IHS Markit®

Hydrogen and Renewable Gas Forum

Governments and market players across the globe are exploring innovative technologies to achieve a low carbon future. Hydrogen and renewable gas are emerging as leading options to support the decarbonisation of all sectors of the economy

Hydrogen can be used as fuel in the transport sector, or heat generation in industrial, residential, and commercial sectors, as well as power generation. Currently it is neither as cheap and convenient as coal or natural gas nor as versatile as electricity. Hydrogen is an energy carrier, not an energy source; it needs energy from other sources to produce it. Hydrogen production typically comes from unabated hydrocarbons, but deployment of carbon capture and storage and water electrolysis to produce hydrogen from renewables could create an economic, low-carbon option in the future.

The IHS Markit Hydrogen and Renewable Gas Forum covers the three regional key market areas of hydrogen as an energy carrier—Europe, California, and China and will expand to other markets in the future, including Japan and South Korea by the end of 2020.

Clients receive a continuous cycle of data and analytics-driven research covering:

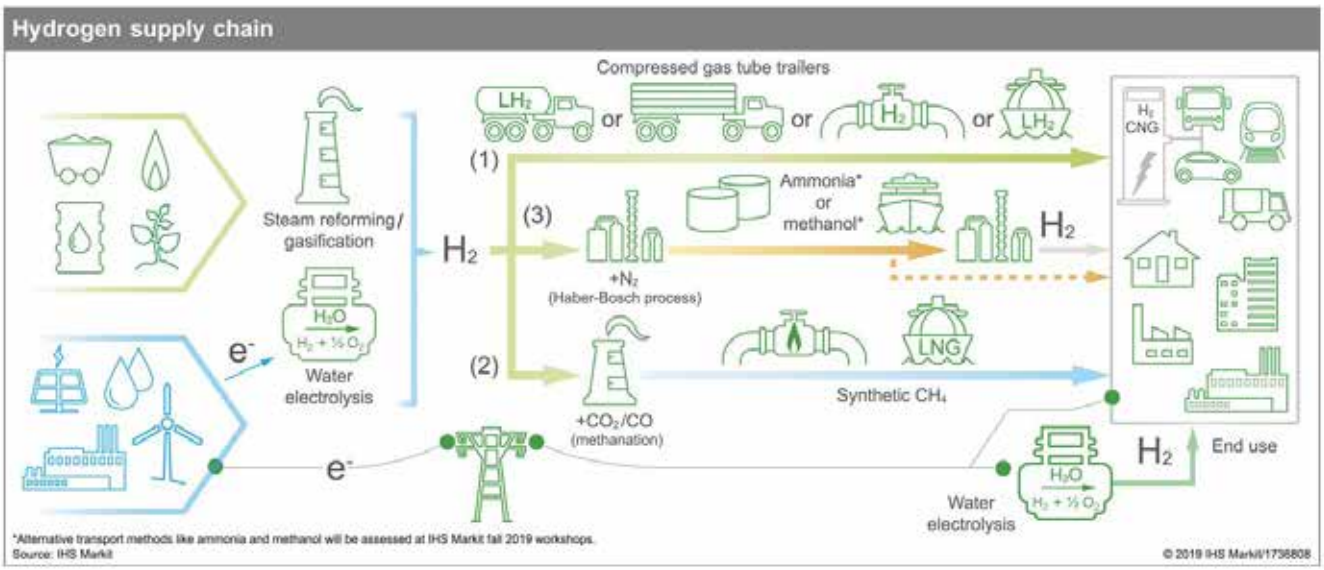
- Policy, technology, market issues, and drivers
- Capex, opex, and input energy prices for hydrogen production cost for key technologies
- Capex and opex for hydrogen transportation and storage options by benchmark volume and distance
- Full energy balance for benchmark years 2020, 2025, 2030, 2040, and 2050
- Plausible demand and supply for hydrogen and renewable gas for these benchmark years
- Corporate strategies and business models for deployment
- Emerging trends: drivers and implications on the outlooks
- Excel models for levelized cost of hydrogen and renewable gas production and automotive fuel cell cost outlooks
- Global database of power to X projects

Clients of the service include:

- Integrated oil and gas companies
- E&P companies
- Utilities
- Mining companies
- Chemical producers
- Automotive manufacturers
- Energy equipment manufacturers
- EPC companies
- Large energy consumers
- Energy service providers
- Regulators and government agencies
- Financial institutions

Key Functions include:

- Strategic/corporate planning
- Portfolio planning
- Forecasting and market analysis
- Business development
- Marketing/sales
- Origination



Detailed modelling of production costs for each supply source

- Analysis provided for benchmark years 2020, 2025, 2030, 2040, 2050
- Capex, opex and input energy prices
- Levelized cost model provided

	Hydrogen	Biomethane	Synthetic methane	Ammonia	Methanol
Reforming (with and without CCS)	Europe			Europe	Europe
	United States			United States	United States
	Mainland China			Mainland China	Mainland China
	Asia importing countries			Asia importing countries	Asia importing countries
	Exporting countries			Exporting countries	Exporting countries
Gasification (with and without CCS)	Europe	Europe	Europe	Europe	Europe
	United States	United States	United States	United States	United States
	Mainland China				
	Australia			Australia	Australia
Methane Pyrolysis	Europe				
	United States				
	Mainland China				
Electroysis -- Ammonia Electrolytic Cell (AEC)	Europe		Europe	Europe	Europe
	United States		United States	United States	United States
	Asia			Asia	Asia
Electroysis -- PEM	Europe		Europe	Europe	Europe
	United States		United States	United States	United States
	Mainland China			Mainland China	Mainland China
	Asia importing countries			Asia importing countries	Asia importing countries
	Exporting countries			Exporting countries	Exporting countries
Electroysis -- Solid Oxide Electrolyser Cell (SOEC)	Europe		Europe	Europe	Europe
	United States		United States	United States	United States
	Asia			Asia	Asia

