

HYDROGEN & FUEL CELL CONNECTION

2019 Autumn Special Edition



The **Hydrogen & Fuel Cell Connection** is a bi-monthly newsletter published by IHFCA that highlights the latest industry news & business opportunities for global H₂ fuel cell research, demonstration and commercialization.

This special autumn edition, China focused, provides an extra report on the Second FCV Itinerant Exhibition & Roadshow (FCVI 2019) taking place in the Yangtze River Delta that is developing China's largest HFC industry belt.



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I. THE ASSOCIATION NEWS

As of Nov. 30, 2019, IHFCA has 86 member organizations from 14 countries. Our latest member is Rugao NEV Research Institute of Jilin University.

Organized by IHFCA, the 4th Int'l Hydrogen Fuel Cell Vehicle Congress (FCVC 2019) took place on Sept. 26-28, 2019 in Rugao, China. The Congress attracted 1,500 delegates from 21 countries and its exhibition hosted 110 exhibitors and 5,000 visitors from five continents.

II. HYDROGEN FUEL CELL NEWS

On Sept. 30, Premier Li Keqiang met with foreign experts who received the *2019 Friendship Award* granted by the Chinese Government. Canadian scientist Dr. Christopher Guzy was awarded for his contribution to China's fuel cell development.

On Oct. 15, MOST and BMVI signed an MoU on Sino-German cooperation on clean mobility technologies and infrastructure. Both countries will enhance alignment in regulations, codes, standards, testing and certification relevant to hydrogen electric mobility.

In Wuxi, Jiangsu, Bosch broke ground on a fuel cell center for the R&D and trial production of HFC products. Equipped with a full array of test equipment of fuel cell components, stacks and systems, the center will strengthen Bosch's R&D and manufacturing capabilities in China. The first of its kind outside of Germany, the center will enable Bosch to serve China's rapidly evolving FCV industry with speed and flexibility.



On Nov. 6, in the presence of President Xi Jinping and President Emmanuel Macron, Sinopec and Air Liquide signed an MoU on the acceleration of hydrogen infrastructure development in China.



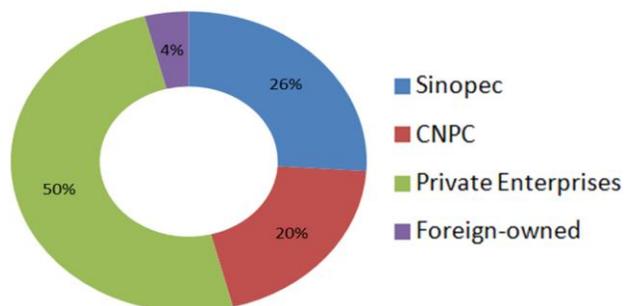
Sinopec opened two H2 stations in Shanghai on Nov. 18, just one month after the inauguration of its first HRS in Zhenjiang

Province. Rebuilt from the original gas stations, these two stations were developed by ALHP, a joint venture established between Air Liquide and Houpu Hydrogen Technology in April 2019.

These two stations, each with a delivery pressure of 35MPa and a daily capacity of 1,000 kg, will be able to meet the needs of 200 fuel cell delivery trucks deployed in the area. Furthermore, each station soon will be equipped with an additional 70MPa dispenser for fuel cell cars.

According to Deloitte, there are over 100,000 gasoline stations across China. Together, Sinopec and China National Petroleum Corporation (CNPC) account for 46% of China's market share.

China's gasoline station market shares (2018)



Foreign-owned station operators # of stations

Shell 1,300

Exxon Mobil 700

BP 500

Total 500

Partners in China



Nel Hydrogen received a purchase order to deliver a 3.5 MW electrolyser to ENGIE, as part of a green hydrogen project to power the world's largest fuel cell haul truck (290 ton) for Anglo American. When scaled up, 100 MW of electrolyser capacity will be needed for the pilot mining site alone. Connecting people with natural resources, Anglo American is re-imagining mining to improve our lives.

For its compact hydrogen refueling stations, in 2019 Nel received a total of 12 H2Station® orders from Hydrogen Energy Network (HyNet), a joint venture created among 13 HFC companies in a bid to roll out 100 H2 stations in Korea by 2022.



