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Hydrogen as the Enabler: Meeting China's Energy Challenge?

An IHS Markit study considering the potential role of hydrogen in China's energy sector

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Introduction

Hydrogen can be both a zero-carbon energy carrier and a readily dispatchable means of storing energy. It burns cleanly as fuel at the point of use.

For China in principle hydrogen offers two significant advantages. It can help to solve the manageability issues as variable renewable energy increases its share in energy supply. At the same time, it can further improve local air quality at a time when coal continues its dominance.

Hydrogen offers China a way towards meeting climate and pollution goals without increasing reliance on imported gas. It also opens a new avenue for developing clean-technology manufactured goods for export.

A series of practical issues need to be addressed for hydrogen to become significant in China's future fuel mix. Businesses and investors will need to be able to develop business models that offer the prospect of acceptable returns, and government policies will need to be imaginative and supportive.

The IHS Markit study will look first at the technology options for the production of low-carbon hydrogen, from indigenous sources of energy in China. Second, it will review the practical issues in rolling out of the fuel into various locations and different sectors of the energy economy. Finally, it will identify possible 'tipping points' which could bring hydrogen into serious contention as an energy source in a net zero-carbon or low-emissions world. The study will take account of the need for balance in China's energy policy, among the three goals of supply security, affordability, and sustainability.

Two questions will take centre stage:

1. Will deployment of hydrogen in China change the country's energy requirements and need for energy imports:

- For pipeline gas and LNG
- For oil and oil products?

2. Will deployment of hydrogen in China change the trajectory of hydrogen deployment globally?

- Can Chinese industry lead the development and deployment of electrolysers, hydrogen fuel-cell vehicles, and other hydrogen technologies, accelerating the path down the learning curve?
- In this case, what will be the implications for other regions?

1. Technology status

This section will describe the various technologies for the production of hydrogen in China. It will compare capital expenditure requirements, operating and maintenance costs, and efficiency. It will take account of learning rates in technology development.

China is today the world's largest hydrogen producer and consumer. On the supply side, current production is mostly in dedicated oil- or coal-based plants in refineries or chemical facilities. Hydrogen production from electrolysis has begun to gain traction globally as an industrial-scale low-carbon option. China has a great potential here, given the size of its renewable resources and the current and future curtailment challenge. On the demand side, China is extending the long-established use of hydrogen as a feedstock in industry by developing hydrogen applications in transport. Competitive production of hydrogen and technology development may further enhance non-feedstock hydrogen applications in a wider range of sectors.

The main technology focus of the study will be on comparison of production by electrolysis, using zero-carbon renewable electricity, with production by regasification of coal or biomass, with carbon capture and storage. Other technologies, which are likely to have limited impact on the overall hydrogen market, such as hydrogen by-product from the chloralkali industry, will also be addressed, albeit in less detail.

2. Practical concerns on the pace of implementation

Practical issues surround the pace at which any new technology or fuel can penetrate the energy mix. For hydrogen use in China these issues include questions of transmission of energy over long distances; the availability of carbon storage sites; the suitability of district heating networks or existing gas distribution grids for use with hydrogen; the need for hydrogen storage and suitability of various solutions; safety aspects of hydrogen use in different circumstances; and, for transport uses, the requirements of the network of refuelling stations.

Appropriate regulatory frameworks will be needed to encourage development of hydrogen. There will be strong competition for hydrogen in some sectors from other ways of reaching climate, pollution, and energy security outcomes – notably from electrification solutions including battery electric vehicles in the mobility sector, and heat pumps for space heating.

3. Government Support

Hydrogen deployment is consistent with many of China's long-term energy and security goals. Recent policies aim to reduce carbon emissions, to improve urban air quality, and to increase use of renewables. Fuel import dependency is also a consideration. Where hydrogen can be produced locally to replace oil and gas consumption in key sectors it may have a role to play. In addition, development of hydrogen production and fuel cell technologies can advance China's ambition to export high value-added technologies. Finally, it is expected that there will be room for both batteries and hydrogen as energy storage. The reasons that make hydrogen a serious contender to batteries lie in the fact that batteries are mostly suitable for short term storage and that the current battery technologies rely on import of metals (such as cobalt) which may come from politically unstable regions.

