Guangdong and Henan Provinces, and Shanghai– for demonstration projects, where local governments that satisfy specific targets will be awarded up to RMB 1.7 billion (about $269 million) as a fiscal bonus.

A mismatch between the demand from more industrialized coastal areas in the east and the supply from more resource-rich areas in the west and northwest has long been a characteristic of energy market dynamics in China. Insofar as hydrogen is a flexible energy carrier and not a natural resource itself, whether and how a geographical mismatch shapes the path for hydrogen market development in China warrants close attention.

Jane Nakano is a senior fellow in the Energy Security and Climate Change Program at the Center for Strategic and International Studies in Washington, D.C.

This commentary is made possible by support from the Hewlett Foundation.

Tags

Center for Strategic and International Studies

1616 Rhode Island Avenue, NW

Washington, DC 20036

Tel: 202.887.0200

Fax: 202.775.3199

MEDIA INQUIRIES

H. Andrew Schwartz

Chief Communications Officer

202.775.3242

aschwartz@csis.org

Samuel Cestari

Media Relations Coordinator, External Relations

202.775.7317

scestari@csis.org

See Media Page for more interview, contact, and citation details.