SAIC Technologies
China Post Solutions

SAIC Motor inked a framework agreement with China Post to establish a partnership on vehicle procurement, fleet operation, and finance. SAIC will develop and supply NEVs (incl. HEVs, BEVs & FCVs) for China Post.

In Jan. 2019, China's 11 Ministries & Commissions (incl. NDRC, MIIT, MEE, MOF, SAMR & NEA) jointly released the *Action Plan for Diesel Truck Pollution Control*. The Plan encourages local governments to deploy fuel cell logistics trucks. By Nov. 2019, over 10 Chinese cities and provinces had released local plans and subsidies to promote hydrogen logistics vehicles.



Changan Fuel Cell Research Center (UK)

Changan Automobile Group, China's fourth largest automaker, inaugurated its Fuel Cell Research Centre in Birmingham, UK. The center is a part of Changan's global strategy for FCV development.

In Oct. 2019, the UK-based Advanced Propulsion Centre (APC) announced it will fund a program to integrate Intelligent Energy's metal-plate fuel cell system into SUVs for Changan, and into buses for Alexander Dennis, the world's largest double deck bus manufacturer.



III. FCVI 2019 REPORT

Co-organized by IHFCA and China SAE, the 2nd FCV Itinerant Exhibition & Roadshow (FCVI 2019) took place from 22 to 25 September 2019 in the Yangtze River Delta Region.

The event, in a fleet of 15 FCVs (incl. five cars, one light passenger vehicle, five buses and five trucks), started in Jiaxing, Zhejiang, travelled through Shanghai, Changshu and Nantong, and completed in Rugao, Jiangsu, along a route that is developing the world's largest FCV cluster.



Jiaxing is the first hydrogen demo city in Zhejiang Province, largely benefiting from its abundant H₂ supply from industrial by-products. The city has opened the province's first HRS and is building China's first commercial liquid hydrogen plant.

Shanghai positions itself as a global leader in FCV demonstration. Home to SAIC Motor and Tongji University, Shanghai is integrating its resources to develop an industry cluster of 100 HFC enterprises covering the entire fuel cell value chain.

Changshu, home to Re-Fire and Toyota Motor Engineering & Manufacturing (China) Co., Ltd. (TMEC), has a concrete plan and true actions for its newly established Hydrogen Industry Park to attract some of the world's most important FCV players. At TMEC, Toyota is carrying out a three-year (2017-2020) test and validation of *Mirai* in the Chinese driving environment.

Nantong is a leading automotive hub in China, especially for new energy vehicles. It is also an important logistics center and home to Gaokai Automobile that leads China's heavy-duty fuel cell truck development.

Rugao has pioneered China's hydrogen economy development since 2010. With an investment of RMB 1B, in 2014 Rugao established an investment firm to foster the city's fuel cell ecosystem. As the UNDP's first Hydrogen Demonstration City, Rugao is developing a techno-economic model integrating renewable hydrogen, stationary power and FCEVs.

Driving the hydrogen economy through worldwide collaboration & public awareness



Along the FCVI 2019 route, IHFCA organized a number of workshops with local governments, OEMs, and H2 infrastructure providers for the integrated development of HRS network with large-scale commercial FCV demonstration.

In 2016, commissioned by the National Manufacturing Strategy Advisory Committee (NMSAC) and MIIT, China SAE published the *Energy Saving & New Energy Vehicle Technology Roadmap*. According to the roadmap, China aims to deploy 5,000, 50,000, and one million FCVs by 2020, 2025, and 2030, respectively.

In May 2019, IHFCA and China SAE released the *Hydrogen Corridor Construction and Development Plan in the Yangtze River Delta Region*. The [plan](#), the first of its kind in China, was developed under the guidance of the newly established Yangtze River Delta Regional Cooperation Office – the joint administrative office responsible for the region’s integrated development, including Shanghai and three provinces of Jiangsu, Zhejiang and Anhui.

For the plan’s effective implementation, IHFCA is working closely with the region’s hydrogen demo cities, including Rugao and Shanghai that recently opened two advanced H2 stations.

CHN Energy Rugao HRS is China’s first hydrogen refueling station that meets 35MPa/70MPa dual mode international standard. It has a 1,000 kg daily refueling capacity and a combined storage capacity of 600 kg at 45MPa and 87.5MPa.



Developed and operated by CHN Energy, the station supports Hyundai and Toyota’s FCV RD&D in China and the UNDP’s hydrogen demonstration project in Rugao. Its fuel quality meets SAE J2719-2011 standard.

