# Global and China Fuel Cell Industry Report, 2020

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## STUDY GOAL AND OBJECTIVES

This report provides the industry executives with strategically significant competitor information, analysis, insight and projection on the competitive pattern and key companies in the industry, crucial to the development and implementation of effective business, marketing and R&D programs.

## REPORT OBJECTIVES

- To establish a comprehensive, factual, annually updated and cost-effective information base on market size, competition patterns, market segments, goals and strategies of the leading players in the market, reviews and forecasts.
- To assist potential market entrants in evaluating prospective acquisition and joint venture candidates.
- To complement the organizations' internal competitor information gathering efforts with strategic analysis, data interpretation and insight.
- To suggest for concerned investors in line with the current development of this industry as well as the development tendency.
- To help company to succeed in a competitive market, and

## METHODOLOGY

Both primary and secondary research methodologies were used in preparing this study. Initially, a comprehensive and exhaustive search of the literature on this industry was conducted. These sources included related books and journals, trade literature, marketing literature, other product/promotional literature, annual reports, security analyst reports, and other publications. Subsequently, telephone interviews or email correspondence was conducted with marketing executives etc. Other sources included related magazines, academics, and consulting companies.

## INFORMATION SOURCES

The primary information sources include Company Reports, and National Bureau of Statistics of China etc.

# Abstract

**Fuel Cell Research: FCV is Expected to Boom over the Next Decade**

In our recent report Global and China Fuel Cell Industry Report, 2020, we analyze the advances and tendencies of fuel cell industry in China and beyond.

Hydrogen, as an efficient clean energy of strategic importance, is drawing widespread attention, and it is in the upswing. Hydrogen fuel cell which is efficient to convert fuel energy with low noise and zero emission, finds broad application in automobiles, ships and trains as well as stationary power plants.

Fuel cell has been such a concern of governments and companies worldwide that have lavished ever more on research and development, demonstration and commercial application. It is noteworthy that hydrogen and fuel cell have already been commercialized in some sectors, among which automobile makes the best of them. Through the lens of life cycle of automobile industry, ICE vehicle has matured, and traditional automakers, however, have quickened their pace of transformation weighed by the thriving new energy vehicle industry, and some leading automakers has been sparing no efforts in the development and application of hydrogen fuel cell vehicles.

**Status Quo and Planning of Global Fuel Cell Vehicle Industry**

Globally, major countries are scrambling to mobilize enormous resources for the development of hydrogen fuel cell vehicles, hoping to take the lead in future competition in energy. For the moment, Japan, South Korea and China are the top three hefty investors in the fuel cell vehicle industry. The typical automakers, Toyota and Hyundai, stay ahead of their peers in production of fuel cell passenger cars, hydrogen buses and logistics vehicles. The discouragement from the Trump Administration in recent two years has hindered development of fuel cell vehicle in the US, but California as the biggest single market of fuel cell passenger cars is still a colossus in the whole industry. Europe has developed fuel cells from an early start, with traditional automakers like Mercedes-Benz and Tier1 suppliers such as Bosch all having forayed into the fuel cell vehicle field.

