IHS Markit®

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

An IHS Markit study

2019

Is there an opportunity for hydrogen use in China?

Key questions to consider:

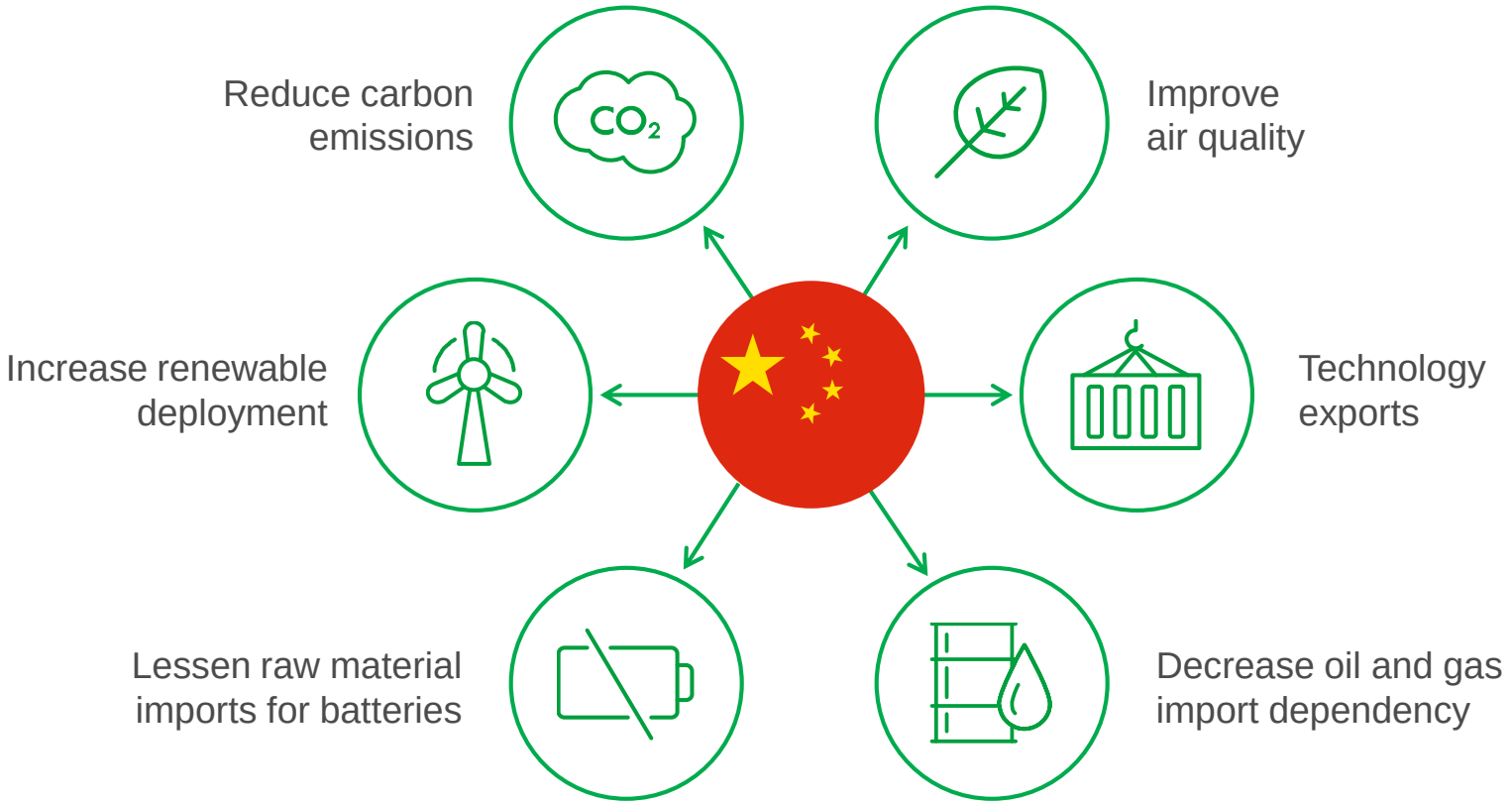
Supply

- How competitive is hydrogen with alternative fuels?
- How much curtailed electricity is there and will it grow in the future with renewable capacity additions?
- Could hydrogen allow for a reduction in imported fuels?

