

Research on focusing on strategic emerging industries and building a safe construction work system—taking the Hydrogen fuel cell vehicle industry as an example

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Abstract: Based on the research and analysis of the development status and characteristics of Hydrogen fuel cell vehicle industry in Zhejiang Province, combined with the domestic and foreign technology development direction and industry development trend, and through extensive demand research, this topic establishes a safe construction work system for Hydrogen fuel cell vehicles, guides the technological innovation and standard creation of new energy vehicles, and promotes the sustainable, healthy, scientific and orderly development of the industry.

Keywords: hydrogen fuel cell automobile industry, safety construction work system, strategic emerging industry

1. Introduction

With the development of environment, economy, energy and social issues have become increasingly prominent. The consumption of greenhouse gas emissions and fossil fuels have caused global warming, glacier melting, and sea level rise, which continuously threaten the environment on which humans rely for survival. During the 2021 "Two Sessions", China made "carbon peak" and "carbon neutrality" an important national strategy, committed to achieving peak carbon dioxide emissions by 2030 and to achieve carbon neutrality by 2060. In China, achieving the "3060" target of "carbon peak" and neutrality" is a tight time and heavy task, and the country should vigorously develop renewable new energy industries. Among them, hydrogen energy is considered one of the most promising clean energy sources in the world, and its zero emission and zero pollution characteristics are recognized as the "ultimate new energy vehicle solution" worldwide. With the continuous increase of policy support and the continuous breakthrough and development of core technologies such as basic materials and key components related to Hydrogen fuel cell vehicles, hydrogen energy vehicles will occupy a larger share in the future market and have broad prospects. Relevant experts predict that China's hydrogen energy vehicle industry will reach a trillion yuan output value by 2030^[1].

2. Development Status of Hydrogen fuel Cell Vehicle Industry in Zhejiang Province

The entirely industrial chain has basically formed. In recent years, through active recruitment and local cultivation, the province has initially formed a relatively complete industrial chain covering hydrogen preparation, storage and transportation, fuel cell systems and key parts, vehicle etc., which is mainly concentrated in Hangzhou Bay area such as Hangzhou Ningbo Jiaying. Firstly, in terms of Hydrogen fuel cell system and core components, the province has gathered a group of leading enterprises in hydrogen energy equipment R&D and manufacturing, such as Edelman (fuel cell system) and Decun Power (Hydrogen fuel engine), which involve fuel cell core materials, stacks, systems, detection, operation and other links. Second, in terms of the entire vehicle, Zhejiang CRRC Geely Group are accelerating the development and production of hydrogen powered vehicle products.

Policy support is constantly increasing. One is the overall planning of the entire province. In September 2021, the Provincial Committee of the CPC issued the Notice on Clarifying the Division of Responsibilities of the Management Department of the Fuel Cell Vehicle Hydrogen station, which took the lead in clarifying the development and construction management body of the Hydrogen station nationwide. In October, the Provincial Development and Reform Commission took the lead in drafting and issuing the implementation plan for accelerating the development of Hydrogen fuel cell vehicle industry, clearly proposing to vigorously cultivate and develop the Hydrogen fuel cell vehicle industry

with the guidance of systematic demonstration applications. Secondly, all cities actively promote it. Ningbo, Jiaxing, Shaoxing, Zhoushan and other places in the province have successively introduced policies and measures to support the development of hydrogen energy, accelerating industrial planning and layout.

The pace of application demonstration is gradually accelerating. One is hydrogen energy supply. The first high-efficiency hydrogen energy storage cogeneration system has been built in the "zero carbon" smart park of Jiaxing Hongchuan Base, and its demonstration applications are continuously expanding. The third is hydrogen powered ships. One sea fishing vessel from Guohydrogen is under construction, and one leisure fishing vessel from Zhongshan Dayang Electric has completed the ship hull design. Construction will officially commence after docking with relevant design and construction specifications. The second is hydrogen powered vehicles. In September 2021, Jiaxing was successfully included in the first batch of national fuel cell vehicle demonstration applications in the Shanghai urban agglomeration. As a pilot city for the application of hydrogen powered public transportation in Zhejiang Province, Jiaxing has promoted the operation of over 100 hydrogen powered public transportation vehicles, with a mileage of over 2 million kilometers; At the same time, the trial operation of three hydrogen powered heavy trucks in Jiaxing Port Area was smooth.