## Timetable of Fuel Cell Vehicle (FCV) and Hydrogen Refueling Station (HRS) Worldwide (by Ownership)

Fuel cell vehicles (FCV): 1,000 units

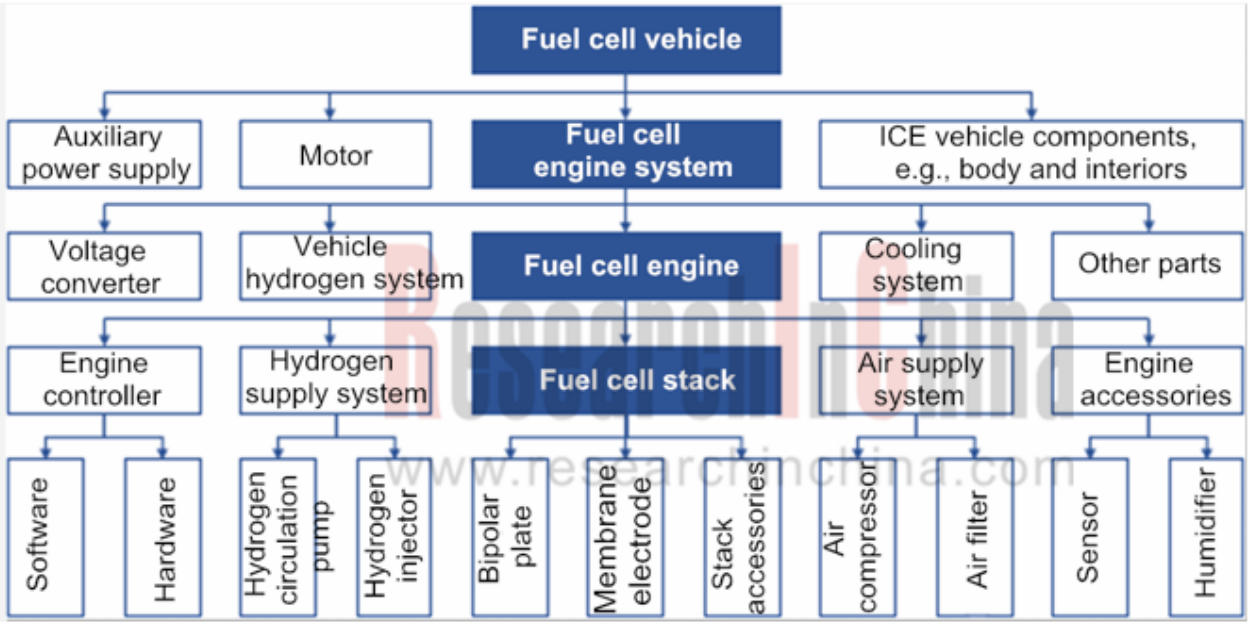
| Country | USA | | China | | Europe | | Japan | | South Korea | |
|---|---|---|---|---|---|---|---|---|---|---|
| Time | FCV | Number of HRS | FCV | Number of HRS | FCV | Number of HRS | FCV | Number of HRS | FCV | Number of HRS |
| 2019 | 8.0 | 66 | 6.2 | 22 | 1.1 | 152 | 2.8 | 100 | 5.0 | 14 |
| 2020 | - | - | 15 | 100 | 10 | 200 | 40 | 160 | 10 | 80 |
| 2022 | 50 | 110 | - | - | - | - | - | - | 81 | 310 |
| 2025 | 200 | 580 | 50 | 300 | | 750 | 200 | 320 | - | - |
| 2030 | 5,300 | 5,600 | 1,000 | 1,000 | 4,245 | 1,500 | 800 | 900 | - | - |
| 2040 | - | - | - | - | - | - | - | - | 6200 | 1,200 |

Source: Hydrogen Energy Economy Roadmaps of Major Countries

**China is Close to Its Leading Peers in Fuel Cell System and Engine**

Fuel cell engine system is comprised of fuel cell engine, voltage converter (DC/DC) and vehicle hydrogen system, of which fuel cell engine packs such core components as stack, engine controller, hydrogen supply system and air supply system.

**Structure of Fuel Cell Engine System**




Source: Beijing SinoHytec

At present, China has come near to global leaders in fuel cell system and engine. In terms of fuel cell engine technology, fuel cell vehicles have been mature enough to be commercialized, with service life of fuel cells for commercial vehicles longer than 20,000 hours, meeting basic needs of vehicles for running; China's hydrogen fuel cell engine system leads the world in several parameters, e.g., power density. Notably, on July 21, 2020, VISH-130A, a fuel cell engine of Wuhan HydraV Fuel Cell Technologies Co., Ltd. (under Vision Group), passed the certification of China Automotive Technology and Research Center Co., Ltd. (CATARC) and China National Accreditation Service for Conformity Assessment (CNAS), with stack power up to 145kW and engine system net output of 130kW. VISH-130A boasts the maximum power among hydrogen fuel cell engines having been certified by the CNAS so far.

**Comparison of Technology between Leading Fuel Cell Engine System Suppliers Worldwide**

| | Ballard | | SinoHytec | HydraV |
|---|---|---|---|---|
| | HD85 | HD100 | YHTG80 | VISH-130A |
| **Net power** | 85kW | 100kW | 80kw | 130kW |
| **Low temperature performance** | -30 | -30 | -30 | -30 |
| **Efficiency** | 60% | 60% | 55% | ≥47% |
| **Service life** | 30000h | 30000h | | 25000h |
| **Power density** | 0.33kW/kg | 0.36kW/kg | 0.5kW/kg | |
| **Dimensions (L*W*H, mm)** | 1130x869x487 | 1200x869x487 | | 980x842.4x650 |

Source: Ballard; SinoHytec; HydraV; ResearchInChina

**China Remains Weak in Core Components and Materials of Fuel Cell with Heavy Dependence on the Imported**

Although with the world's advanced fuel cell engine technology, China still has weak foundation in supply chain of fuel cell engine system, having yet to build a mature components supply system. The country still needs to import most of core components and key materials including catalyst, proton exchange membrane and carbon paper, and falls far behind its foreign counterparts in technologies from membrane electrode and bipolar plate to air compressor and hydrogen circulation pump. Chinese companies still need breakthroughs in basic materials, core technologies and key components, especially in commercialization of key parts like membrane electrode.