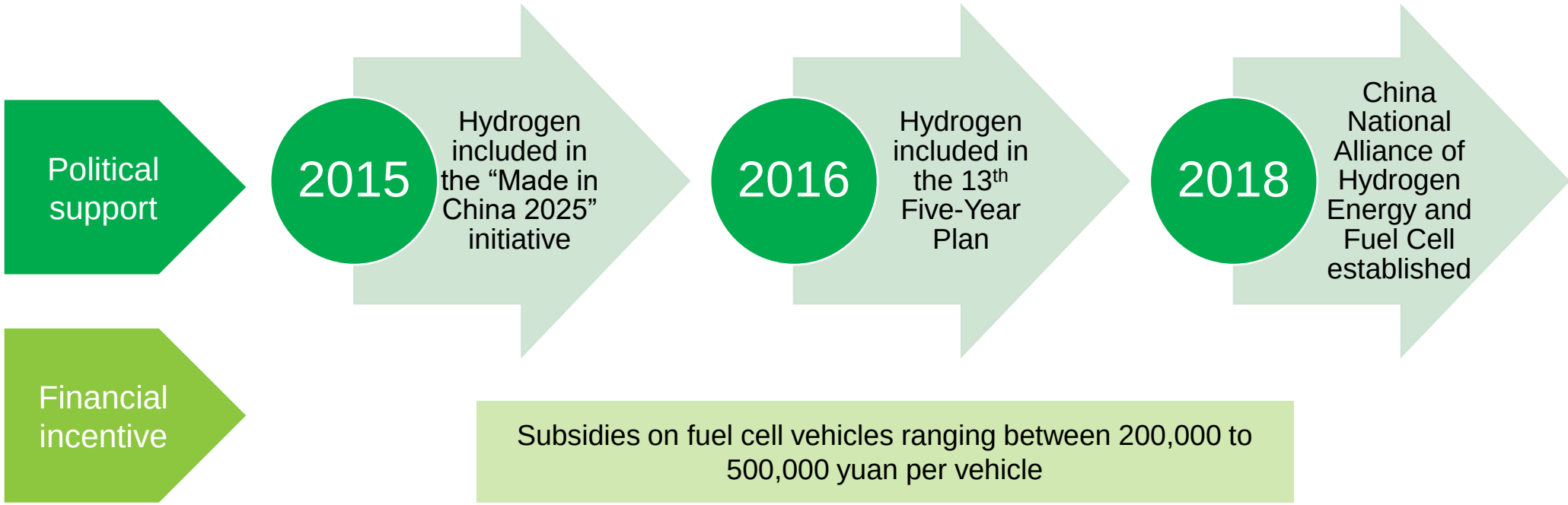
Demand

- Which are the most prospective end-use sectors for hydrogen use?
- With the addition of substantial new renewable capacity, how can hydrogen help to balance the power system?

Hydrogen deployment is consistent with many of China's long-term goals



Hydrogen energy development is receiving increasing attention and support from the Chinese Government



Why hydrogen? Hydrogen has multiple applications across the economy

End use applications of hydrogen for energy use

Transport

- Displace batteries or fossil fuels

Industry and Heating

- Displace natural gas in pipelines and end uses
- Replace coal used for direct heat