The ability to ensure hydrogen energy supply continues to strengthen. One is the hydrogen production capacity. The production capacity of high-purity hydrogen in Ningbo, Jiaxing, Shaoxing, Jinhua, Quzhou and other places can reach more than 100000 tons. The comprehensive utilization capacity of industrial hydrogen rich enterprises such as Jiahua Energy, Ningbo Jinfa, Satellite Petrochemical, Wanhua Chemical Group and others has been continuously strengthened. With the completion and operation of a batch of hydrogen production projects such as China National Nuclear Corporation and China Resources Power, Zhejiang's hydrogen production capacity will continue to improve. The second is the hydrogen storage capacity. The R&D and industrialization capabilities of hydrogen storage and transportation equipment in enterprises such as Juhua Group, Hangzhou Oxygen Group, Hangzhou Best, Fengyuan Hydrogen Energy, and Linde Gas have been continuously improving. Among them, Juhua Group and Zhejiang University have jointly developed 98MPa hydrogen storage tanks, leading the world in technology. The third is the construction of Hydrogen station. So far, 14 Hydrogen station (including integrated energy stations) have been built in the province, including 3 in Hangzhou, 4 in Ningbo, 4 in Jiaxing and 1 in Huzhou, Shaoxing and Taizhou [2].

Accelerate the layout of innovative research and development platforms. Zhejiang Energy Group is strengthening cooperation with Aerospace 101 Institute, accelerating the construction of carbon neutrality laboratories, hydrogen research and development centers, and hydrogen industry enterprise incubation bases; Zhejiang Tsinghua Yangtze River Delta Research Institute Hydrogen Energy Science and Technology Park Innovation Center is accelerating construction and making every effort to build a hydrogen testing and testing center in the Yangtze River Delta. At present, Zhejiang Energy Group, Zhejiang University, Shanghai University, Shanghai Jiaotong University and other scientific research institutions and related enterprises inside and outside the province actively layout hydrogen energy R&D platforms in Zhejiang. Among them, Zhejiang University and Princeton University have established a joint research center, specializing in hydrogen energy preparation and storage and transportation technology.

3. Problems in Hydrogen fuel cell vehicle industry in Zhejiang

At present, the development of Hydrogen fuel vehicle industry in Zhejiang Province has begun to take shape, but there are still some problems.

First, difficulty in breaking through core technologies and key materials. In recent years, in order to promote the rapid development of the Hydrogen fuel cell vehicle industry, China has issued a number of support and encouragement policies. However, the overall development of the hydrogen energy industry in Zhejiang and even the whole country is still in its early stages. Although there is some layout in the vehicle, system, and stack aspects, most of the core equipment and key materials still rely mainly on imports, with a low localization rate. For example, the compressor, hydrogenation gun, hydrogen liquefaction and other core equipment of the Hydrogen station, as well as the proton membrane, carbon paper, catalyst and other key materials are mainly imported. Therefore, it is urgent to accelerate breakthroughs in key core technologies, enhance core competitiveness, and enhance the level of fuel cell vehicle technology and equipment in Zhejiang through technological breakthroughs and innovation.

