Research on the Development Practice and Path of Fuel Cell Vehicles

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Abstract. As one of the important categories of new energy vehicles, the fuel cell vehicle industry is an inevitable trend in the development of China's automotive industry and one of the main directions of the "dual-carbon" goal. Research on the development path of fuel cell vehicles is important for promoting the high-quality development of the industry. It is of great significance to accelerate the rapid marketization of products. This article systematically sorts out the development path of China's new energy vehicles, and summarizes the development of the new energy vehicle industry in terms of development history, strategic choices, and development results. At the same time, it deeply analyzes the problems existing in the development of fuel cell vehicles. Taking the development experience of new energy vehicles as a reference, and guided by the problems in the development of fuel cell vehicles, it provides suggestions for the development path of fuel cell vehicles.

Keywords: Fuel Cell Vehicle · Development Practice · Development Path

1 Introduction

Energy issues have become a topic of common concern in the world today. With the continuous increase in the number of cars, the worldwide energy crisis and climate issues have attracted widespread attention from all countries. As a green and efficient secondary energy source, hydrogen energy has the advantages of wide sources, high combustion heat value, clean and pollution-free, and storable. It is an important part of clean energy in the future.

Hydrogen fuel cell vehicles are an important field for the large-scale commercial application of hydrogen energy. They have the characteristics of long battery life, short refilling time, high power density, and low starting temperature. It has become an important supplement to the mainstream technical route of new energy vehicles in commercial vehicle heavy-duty scenes and alpine regions.

In 2009, the four ministries and commissions jointly launched 1,000 vehicles in ten cities. Through financial subsidies, ten cities will be developed each year within three years, and 1,000 new energy vehicles will be launched for demonstration operations in each city. At the end of 2012, a total of 27,400 new energy vehicles were

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promoted in 25 pilot cities, of which 11,777 new energy buses were promoted. The demonstration and promotion of new energy vehicles is of great significance. Regarding fuel cell vehicles, in September 2020, the Ministry of Finance, the Ministry of Industry and Information Technology, the Ministry of Science and Technology, the Development and Reform Commission, and the Energy Administration jointly issued the "Notice on Carrying out Fuel Cell Vehicle Demonstration Applications". The city agglomerations shortlisted for demonstration are approved and allocated reward funds in accordance with the completion of their goals.

The demonstration application of fuel cell vehicles will support the breakthroughs in key core technologies and industrial applications of fuel cell vehicles, and promote the formation of a fuel cell vehicle development pattern with reasonable layout, different priorities and coordinated advancement, and lay a solid foundation for the large-scale industrial development of fuel cell vehicles.

Regardless of whether it is from a carbon credit perspective, an energy perspective, or a market perspective, all regions have shown great enthusiasm for the development of fuel cell vehicles. Under such an environmental background, the demand for fuel cell vehicle-related services by local governments and enterprises has increased significantly.

2 New Energy Vehicle Development Practice

2.1 Development History of New Energy Automobile Industry

The development of new energy vehicles in China began in the 1990s. During the period from the "Eighth Five-Year Plan" to the "Ninth Five-Year Plan", China began to conduct research on the related technologies of new energy vehicles, and carried out research on the necessity and feasibility of the development of new energy vehicles. During the "Tenth Five-Year Plan" period, China began to study the development layout of new energy vehicles; during the "Eleventh Five-Year Plan" and "Twelfth Five-Year Plan" period, new energy vehicles were initially industrialized in China and tried to carry out demonstration and promotion of new energy vehicles; During the "13th Five-Year Plan" period, new energy vehicles have entered a new stage of accelerated development.

The development of new energy vehicles is a strategic choice for the high-quality development of China's automobile industry in the new era. The new energy automobile industry is now entering a new stage of accelerated development. The state has successively issued a full range of incentives and regulatory policies. In 2020, the Ministry of Industry and Information Technology and other four departments issued the "Regarding the amendment to the Regulations on the Administration of New Energy Vehicle Manufacturers and Product Access", the "Notice on Improving the Fiscal Subsidy Policy for the Promotion and Application of New Energy Vehicles", and the "Development Plan for the New Energy Vehicle Industry", including lowering the entry barriers for auto companies and extending subsidies deadline, speeding up the construction of charging/replacement stations, and implementing charging preferential treatment, covers almost the entire life cycle of new energy vehicles. From the perspective of the development process, the development of China's new energy automobile industry can be roughly divided into four stages, namely, the start-up stage, the layout and preliminary industrialization

stage, the support and large-scale promotion stage, and the simultaneous support and standardization stage.

2.2 Strategic Choice of New Energy Vehicle Development

At present, China's new energy vehicles maintain a good momentum of development in terms of market size and development quality. The private consumer market continues to grow, and the potential of the sinking market is gradually released. The sales of traditional car companies and new car manufacturers have successively exceeded historical levels, but it still exist long-term issues that affect the development of the industry, such as supply chain security, core technology research and development, product safety and reliability, and convenience for energy supplements. Entering a new stage of market-oriented development, the new energy automobile industry is facing pressure from the rapid expansion of market scale, while facing global epidemics, dual-carbon targets, climate change, supply chain adjustments, in-depth application of information and smart technologies, and changes in human travel patterns, competition and cooperation among major powers and other complex and changeable development environments.