Power

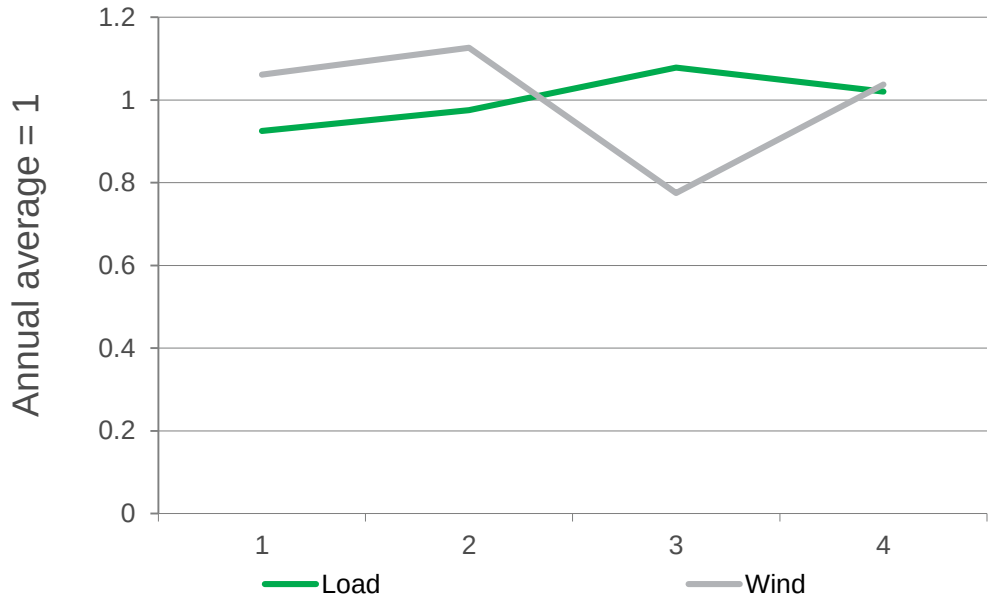
- Intra-day balancing of renewable generation and power demand
- Seasonal balancing of renewable generation and power demand
- Reduced fossil generation

Source: IHS Markit

Why hydrogen? Hydrogen can help integrate intermittent renewables

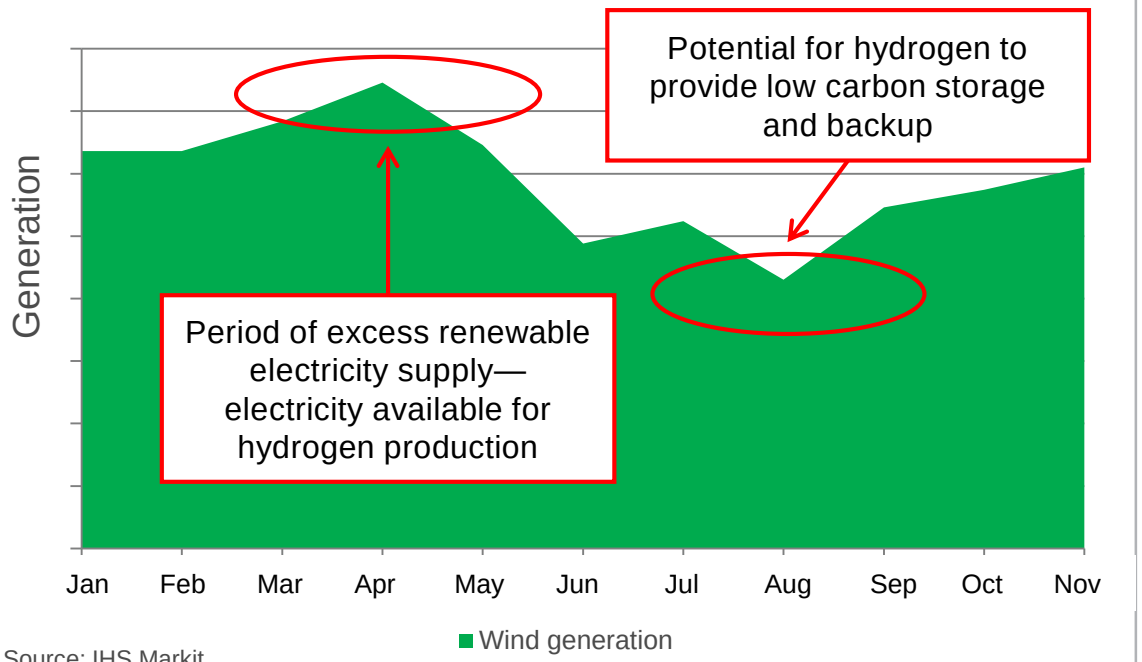
Using electricity that would otherwise be curtailed, while also providing low-carbon backup power

