Rijksdienst voor Ondernemend Nederland

Opportunity Report

Shandong Hydrogen Industry

NBSO Jinan & Qingdao

>> Duurzaam, Agrarisch, Innovatief en Internationaal ondernemen

Colofon

Dit is een publicatie van:
Rijksdienst voor Ondernemend Nederland
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Datum:
28 July 2020

1. Overview

Hydrogen energy has been given high priority on governments' agenda for industrial development in recent years. According to the prediction of China Hydrogen Energy Alliance, the market demand for hydrogen in China will reach 35 million tons by 2030, and it will account for over 10% of the country's total energy supply by 2050.

On June 18, the Medium- and Long-term Development Plan on Hydrogen Industry of Shandong Province (hereinafter referred to as 'the plan') was issued by the provincial government. The plan was drafted by the Chinese Academy of Engineering, the country's top technical and engineering talent pool. It sketches a guideline for the development of hydrogen energy in Shandong Province for the next ten years.

2. Why Shandong

Shandong lies on the east coast of China. It covers 156,000 square kilometers land area and nearly 160,000 square kilometers ocean area, with a total population of 100 million. It is the 3rd largest economic powerhouse in China, after Guangdong Province and Jiangsu Province. Shandong published the hydrogen plan based on following facts.

Firstly, Shandong represents a major province in terms of chemical, metallurgical and energy industries, as a result of rich petroleum and coal reserves and decades' large-scale mining, refining and consistent investment in petro- and coal-chemical facilities. This gives Shandong a unique advantage in hydrogen source as by-product (known as 'grey hydrogen') from industries powered by fossil fuels, such as chlor-alkali production and coking industries. About 2.6 million tons grey hydrogen are produced annually in the province, ranking 1st in China. The hydrogen has its cost advantage for large-scale utilization for its high quality and low price.

Secondly, Shandong has the largest installed capacity of photovoltaic power and 4th largest installed capacity of wind power in China. Furthermore, the nuclear power in operation and under construction totaled 5.7 million kilowatts. These all lay a solid foundation for hydrogen production from new energy sources ('green hydrogen') in the future.

Thirdly, with deep collaboration with leading universities and research institutes across the country, over 50 enterprises and research institutes in Shandong have been deeply involved in hydrogen industry and have made significant progress in key materials and core components of fuel cells (FCs), system integration and intelligent control, high energy-efficient storage & transportation and new PEM FCs. For example, Weichai Group, the top diesel maker in China, has the annual capacity of 20,000 FC engines covering 30-120kW, and the quality of Dongyue Group's proton exchange membrane is close to the world's advanced level.

3. Mid-Long-Term Goal

The plan aims to build up Shandong brand in hydrogen and construct national hydrogen and FC demonstration zone by strengthening research and innovation, improving equipment manufacturing level, building hydrogen industrial chain and ecology, as well as accelerating hydrogen demonstrations and applications. To achieve this, the plan is translated into three phases.

2020-2022 Full-scale starting-up phase

The industrial development system will be gradually established. Core technologies such as purification of industrial by-product hydrogen, FC engines, key materials and power system integration achieve breakthroughs and reached the advanced level in the country. Hydrogen fueling infrastructure will be promoted in an orderly manner. Initial demonstration and promotion will be carried out by introducing fuel cell vehicles (FCVs) into public transportation, logistics, etc.

2023-2025 Speeding-up phase

The hydrogen industry chain will be gradually complete and robust. The core technology of FCs is close to international advanced level. The network of hydrogen production, storage & transportation, fueling facilities will be improved. Hydrogen energy will be used in commercial vehicles, passenger cars, vessels, port machinery, distributed generations, and energy storage.

2026-2030 Competitive advantage building phase

The key industrial technologies reach the world's advanced level, and a smart ecosystem that deeply integrates the hydrogen energy industry and the new generation information technology will be established. The national demonstration zone will be completed by 2030 that integrates innovation, R&D, equipment manufacturing, scene application and commercial operation.