Jinshan HRS in Shanghai Chemical Industry Park is China’s largest H2 refueling station (1,920 kg). Developed by Sunwise, Linde, and two local partners with a total investment of \$7.2M, the station pioneers China’s integrated hydrogen and FCV development.



The station supports the demonstration of FC cars, buses and trucks (incl. 20 SAIC Maxus). Its low-cost hydrogen (approx. \$6.0/kg) is produced from local industrial by-products and delivered to the site by pipeline.



FCVI 2019 had the participation of 24 enterprises and a fleet of 15 FCV models. Toyota, Honda, and Hyundai sent their latest *Mirai*, *Clarity*, and *NEXO* to the event, which attracted wide attention.

SAIC, China's largest automaker, presented fuel cell car *Roewe 950* (430 km, 70MPa) and light-duty passenger vehicle *Maxus FCV80* (490 km, 35MPa) to the event. Both models have been in small series production since 2016.



Maxus FCV 80 is a 13-seat minibus. By Nov. 2019, 394 units of *FCV80* had been deployed in six Chinese cities, with operating temperatures ranging from -25°C in Dalian to 42°C in Hainan.

FAW, China's oldest automaker, presented its first fuel cell truck (Model J6F) to the event. Designed



for urban logistics, this light-duty truck was built on FAW's popular J6F platform and has a range of 350 km.

BAIC FOTON, which offers a wide range of buses and coaches, presented three FCVs to the event: *AUV 8.5-meter coach*, *AUV 12.0-meter bus*, and *AUMark* light-duty logistics truck.

Both *AUV* models have a stack electrical efficiency of 53-55%, a combined heat and power efficiency of 85%, refueling 15-20 minutes, cold start -30°C, and vehicle range 400 km, with fuel consumption of 4.7 kg and 5.3 kg per 100 km, respectively.



The *AUV 8.5-meter coach* is suitable for suburban roads and intercity transport. Before FCVI 2019, the coach already had a revenue service of over 200,000 km in less than six months, with a daily average of 1,330 km.

DONGFENG, China's largest commercial vehicle manufacturer, presented a 7.5-ton fuel cell truck.



It's a mature model that has been chosen by over 20 logistics firms, including STNE's 500-unit deployment since 2018.



Twenty university students selected across China were invited to attend FCVI 2019 and learn about hydrogen fuel cells. They will serve as “Hydrogen Ambassadors” to spread the FCV gospels after returning to their campuses.



Our student ambassadors benefited greatly from a variety of event activities. In a face-to-face dialogue,

Mr. Mark Sun from Anglo American Platinum shared his insights on how investments align with technology advances and required skills to develop a successful, meaningful career. While it seems there are many investment opportunities out there, an investor has to select the few that have the real winning edge to be successful.

China Central Television (CCTV) also sent its “Hydrogen Ambassador” to cover a full report of the event. The live broadcast had a remarkable usage of hydrogen-powered UAVs with wide shots to capture the moving FCV fleet.

Embracing clean, renewable energies for a low-carbon economy, FCVI 2019 is a global initiative promoting both policy and technical dialogues. Compared with FCVI 2018, the 2019 fleet had an overall improvement in fuel cell performance.

Fuel cell trucks and buses shown at FCVI 2019 also had encouraging advances in rated power and domestic supply chain, which are align with China’s rapid product upgrade and anticipated subsidy adjustment with tightened qualification.

SAIC Roewe 950 is the only Chinese fuel cell car presented at the event. Powered by SHPT P240S engine, China’s first commercialized fuel cell car has an NEDC range of 430 km and an onboard H2 storage capacity of 4.2 kg (Type III, 70MPa).

In addition, FCVI 2019 witnessed Toyota, Honda and Hyundai’s acceleration of FCV RD&D for the Chinese market. During the event, Hyundai NEXO completed its first long distance on-road driving in China.



If history is a mirror to the future, the evolution and outlook of China’s high-speed railway may provide a prediction of the country’s hydrogen highway development.

China began its high-speed rail (HSR) network construction in early 2000s. It was after careful evaluation of two types of track technologies for the new national HSR network: high-speed trains with wheels that run on conventional standard gauge tracks vs. magnetic levitation trains that run on special maglev tracks.