Misalignment between quarterly load and wind production profile



Source: IHS Markit

Use of hydrogen to support integration of intermittent renewables



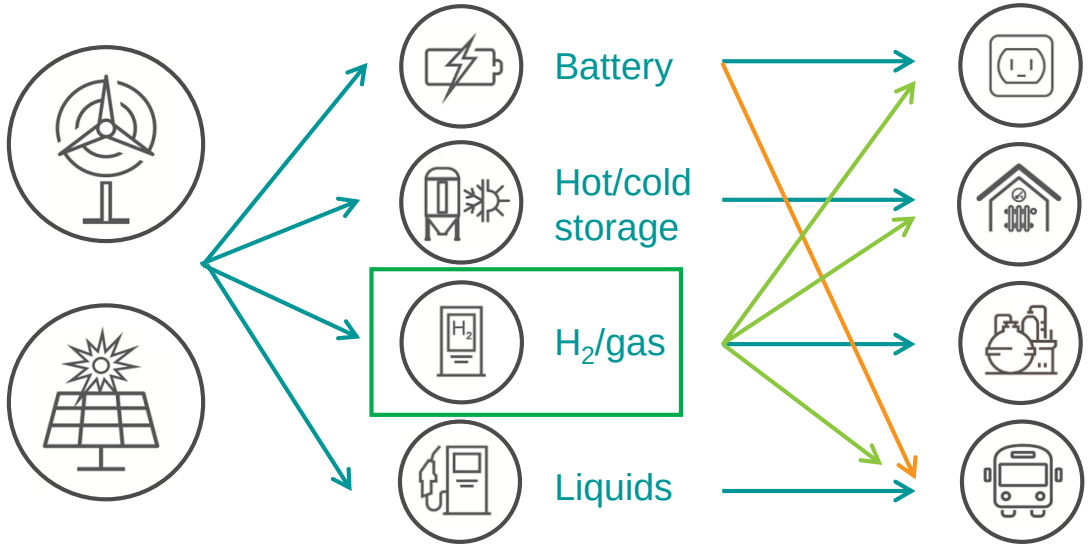
Source: IHS Markit

Hydrogen is one of many competing options

Economics and practicality will determine scale and pace of adoption

Power-to-X-to-power? Other solutions may be better

Power → **X (store / transport)** → **End use**



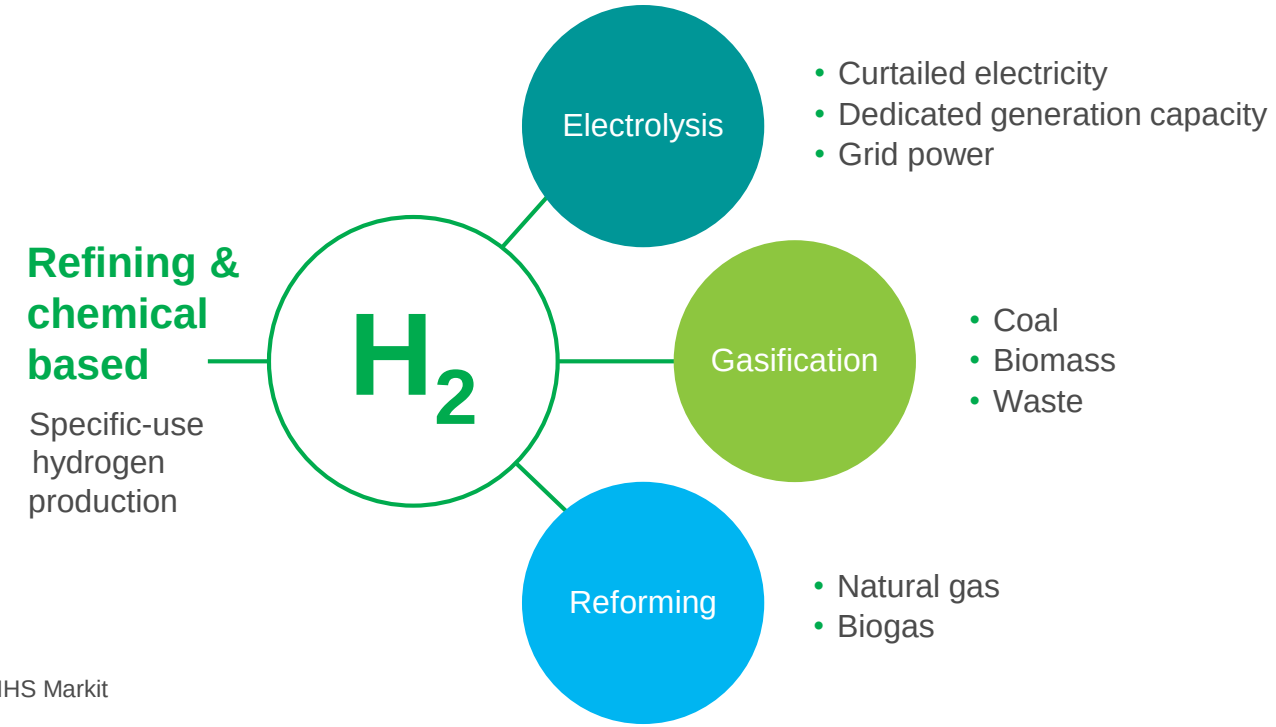
- Power to hydrogen to power is in direct competition with batteries for intra-day balancing
- Power to heat requires a heat sink
- Power to gas could replace natural gas in industry, where the need is often for its hydrogen content
- Power to liquids and power to hydrogen competes with gasoline or diesel