Plan on Hydrogen Fueling Station and FCV (2020-2030)

City	Year 2020-2022		Year 2023-2025		Year 2026-2030	
	Fueling Station	FCV	Fueling Station	FCV	Fueling Station	FCV
Jinan	6	600	15	1500	28	8000
Qingdao	6	600	15	1500	28	8000
Weifang	6	600	12	1200	20	5000
Zibo	4	400	9	900	15	4000
Jining	3	300	9	900	15	4000
Liaocheng	3	300	9	900	15	4000
Others	2	200	31	3100	79	17000
Total	**30**	**3000**	**100**	**10000**	**200**	**50000**

4. Innovation Platform & Player

Jinan and Qingdao, respectively the capital city and economic center of Shandong Province, are given privilege in the plan as two cores of the provincial hydrogen development strategy.

- ***Jinan***

  Capital city of Shandong. Jinan is rich in by-product hydrogen from steel works in the southern area. Jinan aims to stimulate innovation, equipment manufacturing, exhibition, and commercial applications of hydrogen energy.

- ***Qingdao***

  Qingdao is the coastal city and the economic and trade center of the province. Qingdao has one of the largest ports in China – Qingdao Port. Qingdao will develop hydrogen fueled rail vehicles and vessels, large-scale applications in seaport logistics, commodity transportation as well as public transportation.

- ***Weifang & Zibo***

  Fuel cell and key material cluster.

- ***Liaocheng & Jining***

  FCV cluster and hydrogen storage equipment cluster.

Hydrogen Innovation Platforms in Shandong

Weichai Fuel Cell Technology Innovation Center	
Investor & Website	Weichai Group https://en.weichai.com/
Research Field	FC and engines
Introduction	Weichai is the top diesel maker in China. It was founded in 1946, and now has over 90,000 employees worldwide. Weichai owns six business segments of powertrain, commercial vehicle, construction machinery, intelligent logistics, luxury yacht, and finance & after-services. For now, Weichai undertakes the state-level R&D program on 'Fuel Cell Engine and Commercial Vehicle Industrialization Technology and Application'. In August 2018, Weichai and Ballard signed for extensive cooperation in the field of FC technology on Chinese market. - Weichai made a major equity investment of approximately USD 163 million in Ballard, which was equivalent to 19.9% of Ballard's shares. - JV will be established to support China's booming FCV market. - A USD 90 million worth technology will be transferred to the JV, which will receive authorization on applying new generation LCS fuel cell stacks and power modules to public transportation buses, trucks and forklifts. - Weichai announced its commitment to supply at least 2,000 FCV modules in China annually.
Dongyue State Key Laboratory of Fluorinated Functional Membrane Materials	
Investor & Website	Dongyue Future Hydrogen Energy Materials Co., Ltd. http://www.dongyuechem.com/en/
Research Field	Long life fuel cell proton membrane
Introduction	Founded in 1987, Dongyue Group is a high-tech enterprise in R&D and manufacture of fluorine and silicone industry. According to public information, the quality of Dongyue Group's fuel cell proton exchange membrane is close to the world's advanced level. Relevant tests are ongoing at car makers such as Volkswagen in Germany.
Yankuang Group New Energy Innovation Center	
Investor & Website	Yankuang Group http://www.yankuanggroup.cn/
Research Field	Purification of by-product hydrogen, high-performance storage material, FC key material, safety control
Introduction	Yankuang used to be the largest coal mine in Shandong and now it's a subsidiary of the super SOE Shandong Energy Group. Yankuang is mainly engaged in mining, high-end coal chemicals, modern logistics and trade. It's one of main suppliers of grey hydrogen in Shandong.
Yantai Moon Hydrogen Energy Research Institute	
Investor & Website	Yantai Moon Co., Ltd. http://www.moon-tech.com/
Research Field	Key equipment for hydrogen collection, purification, storage & transportation, applications
Introduction	Founded in 1956, Yantai Moon Co., Ltd. is a comprehensive equipment manufacturing enterprise. The main business covers low-temperature freezing, central air conditioning, eco-friendly heating, energy and chemical equipment, precision castings, smart services, and hydrogen energy development.