Second, insufficient construction of hydrogenation infrastructure. An important factor limiting the development of domestic Hydrogen fuel cell vehicle industry is the insufficient construction of hydrogenation infrastructure. At present, the Hydrogen fuel cell vehicle industry in Zhejiang Province is in the early stage of development, and the number of fuel cell vehicles in operation is small. The construction, operation and maintenance of Hydrogen station is also difficult to lead to economies of scale and minimize the cost, resulting in almost no profit from construction and operation. Domestic hydrogenation equipment has weak industrial application ability, few innovation modes and high cost. Infrastructure construction plays a decisive role in the effective application and promotion of Hydrogen fuel vehicles. According to the prediction of experts in the new energy vehicle industry, in order to meet the needs of most cities in China, the country needs to build more than 1400 Hydrogen station before 2030^[3]. According to the "14th Five Year Plan" Hydrogen Energy Industry Development Forum, by the end of 2020, there are about 544 Hydrogen station in the world, 128 Hydrogen station in China, and 14 Hydrogen station have been built in Zhejiang, which is far behind Guangdong (35) and Shandong (15). On the one hand, in the current safety management system for dangerous chemicals, hydrogen is included in the management of dangerous chemicals, which makes local governments and enterprises have more concerns about the development of hydrogen energy industry and the construction of Hydrogen station. On the other hand, there is still a lack of corresponding specifications and standards for the access, land use, construction, acceptance, operation, supervision and other links of the Hydrogen station in the actual construction;

Third, macro policies and management mechanisms have not yet been formed. Although the development of the Hydrogen fuel cell vehicle industry has been recognized by the state in terms of top-level design, its policy system and special planning are too vague, and the focus, goal and future direction of industrial development have yet to be clarified. Relevant competent departments still list hydrogen as a hazardous chemical management, and have weak awareness of hydrogen energy. It is difficult to approve the construction of Hydrogen station, which has a great constraint on the development of Hydrogen fuel cell vehicle industry. The Notice on Clarifying the Division of Responsibilities of the Management Department of the Fuel Cell Vehicle Hydrogen station issued by the Zhejiang Provincial Party Committee basically clarified the responsibilities of the relevant subjects in the development and construction management of the Hydrogen station, but the coordination mechanism between the relevant provincial departments has not been established, the policy coordination and work coordination are not enough, and the safety management of hydrogen storage, hydrogen production, hydrogen transportation, hydrogen use and other links needs to further refine and formulate standards and specifications, Ensure that policy measures can be implemented and operated. In addition, there is insufficient linkage between the upper and lower levels of provinces, cities, and counties, and there has not yet been a true "provincial chess game". At present, the main application field of Hydrogen fuel cells is vehicles. However, due to the high cost of Hydrogen fuel cell vehicles, the imperfect safety specification system, and the lagging construction of hydrogenation infrastructure in the province, the overall development speed of Hydrogen fuel cell vehicles in Zhejiang is not fast, and the demonstration application and scene promotion of hydrogen vehicles are insufficient. From the perspective of hydrogen vehicle usage, Zhejiang currently only operates more than 101 hydrogen buses, less than 215 hydrogen vehicles operated in Beijing and 450 hydrogen logistics vehicles put into operation in Guangdong, with a relatively weak foundation.

Fourth, lack of commercial promotion model. At present, the main reason for the lack of commercial promotion mode of Hydrogen fuel cell vehicles is the high production and manufacturing costs of the whole industry chain. From the four aspects of hydrogen production, storage, transportation and use, the current technology is not very mature, the renewable energy hydrogen production technology is not perfect, the compressor and high-pressure storage tank equipment costs are high, the fuel cell stack and membrane electrode assembly costs are high, which affects the development speed of the fuel cell vehicle industry, and there is still a big gap between large-scale commercial applications.

4. Development Measures of Hydrogen fuel Cell Vehicle Industry in Zhejiang Province

In recent years, Zhejiang has made a clear development path and made a systematic plan and layout for the Hydrogen fuel cell vehicle industry. Through pilot demonstration, strong chain supplement, regional linkage, and active cultivation and attraction, a relatively complete industrial chain covering hydrogen preparation, storage and transportation, fuel cell systems and key parts, and vehicle manufacturing has been initially formed, strengthening the leading and exemplary role of Zhejiang in the development of the national Hydrogen fuel cell vehicle industry.