Source: IHS Markit

There are many routes to produce hydrogen in China

The cost, size, and production potential varies significantly

Existing and potential hydrogen production in China

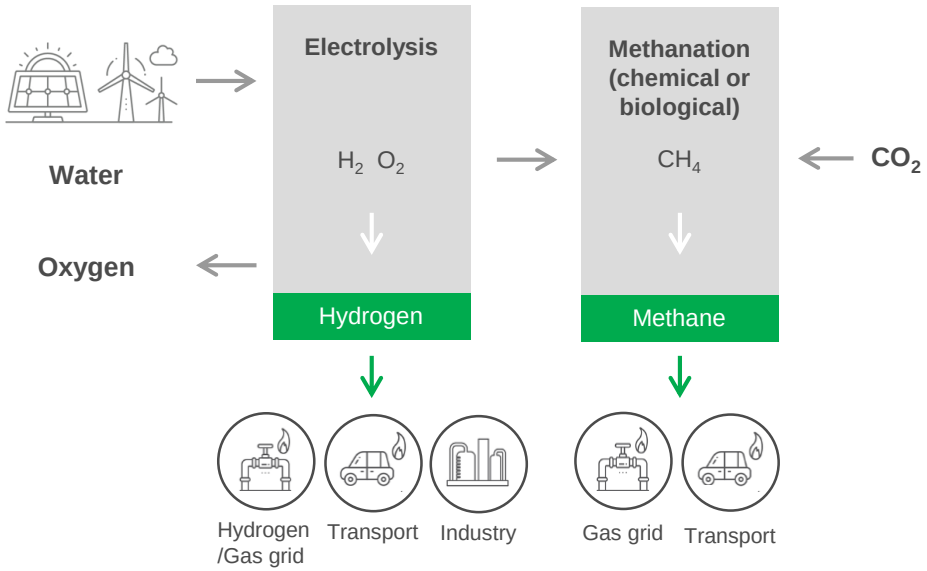


Source: IHS Markit

The study will use a levelized cost of hydrogen model to assess the competitiveness of different sources of hydrogen production and hydrogen's competitiveness with other energy sources.