**Fuel cell catalyst:** it should perform very well in properties such as activity, stability and durability and could develop into a commercial product mature enough to be mass-produced only after long-term application. Now in China, catalyst verified abroad is the first option, mainly low platinum loading catalyst with high quality and high activity; homemade catalyst test is under way at the same time.

In the global fuel cell catalyst market, Toyota uses subsidiaries' catalyst for fuel cell vehicles; Hyundai chooses fuel cell catalyst of a local producer (acquired by Umicore) in South Korea; Honda's catalyst for fuel cell vehicles is supplied by TANAKA Precious Metals; Chinese fuel cell vehicles use catalyst from TANAKA Precious Metals and Johnson Matthey.

## Major Catalyst Suppliers Inside and Outside China and Properties of Their Products

| | | Load (wt.%) | Carrier | Remark |
|---|---|---|---|---|
| TANAKA Precious Metals | Platinum (Pt) catalyst | 40~70wt.% Pt | High specific area carbon | In 2019, TANAKA added a fuel cell (FC) catalyst development center for capacity expansion, based on which TANAKA can meet increasing demand for electrode catalyst from the growing fuel cell market and build a stable supply system. |
| | | 30~50wt.% Pt | VULCAN® XC72 | |
| | Platinum/ruthenium (Pt/Ru) catalyst | 50~58wt.% Pt, Ru | High specific area carbon | |
| Johnson Matthey | HIFUEL base metal catalyst | | | Johnson Matthey produces the most widely used fuel cell catalyst and has the world's state-of-the-art catalyst production technology. |
| | HIFUEL precious metal catalyst | | | |
| Sino-Platinum Metals | Palladium on carbon (Pd/C) catalyst | 1~10wt.% Pd metal | Carbon | Sino-Platinum Metals and SAIC have partnered in vehicle fuel cell catalyst for several years. |
| Ningbo Cotrun New Energy S&T | Platinum black (Pt black) catalyst | 99.5wt.% Pt | | |
| | Platinum ruthenium black (PtRu black) catalyst | 65wt.%Pt, 35wt.% Ru | | |
| | Platinum ruthenium on carbon (PtRu/C) catalyst | 35 wt.% Pt, 25wt.% Ru, 40wt.% C | | |
| | Platinum on carbon (Pt/C) catalyst | 40~70wt.% Pt | Carbon | |
| | Palladium on carbon (Pd/C) catalyst | 20~40wt.% Pd metal | Carbon | |
| Wuhan Himalaya Optoelectronics Technology | | | | Daily capacity of Pt/C catalyst: 200g; particle size of catalyst: 2nm~3nm; electrochemical active area: 90m2/g (60%Pt/C catalyst) |

**Proton exchange membrane (PEM)** is the core component of a proton exchange membrane fuel cell, accounting for 30% of the entire fuel cell stack cost; and its quality determines the lifespan of the fuel cell. PEM basically transmits protons, ensure the passage of protons, and intercept electrons, hydrogen molecules, water molecules, etc., guaranteeing the performance and service life of the stack.

Concerning proton conductivity or stability, perfluorosulfuric acid membrane is the best option for the current automotive proton exchange membrane. Dongyue Group is the sole Chinese enterprise that has realized the industrialization of perfluorinated ion exchange resin, perfluorosulfonic acid proton membrane and ETFE and that can compete with foreign companies Gore and Chemours in proton exchange membrane.