First, the government should strengthen and stabilize the coordinated development of the chain, guide advantageous enterprises to increase their research and development efforts, enhance their research and development capabilities, and become innovative enterprises with core competitiveness. Each demonstration area (site) focuses on the Hydrogen fuel cell vehicle industry chain, and bases on its advantages to carry out characteristic industry cultivation. Jiashan is accelerating the integration of research and development, manufacturing, and application in the field of hydrogen energy and fuel cells, striving to become an integrated regional hydrogen energy and fuel cell industry base in the Yangtze River Delta. In 2022, Edelman Corporation will ship 66.5MW Hydrogen fuel cells, accounting for 8.9% of the market, ranking the second in China; Zhejiang Lanneng is a leading enterprise in the global research and development and manufacturing of high-pressure gas storage and transportation equipment, with a market share ranking first in the country in the field of hydrogen storage and transportation. At the same time, we will vigorously cultivate "single champion", "invisible champion", and specialized and innovative "little giant" enterprises. Relying on the unique advantages of "China's Automobile and Motorcycle Industry Base", the first batch of national demonstration cities for the promotion of new energy vehicles and the first provincial pilot city for the promotion and application of new energy vehicles in the province, Jinhua has strengthened the cultivation of the Hydrogen fuel cell vehicle industry and gradually extended the hydrogen energy industry chain.

Second, strive to create two "hydrogen corridors". To comprehensively promote demonstration applications, further strengthen regional linkage, organically combine industrial layout and application scenarios, and focus on creating two "hydrogen corridors" with Zhejiang characteristics. First is to focus on Jinhua, Ningbo, and Zhoushan, and rely on G15 (Yongjin Expressway) to build a hydrogen energy high-speed channel, focusing on building the "Yiyongzhou" hydrogen corridor. Second, Jiaxing, Hangzhou, Shaoxing, Ningbo and other important node cities around Hangzhou Bay form G92 (Hangzhou Bay Ring Expressway), local government is building a "Hangzhou Bay Ring" hydrogen corridor.

Third, the government should strengthen the construction of the industrial chain. Innovate the cooperation model between component enterprises and complete vehicles, coordinate and promote upstream and downstream cooperation in the industry, and promote the coordinated development of the entire industry chain. Support vehicle leading enterprises to research, local governments develop and produce Hydrogen fuel cell vehicles, and focus on promoting the industrial application of Hydrogen fuel cells in the field of medium and long distance, medium and heavy commercial vehicles, engineering vehicles, and special vehicles. Focusing on provincial demonstration areas, local governments are encouraged to actively attract leading competitive enterprises at home and abroad, such as key components of Hydrogen fuel cells, hydrogen production and hydrogen storage equipment, and arrange a number of industrial chain projects through strong chain replenishment. Local governments promote Hydrogen fuel cell industry chain enterprises in the province to strengthen cooperation, build industrial clusters together, and improve the overall competitiveness of the industry.

Forth, building a collaborative innovation platform. Local governments develop a list of key scientific and technological projects for the Hydrogen fuel cell vehicle industry, increase special support for science and technology, encourage enterprises to strengthen the research and development of special equipment such as testing equipment and intelligent manufacturing equipment, as well as the research and development of basic materials such as high-performance Proton-exchange membrane, catalyst, carbon paper, and strive to achieve independent control of key equipment and core technologies. The government should support universities, research institutions, and related enterprises to establish a collaborative mechanism of "industry, academia, research, and application", and support backbone enterprises to create high-energy innovation platforms. The government should promote the automobile and parts enterprises with outstanding innovation ability, combine the upstream and downstream innovation resources of the industrial chain, create a provincial technological innovation center for the automobile industry, and carry out key core technology research in the field of Hydrogen fuel cell vehicles. According to the construction of national and provincial innovation platforms, provincial policies for promoting and applying new energy vehicles will provide local incentives and support. Jiaxing is vigorously building a platform for the Yangtze River Delta (Jiaxing) hydrogen energy industry park in the Jiaxing Port Area, promoting the construction of characteristic hydrogen energy industry theme parks in areas such as Haiyan, Jiashan and Pinghu, and forming a "one main and three auxiliary" hydrogen energy industry cluster development pattern. Shaoxing initiated the establishment of the Shaoxing Hydrogen Energy Industry "Innovation and Entrepreneurship" Alliance, collaborating with 29 key hydrogen energy industry enterprises, research and development innovation institutions, and demonstration application platforms in the city to create a hydrogen energy industry innovation community.