Power to gas (electrolysis) or gasification technologies could be options for China to expand hydrogen production for energy use

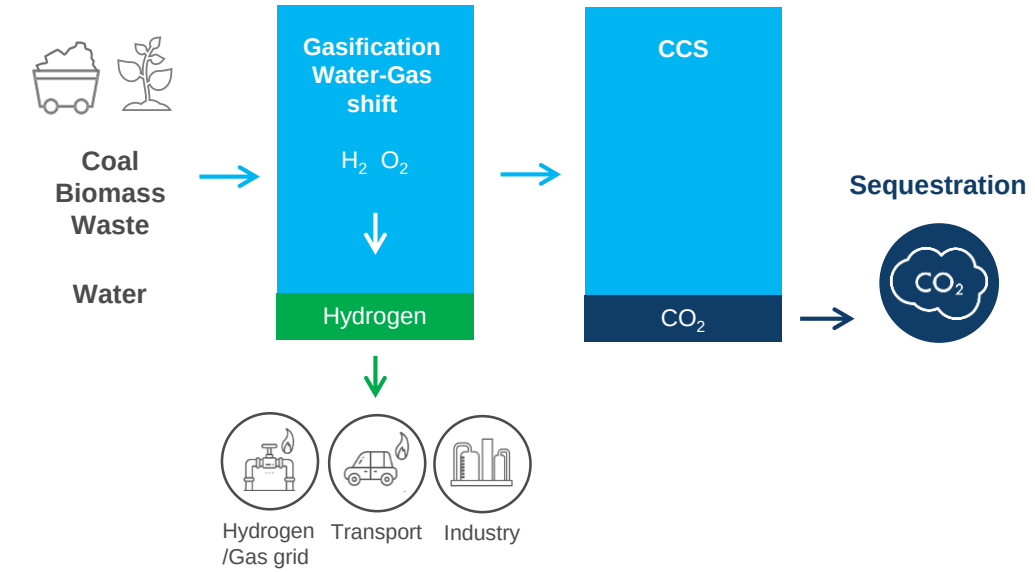
Power to hydrogen and power to gas



H_2 Hydrogen O_2 Oxygen CH_4 Methane CO_2 Carbon dioxide

Source: IHS Markit

Solid fuel gasification with CCS

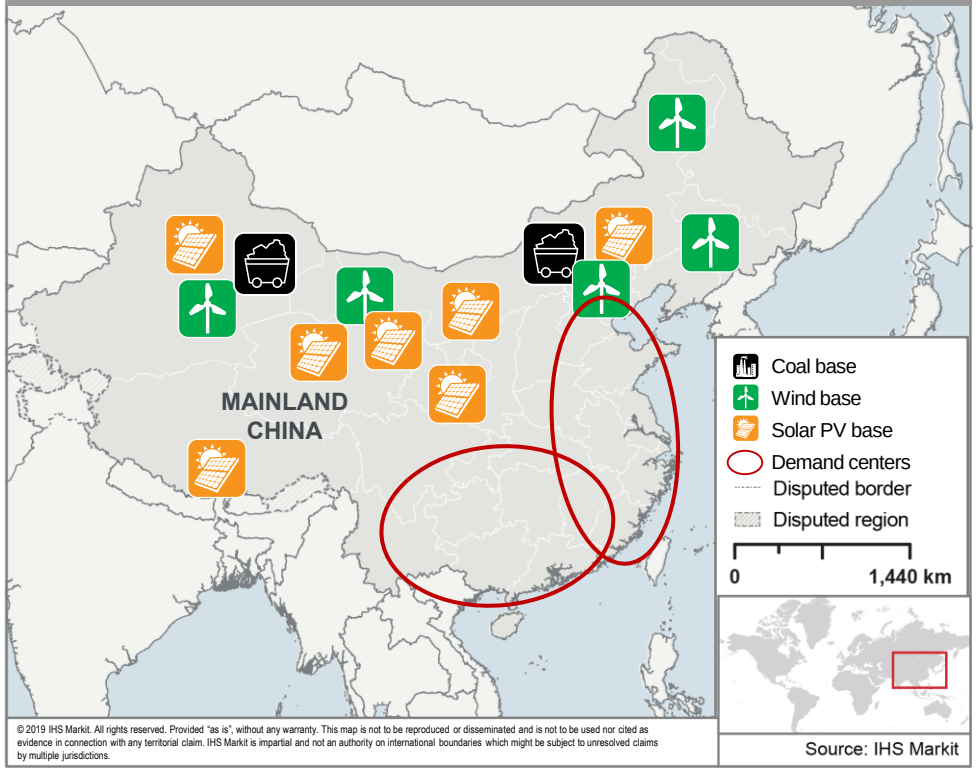


H_2 Hydrogen CO_2 Carbon dioxide

Source: IHS Markit

Large-scale hydrogen production potential is likely to be situated far from the major demand centers