After more than ten years of development, China's new energy automobile industry has successively passed through the initial stage of policy-driven and the transitional stage of dual-driven by policy and market. In terms of strategic choices, it has successively experienced technology research and development promotion policies such as government-led, government financial investment, new energy vehicle key parts support, tax incentives, etc., guided and improved the standard system and access management system, and established an energy development management agency. With the complete withdrawal of industrial subsidies in 2022, China's new energy vehicles have truly entered a new stage of market-oriented development.

The electrification of automobiles is parallel to the speed-up of intelligent automobiles [1]. With the first-mover advantage, China's automobile industry has achieved world-renowned achievements in the electrification stage. In the future, connectivity, intelligence, and digitization will not only represent a major development opportunity for China's new energy automobile industry, but also mean more challenges. At the same time, the implementation of the dual-carbon strategic goal will accelerate the transformation and upgrading of the automobile, transportation, and energy industries. The State Council issued the "Carbon Peak Action Plan by 2030", which clearly puts forward the requirements for green and low-carbon actions in the transportation industry. Under the guidance of the dual-carbon strategy, the coordinated development of new energy systems, power systems and new energy vehicles with new energy as the mainstay has become inevitable.

2.3 Achievements in the Development of the New Energy Automobile Industry

From the perspective of the development path of new energy vehicles, China mainly promotes and supports pure electric vehicles. In recent years, fuel cell vehicles have also been developed rapidly, especially hydrogen fuel cell vehicles. Overall, the development of new energy vehicles in China is stable and has achieved a certain effect.

2.3.1 Industry Support Policies Are Stable and Gradually Cover

Based on the advantages of low energy consumption, low emissions, and low pollution, new energy vehicles have been vigorously promoted in many countries since their inception. In order to accelerate the development of the new energy vehicle industry, the Chinese government has issued a series of support policies. Beginning in 2001, The research and development of new energy vehicles began through the "863 Program", a large amount of capital support has been invested successively.

The support policies for the new energy automobile industry, from the beginning of focusing on subsidizing manufacturers, to focusing on terminal sales promotion subsidies, and then to subsidies for the construction and maintenance of key components and charging facilities in the industrial chain, the industrial policy basically covers the entire industrial chain, showing full coverage situation.

2.3.2 The Marketing Effect Becomes More Obvious

The development of electric vehicles in China has gone through a process of government guidance and encouragement, positive responses from enterprises, and gradual acceptance by the public. After the efforts to cultivate during the 12th and 13th Five-Year Plan, my country's new energy vehicles have a certain degree of competitiveness in the international market. In 2020, the production and sales of new energy vehicles will reach 1.366 million and 1.367 million respectively, a year-on-year increase of 7.5% and 10.9% respectively. After years of market cultivation, new energy vehicles have seen large-scale developments in production and sales [2].

2.3.3 New Energy Vehicles Have Rapidly Improved Their Independent Innovation Capabilities and Levels

After years of development, China's new energy automobile industry has become increasingly mature in technology and has broken through a number of key technologies. A number of new energy automobile companies with strong technical strength have emerged, and their products have achieved diversified development. Local governments have also given a lot of financial support to the research and development of new energy vehicles. At present, China has made major breakthroughs in the research and development of key materials, core technologies and products for power batteries, and the overall level has reached the international advanced levels of the United States, Germany, and Japan. The main performance indicators of the lithium-ion and nickel-metal hydride as well as multiple series of automotive power batteries developed by BYD, Leitian, Lishen and other companies are at the international leading level. China's new energy vehicle research and development capabilities continue to improve, and it has mastered vehicle integration technology with independent intellectual property rights that is suitable for private vehicles and public transportation. China's new energy vehicle independent innovation capability and level have been greatly improved, with a number of technologies and products with independent intellectual property rights, and the industry's competitiveness has been continuously enhanced.

3 Problems Facing the Development of Fuel Cell Vehicles

3.1 Lack of Top-Level Design

The application of hydrogen energy involves a series of comprehensive technologies, from materials to transportation, hydrogenation and even the entire life cycle of final operation. To formulate a clear operation path, the national top-level design is particularly important. However, China lacks the top-level design for the development of fuel cell vehicles, and there is no unified guiding program document. The industrialization of hydrogen energy is relatively complex, and cannot be completed purely by market mechanisms or by one company. To build an ecosystem of the hydrogen energy industry requires the government, enterprises, research institutions and other parties work together. With reference to the international effective hydrogen energy project management mechanism, standard top-level design is carried out [3].

China gives full play to the advantages of the system, and provides guidance on the approval of hydrogen refueling stations and hydrogen production plants from the level of national ministries and commissions. At the same time, it formulates a development route with cost and user experience as the core elements and synergistic development mechanism of vehicles and hydrogen energy infrastructure.