The government has already announced several initiatives to develop the hydrogen industry in the past few years. In 2015, the "Made in China" initiative included hydrogen as a key technology to develop in the domestic market. In 2016, the 13th Five-Year Plan promoted hydrogen to be produced from renewable power in the northern resource-rich region. The Plan's Hydrogen Fuel Cell Technology Roadmap outlined specific targets for mass application of hydrogen in the transport sector. The China National Alliance of Hydrogen Energy and Fuel Cell has been established to further develop the industry with expertise and investment by various companies. In terms of financial incentives, various levels of subsidy are provided, adapted for different types of vehicles in different regions.

Policy support will remain a key driver in achieving a large-scale penetration of hydrogen in the energy market, both locally and globally, as it is doing in China's renewable and electric vehicle development.

4. Tipping Points

The study has unique breadth in being able to provide analysis of the entire hydrogen value chain—from the key production technologies to the full range of potential energy demand uses. It will identify triggers or 'tipping points' that can allow for a take-off of hydrogen in China's energy demand. These will differ sector by sector and will include optimal location of hydrogen production relative to renewable electricity sources and end-use of hydrogen. The report will provide a unique insight into the potential tipping points for each of the following applications:

- Heavy duty transport for fleet vehicles (buses, trucks versus diesel or batteries)
- Passenger vehicles
- Converting coal-based district heat to hydrogen, in comparison with other low emissions options
- Broadening the industrial use of hydrogen in selected sectors (e.g. refining, ammonia and methanol production)
- Management of curtailment – low or zero-marginal cost electricity that is produced for which there is no demand
- Provision of long-term or high-volume storage to help balance the electricity system
- Relative long-distance transport costs of hydrogen as an energy vector, compared with electricity and/or natural gas.
- Other key 'tipping points' may emerge as the study proceeds.

- The analysis for the tipping points will include costs of the relevant hydrogen-use technologies and their ancillary equipment, compared with the costs of a credible alternative solution to hydrogen. The cost of carbon avoided by the various hydrogen routes will also be calculated.

5. Business models for integrating hydrogen

Companies in many different sectors will take an interest in the commercial possibilities, because of the diversity and potential scale of the future use of hydrogen in China. These companies' choices of appropriate business models will depend both on the anticipated uses, and on the existing business model of the company concerned.

This section of the report will review existing structures by which companies are integrating hydrogen into their businesses in other parts of the world. It will suggest models that may be adapted by utilities, by gas supply and infrastructure companies, by integrated energy companies, and by new entrants to the fuel supply business. Key questions are likely to include:

- For hydrogen from electrolysis, whether to develop an economic model that accepts curtailed electricity as the basis for strategy or to adopt a dedicated facility approach to manufacture;
- For infrastructure owners and owner-operators, whether to pursue a geographic pure hydrogen strategy or a strategy of carbon-reduction by blending, or indeed to combine both;
- Some companies may be constrained, for commercial or regulatory reasons, to a specific sector focus; others may prefer a broader approach, incorporating for example mobility, industrial uses, and supply/distribution to heating markets;
- What scale of production to aim for, over what time frame – the answers are likely to be different for different methods of hydrogen production;
- Some companies may have an interest in developing very large-scale operations, which could have a significant effect on the competitive environment;
- Some companies may be focussed on developing hydrogen technologies for domestic use and for export.

6. Quantitative analysis

- The quantitative analysis will assess potential scale and volume of hydrogen for 2030, 2040 and 2050 within China's overall energy balance. The analysis will take specific example regions and sectors to assess the potential for hydrogen use and production. These specific examples will allow calculation of the scale of total hydrogen demand for all China.

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