Hydrogen production distant from major demand centers



- Hydrogen produced from curtailed electricity or coal gasification could be used in local demand centers near the point of production
- The greatest potential for large-scale hydrogen production is located far from the major demand centers
- Large-scale adoption of hydrogen across the economy would require the development of hydrogen transmission infrastructure

Research topic areas – production and transport

- Hydrogen production supply costs—creation of a levelized cost of hydrogen model for the following sources:
  - Electrolyser – three sources of electricity: (i) Curtailed electricity, (ii) dedicated generation capacity, (iii) grid power
  - Gasification – three sources (i) Biomass, (ii) coal, (iii) waste
  - Reforming of natural gas
- Technology developments—focus on electrolyser costs
- Example cost calculations of producing hydrogen at distant locations and transporting to a demand center
- Comparison of hydrogen costs to natural gas and other energy sources

Research topic areas – end-use sector analysis

- Heating sector—is there an opportunity for hydrogen to be the energy source in CHP?
- Transport—sector analysis for use in road transport.
  - Can hydrogen vehicles compete in any part of the transport sector with other technologies?
- Power sector analysis
  - Use of curtailment—power that is produced for which there is no demand
  - Balancing power system—how can hydrogen play a role?
- Global developments—what is happening in other regions that could be applicable to China?

Overall quantitative approach

Putting together costs and opportunities

Supply cost analysis: Green and other hydrogen production technologies analysis

Levelized cost of hydrogen under various technology starting points

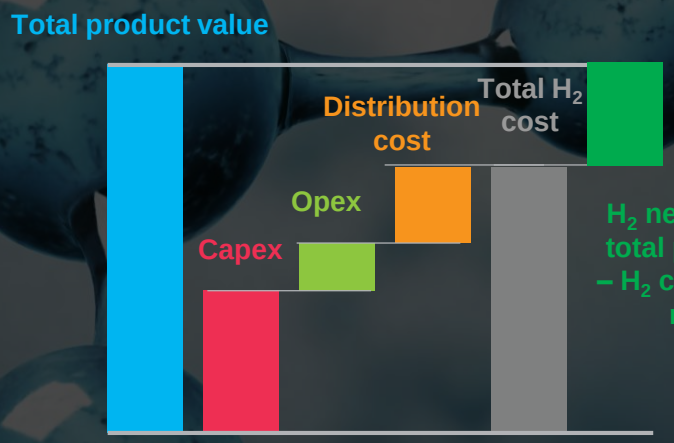
Green H_2 (electrolysis)

Other H_2 technologies (coal, etc.)

Case study on costs of hydrogen transportation

Tipping point analysis by end use sector

Identify the netback value or cost of hydrogen in each major end use under various sensitivity cases of future costs and policy.



- Power
- Space conditioning
- Industry
- Transportation

Source: IHS Markit

Project timeline and deliverables: an approximately eight-month schedule

Study kick-off
February 2019

Intermediate workshop and presentation materials
Beijing
3rd of July 2019

Final workshop and presentation materials
Beijing
October / November 2019

- **Study kick-off**
- **Introduce the study participants.**
- **Overview of the project timeline and scope.**
- **Discuss the first workshop agenda and logistics.**

- **Why hydrogen now:** an overview of policy initiatives supporting hydrogen development.
- **Hydrogen supply analysis:** presenting the results and insights from the IHSM Levelized Cost of Hydrogen ($LCOH_2$) modeling from electrolysis, gasification and reforming.
- **Cost competitiveness:** determining how hydrogen compares with other forms of energy.

- **Practicalities:** understanding the technical and policy issues impacting the potential role of hydrogen in power, industry, transport, and heat in China.
- **Identifying the tipping points:** determining the triggers and conditions required for hydrogen to be used more widely.
- **Costing:** quantifying indicative costs needed to move hydrogen from demonstration to commercial success in each principal end use.

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