Asian importing countries: South Korea and Japan

Exporting countries: Australia, Middle East and North Africa

Completed

First half 2020

Second half 2020

Mainland China completed, South Korea/Japan to be completed Second half 2020

Not applicable

Transportation and storage of low carbon gases

- Analysis provided for benchmark volumes and distances
- Capex and opex

	Hydrogen	Ammonia	Methanol	Biomethane	Synthetic methane	LOHC
Tube trailer	Europe United States Asia					
Liquid trailer	Europe United States Asia	Europe United States Asia	Europe United States Asia	Injected into gas grid - costs and treatment as natural gas		Europe United States Asia
Pipeline	Europe United States Asia					
Liquid ship	Europe United States Asia	Europe United States Asia	Europe United States Asia			Europe United States Asia
STORAGE						
Compressed tanks	Europe United States Asia	Europe United States Asia	Europe United States Asia			Europe United States Asia
Liquid tanks	Europe United States Asia	Europe United States Asia	Europe United States Asia			Europe United States Asia
Salt cavern	Europe United States Asia					
Depleted oil and gas field	Europe United States Asia					

Completed

First half 2020

Second half 2020

Mainland China completed, South Korea/Japan to be completed Second half 2020

Not applicable

Levelized cost comparison for low-carbon gases and alternative fuels

- Analysis provided for benchmark years 2020, 2025, 2030, 2040, 2050
- Capex and opex

	Low carbon fuels						Current dominant fuel (baseline) and other alternatives	
	Hydrogen	**Biomethane**	**Synthetic methane**	**Ammonia**	**Methanol**	**Synthetic jet fuel**	**Diesel/gasoline/ jet fuel**	**Battery electric**
END USE - TRANSPORT								
Light duty	Europe United States Asia	Europe United States					Europe United States Asia	Europe United States Asia
Medium duty	Europe United States Asia	Europe United States					Europe United States Asia	Europe United States Asia
Heavy duty	Europe United States Asia	Europe United States					Europe United States Asia	Europe United States Asia
Buses	Europe United States Asia	Europe United States					Europe United States Asia	Europe United States Asia
Shipping	Europe United States Asia	Europe United States Asia	Europe United States Asia	Europe	Europe		Europe United States Asia	Europe United States Asia
Aviation						Europe United States Asia	Europe United States Asia	
END USE - INDUSTRY							**Coal**	**Natural gas**
Iron and steel	Europe United States Asia						Europe United States Asia	Europe United States Asia
END USE - RESIDENTIAL AND COMMERICAL							**Heat pumps**	**Direct electricity**
Space heating	Europe United States	Europe United States					Europe United States	Europe United States
Water heating	Europe United States	Europe United States					Europe United States	Europe United States

- Completed
- First half 2020
- Second half 2020
- Mainland China completed, South Korea/Japan to be completed Second half 2020
- Not applicable

Use of low carbon hydrogen in the power sector

– **Analysis provided for benchmark years 2020, 2025, 2030, 2040, 2050**

Power storage		
Hydrogen produced from renewables linked to a gas turbine	**Lithium Ion Battery**	**Pumped Hydro**
Europe	Europe	
United States	United States	
Mainland China	Mainland China	Mainland China

Costs of carbon capture	
Precombustion with methane reformer or coal gasifier--hydrogen is input fuel to produce elec	**Coal or gas used to produce elec or industrial use, with CCS**
Europe	Europe
Mainland China	Mainland China

Completed

First half 2020

Second half 2020

Mainland China completed, South Korea/Japan to be completed Second half 2020

Not applicable

Long-term outlooks

- **Analysis provided for benchmark years 2020, 2025, 2030, 2040, 2050**
- **For each region a long-term outlook has been developed that is in line with the region's climate goals**
- **From this case a plausible case for hydrogen demand by sector and supply by fuel has been developed**

Long-term outlooks	
Europe	Two cases testing net-zero carbon by 2050 -- one with large role for hydrogen, the other looking at electrification
United States	Net-zero carbon California by 2050
Mainland China	CO_2 emissions 65% below 2015 levels by 2050
Japan	Target to test will be determined in discussion with the H2 community
South Korea	Target to test will be determined in discussion with the H2 community

Deliverables

- Demand by sector by fuel in the reference case--biomass, coal, electricity and heat, hydrogen, natural gas, oil
- Demand by sector by fuel in the plausible hydrogen case--biomass, coal, electricity and heat, hydrogen, natural gas, oil
- Supply of hydrogen by fuel
- Installed capacity of electrolysers needed to supply hydrogen
- Capacity of SMR and gasification
- Fuel needs for hydrogen supply
- Renewable power generation capacity for hydrogen supply
- (For Europe and California only) curtailed renewables used for hydrogen supply
- CO_2 emissions by fuel, by sector in the reference case
- CO_2 emissions by fuel, by sector in the plausable hydrogen case

Completed

First half 2020

Second half 2020

Mainland China completed, South Korea/Japan to be completed Second half 2020

Not applicable

About IHS Markit

IHS Markit (NYSE: INFO) is a world leader in critical information, analytics and solutions for the major industries and markets that drive economies worldwide. The company delivers next-generation information, analytics and solutions to customers in business, finance and government, improving their operational efficiency and providing deep insights that lead to well-informed, confident decisions. IHS Markit has more than 50,000 key business and government customers, including 80 percent of the Fortune Global 500 and the world's leading financial institutions. Headquartered in London, IHS Markit is committed to sustainable, profitable growth.

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