Fifth, take the lead in layout and try first. In November 2021, the Development and Reform Commission of Zhejiang Province and other six departments jointly issued the Implementation Plan of Hydrogen fuel Province on Accelerating the Cultivation of Hydrogen fuel cell vehicle Industry, which clearly defined the cultivation and development of hydrogen fuel cell vehicle industry led by systematic demonstration applications. Considering the rational layout and orderly development of the Hydrogen fuel cell industry, as well as the overall planning of the hydrogen energy industry foundation and technical conditions and other factors, seven provincial demonstration areas (sites) are selected to be constructed in Shaoxing, Jinhua, Zhoushan, Ningbo, Jiaying, Jiashan County and Changxing County. The government should support the active exploration of technological innovation, product promotion, enterprise cultivation, and scenario operation, with provincial-level demonstration zones (points) as the main body, and strive to form a batch of replicable, promotable, and demonstrative typical achievements^[4].

5. Safe construction work system of Hydrogen fuel cell vehicle industry in Zhejiang

The safety construction of Hydrogen fuel cell vehicle industry in Zhejiang should be people-oriented, adhere to the people first, life first, put the protection of people's life safety in the first place, firmly establish the concept of safety development, adhere to the policy of safety first, prevention first, and comprehensive management, and prevent and resolve major safety risks from the source, vigorously promoting the healthy and high-quality development of Hydrogen fuel cell vehicle industry in Zhejiang Province. The government should ensure the safety and stability of the industrial chain.

First, enterprise safety production management. The enterprise shall set up corresponding safety production management organization or provide full-time safety production management personnel in accordance with the provisions of the Production Safety Law of the China and other relevant laws and regulations. The appointment and dismissal of safety production management personnel of enterprises engaged in hydrogen energy production and storage activities shall be notified to the competent department responsible for safety production supervision and management. The main person in charge of the enterprise is the first person responsible for the safety production of the unit, who is fully responsible for the safety production work of the unit. Other responsible persons are responsible for safety production work within their scope of responsibility.

The main responsible person and safety production management personnel of the enterprise must possess safety production knowledge and management capabilities corresponding to the hydrogen energy production, operation, and transportation activities engaged in by the unit. The main person in charge of the enterprise is responsible for establishing, improving and implementing the safety production responsibility system for all employees in the unit, and strengthening the standardization construction of safety production; Related enterprises should organize the formulation and implementation of safety production regulations and operate procedures for the unit; Related enterprises should organize the formulation and implementation of safety production education and training plans for the unit; Enterprises must ensure the effective implementation of safety production investment in this unit; Enterprises must timely and truthfully report production safety accidents. The main person in charge of the enterprise is responsible for organizing the preparation and implementation of the production safety accident emergency plan (hereinafter referred to as the emergency plan) of the unit, and is responsible for the authenticity and practicality of the emergency plan; Each responsible person in charge shall implement the responsibilities specified in the emergency plan according to their respective responsibilities.

Enterprises should provide safety production education and training to their employees, ensuring that they have the necessary knowledge of safety production, are familiar with relevant safety production rules and regulations and safety operation procedures, master the safety operation skills of their own positions, understand accident emergency response measures, and be aware of their rights and obligations in safety production. Employees who have not passed safety production education and training are not allowed to work on duty.