Other Players in Shandong Hydrogen

Sinotruk	
Activity	Manufacture of FC heavy duty trucks
Introduction	http://en.sinotruk.com/View/AboutGroup.aspx Sinotruk is the largest heavy-duty truck maker in China. Sinotruk, Weichai Group and Zhongtong Bus are subsidiaries of Shandong Heavy Industry Group, a SOE of Shandong. The first prototype FC truck was launched in 2017 and FC trucks were successfully used in the first demonstration at Qingdao Port. A green smart manufacture project is currently under construction and will reach the capacity of 1 million new energy commercial vehicles, including heavy-duty trucks, forklifts, logistics equipment by 2022.
Zhongtong Bus	
Activity	Manufacture of FC buses and vehicles
Introduction	http://www.zhongtong.com/ Zhongtong Bus is the subsidiary of Shandong Heavy Industry Group. It started to develop FC buses in 2014 and achieved full coverage for logistics vehicles and 9-12m vehicles in 2016. Commercialized operation was realized in 2018. In 2019, 102 FC buses and 632 FC logistics vehicles were sold, mainly in Shandong. Zhongtong Bus uses FC systems produced by Weichai Group for their vehicles. Zhongtong Bus plans to expand its capacity to 5,000 FC engines and become a national manufacture base for 9-12m FC city buses and 4.5-7.5ton FC trucks.

5. Opportunity

In general, we see opportunities for Dutch companies and research institutes who have developed advanced technologies and/or products for hydrogen industry. We also think Dutch strong R&D and innovation capability can be good counterpart of Shandong to carry out joint projects in the future.

Shandong has competitive advantages in grey hydrogen source from its huge industrial activities and FCV manufacturing capability. On the other hand, Shandong has obvious disadvantage the R&D and innovation capability is highly dependent on external institutions outside the province and even abroad, such as Chinese Academy of Sciences, Chinese Academy of Engineering, Tsinghua University, Tongji University, etc. An example of international cooperation was in 2018, Weichai Group invested USD 163 million to Canadian Ballard and set up a JV to commercialize the new generation FC stacks and power modules for commercial vehicles, which have been successfully scaled-up to an annual capacity of 20,000 FC engines in 2020.

In this newly published plan, it's clearly stated that Shandong is open and welcome to international cooperation with universities, research institutes and enterprises across the world to jointly develop state-of-the-art technologies and application scenarios, as well as global talents in hydrogen domain. In the meantime, Shandong will strengthen exchange and cooperation with international organizations such as the International Hydrogen Energy Association and the International Hydrogen Energy Commission and encourage Shandong enterprises to set up R&D platforms and JVs abroad to facilitate cooperation. Last but not least, Shandong proposes in-depth cooperation with foreign standard organizations in order to formulate standards for the entire hydrogen industry chain.

Major technical bottlenecks are listed as below.

- Hydrogen production from renewable energy, carbon capture and packaging for fossil fuel source hydrogen, high-temperature water electrolysis for hydrogen.
- Storage of liquid/solid state hydrogen, high-pressure storage & transportation equipment and light-weight technology, high-efficiency production & storage & transportation of liquid hydrogen, pipeline transportation.
- Hydrogen storage and materials for FCVs.
- PEM FC technology, mass production technology of proton exchange membranes, carbon paper, membrane electrodes, bipolar plates, and stacks.
- Hydrogen purification for FCVs.
- Mass production technology of key materials and components of solid FCs.
- FC oil-free air compressor, hydrogen pump.
- Vehicle multi-energy matching and management technology.
- Multi-power management technology for fixed/distributed generations, long-life operation management strategy and reliability technology of hydrogen power FCs in fixed generations.

From a sectoral perspective, we suggest attentions to following sectors.

- Grey hydrogen purification, storage & transportation, fueling facilities technologies and core components.

- FC technology and applications to commercial vehicles, vessels, and equipment.
- Green hydrogen technology by making use of abundant solar, wind and nuclear energy in Shandong.

6. Contact Information

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7. Source

- The Medium- and Long-term Development Plan on Hydrogen Industry of Shandong Province

- Official websites of relevant parties

- Interview with relevant parties

Dit is een publicatie van:

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