**World's Leading PEM Suppliers and Product Performance**

| | Supplier | Product | Thickness | E.W value | Note |
|---|---|---|---|---|---|
| Foreign | **Chemours** | Nafion membrane | 15-250 | 1,100-1,200 | Strong chemical stability, high mechanical strength, high conductivity under high humidity, high current density at low temperature, low proton conduction resistance, the highest market share |
| | **Gore** | Gore-select composite membrane | 7.6-25 | - | Gore uses a proprietary reinforced membrane technology based on ePTFE (expanded polytetrafluoroethylene). GORE-SELECT® Membrane is ultrathin, durable and power-dense, allowing it to support cost-effective fuel cell technology. It is widely used in the world's leading fuel cell vehicle models, with the world's cutting-edge technology |
| | **3M** | PAIF high-temperature proton exchange membrane | 10- | - | Mainly used in alkaline environments |
| | **AGC** | Flemion membrane | 50-120 | 1,000 | Longer chain, performance equivalent to Nafion membrane |
| | **Asahi Kasei** | Aciplex membrane | 25-100 | 1,000-1,200 | Longer chain, performance equivalent to Nafion membrane |
| Domestic | **Dongyue Group** | DF260, DF988, DF2801 | 15-150 | 800-1,200 | High performance, short-chain perfluorosulfonic acid membrane suitable for high-temperature PEMFC, the most mature domestic PEM technology, small-batch production. |
| | **Wuhan WUT New Energy** | WUT PEMs (composite membrane) | 16.8-50.8 | - | Low cost, high electrical conductivity and mechanical strength, good dimensional stability, excellent physical and chemical durability.<br>Test samples have been provided to several research agencies at home and abroad, and have been praised by the latter |

Moreover, fuel cell carbon paper/powder is totally dependent on imports. Carbon powder is cheap and may well be completely imported, but from a technical point of view, the inadequate technical research on carbon materials and the weak foundation will have implications for entire research equipment of the fuel cell system in China.

In recent years, there have emerged a number of suppliers of core fuel cell components in China, but they are still heavily reliant on exports, and their technical level of core components needs improving.

**China's fuel cell vehicle promotion: commercial vehicles go first**

In the promotion of fuel cell vehicles in China, fuel cell commercial vehicles take precedence over the rest, due to a combination of factors such as fuel cell technology, cost, and infrastructure of hydrogen refueling stations. 100 models of fuel cell commercial vehicles are among the fuel cell vehicles listed in the Catalog of Recommended Road Vehicles released by the Ministry of Industry and Information Technology of China in 2019 but no fuel cell passenger car is on the list. Over the past five years, only SAIC, Chery and BAIC have showed fuel cell passenger cars, most of which were still prototypes, except a SAIC Roewe 750 car that was licensed in Weifang city of Shandong in April 2020. According to fuel cell vehicle promotion programs across China, buses, logistics vehicles, and special vehicles prevail but passenger cars are not taken seriously.

As concerns development route of fuel cell vehicles, foreign countries adopt the strategy of developing commercial vehicles and passenger cars in sync while China prioritizes commercial vehicles over passenger cars. In the next three or five years, fuel cell systems will be massively used in commercial heavy-duty and logistics vehicles in China, and passenger car will be an obscure corner still.

Product support programs of key suppliers of fuel cell components mirror China’s strategy of “commercial vehicles first, passenger car second”. SinoHytec's flagship product, hydrogen fuel cell engine system, targets commercial vehicle manufacturers who are early entrants in the fuel cell vehicle market, including Shenlong Bus, Beiqi Foton, Yutong Bus, Zhongtong Bus and Geely Commercial Vehicle.

**Features of SinoHytec's Hydrogen Fuel Cell Engines and Brands Supported**

| | YHTG60S | YHTG40 | YHTG80 | YHTS60 |
|---|---|---|---|---|
| |  |  |  |  |
| **Description** | Structural design and control strategy are all technologically optimized, leading to lighter weight, smaller size, lower cost and higher efficiency and being applicable to such vehicles as buses, coaches and logistics vehicles. | Use of self-developed, homemade stack; plug and play; further improvements in performance, reliability and maintainability; humidification unrequired; lower cost; comparable to foreign mainstream products. | | Use of Toyota's sheet metal stack; high reliability, long service life; applicable to buses, coaches, and other vehicles. |
| **Features** | ◆ 100% homemade core components;<br>◆ Power density: >500W/kg;<br>◆ A sharp cut in cost | ◆Self-developed, homemade stack: start at -30℃, storage at -40℃;<br>◆High protection level: IP67;<br>◆ High integration and modular design: compact, easy to maintain, and lower maintenance cost;<br>◆ Remote intelligent monitoring and diagnosis technology: real-time monitoring of engine operation, real-time intelligent diagnosis based on data. | | ◆ Self-start at -30 ℃, ultrafast warm-up;<br>◆ Demonstrate all advantages of the metal plate technology roadmap, and lead in the industry in terms of parameters |
| **Brands Supported** | | FOTON, 北汽新能源, 中通汽车, 陕汽控股, 申龙客车, 广汽传祺 | FOTON, 申龙客车, 宇通客车 | FOTON |

Source: SinoHytec; ResearchInChina

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