Despite unmatched advantage in speed, the maglev didn’t gained widespread use in China due to high cost. Today, standard gauge railway is the mainstream tech in China and the world.

After completing its “4 Vertical & 4 Horizontal” HSR network in 2016, China is expanding the network to “8 Vertical & 8 Horizontal”. A railway running in an east-west direction largely parallel to the Yangtze River is under construction. After its open in summer 2020, it will connect Rugao to Shanghai via Changshu in 90 minutes.

Rugao (如皋) and Changshu (常熟) in Chinese literally mean “highland over water” and “always ripe”, respectively. Due to the fertile soils, both cities have enjoyed a high level of agricultural civilization since ancient times.

Linked by the 1,088-meter Sutong Yangtze River Bridge, the world’s second longest cable-stayed bridge, today Rugao and Changshu are known for their HFC industry.

Rugao, China’s Hydrogen Highland, has developed an industry cluster of over 20 HFC enterprises, including CHN Energy, Horizon, and XecaTurbo.

In Sept. 2019, XecaTurbo built China’s first oil-free fuel cell compressor assembly line with an annual capacity of 10,000 units. Its XT-FCC300 module, along with Horizon Fuel Cell’s compact graphite fuel cell stacks, has been tested and installed on a 42-ton fuel cell tractor.

Listed by *Forbes* as one of China’s best cities for business, Changshu is a green, wealthy city with \$36,000 GDP per capita (2018). So far, 83 Fortune 500 enterprises, including Toyota and Air Liquide, have business presence in Changshu.

Established in 2010, TMEC in Changchu is Toyota’s largest global R&D center for new energy vehicles. In 2016, TMEC built a 70 MPa H2 station (200 kg) to support Toyota’s FCV RD&D for the Chinese market.

In Dec. 2019, Toyota Tsusho, Re-Fire and Changshu National Hi-tech Development Zone (CNZ) signed a partnership agreement on FC heavy-duty trucks. At present there are three HRSs under construction at CNZ: two by Jiahua Hydrogen & one by Air Products.



IV. CHINA'S FCV JOURNEY

China began its fuel cell research in 1957, when Dalian Institute of Chemical Physics (DICP) of the Chinese Academy of Sciences (CAS) embarked on alkaline membrane fuel cell research for space applications.

In 1990, Changchun Institute of Applied Chemistry of the CAS developed China's first PEM fuel cell (100 W). In the following years, China developed a series of 1-5 kW PEMFCs.

By 2002, a total of seven Chinese FCVs had been demonstrated. The first was a golf cart with a 5 kW fuel cell stack demonstrated by Tsinghua University in 1999. In 2001, DICP and its spin-off Sunrise Power developed a 30 kW stack, which was integrated into a seven-meter hydrogen bus built by Dongfeng Motor.

In October 2001, SAIC Motor, in collaboration with General Motors, demonstrated a fuel cell electric sedan named *Phoenix*, with a 25 kW stack provided by GM.

In 2001, the Ministry of Science & Technology (MOST) listed fuel cell and electric vehicles as one of the seven special projects under China's Hi-tech Development Program (863 Program). This laid the very foundation of China's long-term FCV development.

Under the 863 Program, Tsinghua University led China's FCB project; Tongji University led the fuel cell passenger car project. The former has close collaboration with SinoHytec and Foton, and the later has partnership with Sunrise and SAIC.

In 2003, Tongji developed China's first fuel cell car prototype called *Start I*. In 2006, its 3rd generation prototype, *Start III*, achieved high scores at the 8th Michelin Challenge Bibendum.

In 2008, three Foton FCBs were demonstrated at the Beijing Olympics. In 2010, the Shanghai World Expo witnessed the demonstration of 196 FCVs (incl. 6 FCBs, 90 VIP sedans and 100 sightseeing vehicles), as well as two H2 stations at 35/70MPa.

In 2019, Sunrise, SinoHytec & SHPT successively released their next generation fuel cell engines. P390 engine developed by SHPT, a SAIC spin-off, has a stack power of 115 kW, a power density of 3.1 kW/L, and cold start at -30°C. P390 has been tested at trial production and will be installed on the 2020 FCVs for serial production.

In 2022, it's expected that over 2,000 FCVs will be demonstrated at the Beijing Olympic Winter Games. History will be made!

For more information about FCV development in China, please email: ryan.qiu@sae-china.org.