Special operation personnel must undergo specialized safety operation training in accordance with relevant national regulations and obtain corresponding qualifications before they can start work.

Special equipment safety management personnel, testing personnel, and operators shall obtain corresponding qualifications in accordance with relevant national regulations before engaging in relevant work. They shall strictly implement safety technical specifications and management systems to

ensure the safety of special equipment.

Second, safety requirements for production process. The design, construction, production, storage, and safety management of production enterprises should comply with the current national and industry standards such as "Basic Requirements for Hydrogen System Safety" (GB/T 29729) and "Design Specification for Hydrogen Stations" (GB 50177). The flanges and valves of hydrogen and oxygen equipment and pipelines, as well as the connections between indoor and outdoor overhead or buried hydrogen pipelines, busbars, and their connecting flanges, should be connected and grounded in accordance with relevant regulations. All metal shells, pipes, bases and frames of the hydrogen production system, as well as vent pipes and air ducts protruding from the roof, should be grounded. The grounding of electrical devices should be connected to a separate grounding wire and the grounding main line, and serial connection is not allowed; All lightning protection and anti-static grounding devices should be regularly tested for grounding resistance [5].

The central control room of the production enterprise should be integrated and networked. The automatic control system of the hydrogen production system should centrally monitor and automatically adjust the main process parameters. When equipment malfunctions, it should promptly alarm, shut down, and handle them properly. The video images and indicator parameters of key parts and key links of production enterprises should be uploaded in real-time to industry supervisors and departments responsible for safety production supervision and management. Tilt photography 3D modeling work should be carried out to comprehensively improve the level of enterprise safety production informatization supervision. Production enterprises should equip special equipment safety management personnel and operators in accordance with relevant national regulations when using special equipment, and provide necessary safety education and skill training. Only after passing the exam and obtaining the corresponding qualification certificate can they start their work.

Third, safety requirements for transportation. Transportation should comply with national and local laws and regulations on the transportation of dangerous (flammable) goods. Enterprises should equip engineering and technical personnel with professional knowledge of mobile pressure vessels and familiar with relevant national technical specifications and corresponding standards as safety management personnel. Safety management personnel should hold corresponding special equipment operation personnel certificates, and escort personnel should obtain qualification certificates stipulated by relevant departments of the State Council. Enterprises should equip operators or escorts with necessary safety protection equipment, special tools, and necessary spare parts for daily operations. Enterprises should develop corresponding emergency response plans for accidents, establish corresponding emergency rescue organizations and response systems, allocate corresponding emergency rescue equipment, and regularly organize drills. Enterprises should handle procedures in accordance with the "Regulations on the Management of Road Transport of Dangerous Goods" and strictly comply with the relevant regulations of relevant departments on the transportation routes, time, speed, and other aspects of dangerous goods.

Forth, safety supervision and management. The market supervision department shall investigate and deal with unlicensed production, storage, and operation in accordance with the departmental responsibilities assigned by relevant laws and regulations. If it is found that special equipment has not been registered or managed for use, or filling personnel have no certificates to work, it shall be investigated and dealt with in accordance with relevant laws and regulations. Strengthen product quality supervision of enterprise production (operation), and strictly investigate and punish counterfeit and inferior products in accordance with their responsibilities in accordance with the law. The government should be responsible for the safety supervision and management of special equipment in hydrogen related enterprises.

6. Conclusion

The Hydrogen fuel cell vehicle is an important direction for the development of Hyundai Motor Company industry and an important starting point for the development of the whole industrial chain of local economy. With the policy driven, the development of Hydrogen fuel cell vehicle industry is changing rapidly. This topic is based on the development foundation of Hydrogen fuel cell vehicle industry in Zhejiang Province, standardize the industrial development, and establish and improve the safety construction work system of Hydrogen fuel cell vehicle industry. The government must combine the direction of new technological innovation and the trend of new industry integration, in order to highlight the characteristics of Zhejiang and demonstrating foresight and leadership.

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