Then it relies on vehicle companies and users to jointly promote the popularization and promotion of hydrogen fuel cell vehicles [4].

3.2 Infrastructure Construction Lags

The construction of hydrogen refueling stations in China has the characteristics of large investment, imperfect approval process, lacking of standard system, etc., and the upstream large-scale hydrogen production, hydrogen storage, and hydrogen transportation systems are also imperfect, resulting in high hydrogen costs.

The small number of hydrogen refueling stations is an important factor restricting the development of the industry [5]. At present, China lacks national-level standardized approval regulations for the planning and construction of hydrogen refueling stations. Local governments have no basis for approving the construction of hydrogen refueling stations and need to explore independently. It takes an average of 2 years from site selection and planning to completion of construction of domestic hydrogen refueling stations, and even 5 years in some places. There is an urgent need for the state to issue guidance on the approval subject, construction approval process and subsidy policy of hydrogen refueling stations.

3.3 Gaps Between Key Technologies and Industrialization Capabilities

China's fuel cell technology faces challenges such as relatively weak basic research, the gap between the core technology level and the international advanced level, and the need to further improve the manufacturing process. At present, the development of key materials for fuel cells mostly stays in the sample or small batch stage, the key components lack batch and stable product supply, the industry chain as a whole has not formed a relatively stable parts supply system, and there are some weak links in the

domestic supply chain, engineering and technological process innovation capabilities need to be strengthened, the full localization of the parts system still needs a certain amount of time to accumulate [6].

4 China's Fuel Cell Vehicle Implementation Path

4.1 Strengthen Top-Level Design and Clarify the Path of Industrial Development

From the perspective of the government, to lead the development of a revolutionary new technology, we should first establish an innovative strategic thinking concept, clarify the development goals of emerging industries, and maintain the continuity and standardization of policies. According to the characteristics of different stages of the development of emerging industries, long-term planning and implementation of relevant policy systems from the entire life cycle of the development of the fuel cell vehicle industry, and good technical guidance and policy support will provide industry participants with clear expectations and confidence.

Based on the development history and status quo of the fuel cell vehicle industry at home and abroad, the development of fuel cell vehicles in China can be divided into four stages. At present, China is in the introduction stage (i.e., the start-up stage). For any emerging strategic industry, the introduction period is the most difficult period. At this stage, the technology of emerging industries is immature, the industry chain is incomplete, the supporting settings are not perfect, the market awareness and acceptance are low, the development direction and prospects of the industry itself are not clear, and the products lack competitiveness. At this stage, the government needs to provide support and guidance from various aspects such as policy, finance and technology.

Specific to the fuel cell vehicle industry, the main task at this stage is to formulate an industrial development strategy, demonstrate the country's determination and goals for the development of the fuel cell vehicle industry, set up strategic basic scientific research projects, and promote the fuel cell vehicle industry to achieve technological innovation breakthroughs. In the stage of layout and preliminary industrialization, industrial development needs to shift from policy support to market leadership. While policy escorts, give full play to the leading role of the market, guide enterprises to actively participate in market competition, and enable the fuel cell vehicle industry to gradually develop in the market competition. Grow. In the stage of support and large-scale promotion, the government should focus on the orderly development of the industry, and by formulating perfect standards and market access mechanisms for the automobile industry, prevent the disorderly entry of social resources and maintain the rapid, stable and orderly development of the industry. At the same time, strengthen the construction of laws and regulations to protect technological innovation and business model innovation.

4.2 Strengthen Subsidies, Innovative Subsidy

In the initial stage of industrial development, due to a series of problems such as immature technology, small market size, low consumer awareness and imperfect supporting infrastructure, the industry develops slowly and the development direction is unclear. The

risks faced by market participants in the early stage are relatively large. In most cases, only a few companies can see the direction of industrial development. At this stage, government subsidies and support mechanisms are crucial. Especially for the fuel cell vehicle industry with large industrial investment, high technical level and long industrial chain, it must rely on government policies and financial support in the initial stage.

4.3 Formulate a Sound Market Access Mechanism and Relevant Laws and Regulations to Encourage Industrial Innovation and Development

At the beginning of industrial development, the government does not need to intervene too much in industrial development. Enterprises should be allowed to use different technologies and products for market trials, and the market should make the final choice. The government should be more about formulating standards and rules to regulate the energy-saving level, safety performance and technical standards of fuel cell vehicles to prevent disorderly development of the industry and waste of resources.

4.4 Guide Social Capital to Participate in the Construction and Operation of Supporting Infrastructure

Each region should, according to its own situation and characteristics, comprehensively consider factors such as the stock of fuel cell vehicles, sales volume over the years, future market expectations, and the characteristics of residents' vehicles, and scientifically plan the construction density and location of hydrogenation facilities. Incorporating the construction of hydrogenation facilities into the overall urban planning and transportation planning, the construction of hydrogenation facilities requires huge investment and a long recovery period. Government investment alone may be unsustainable, requiring multi-party capital investment. The government should do a good job of guiding and give support in terms of land, funds, policies and so on. Central enterprises such as PetroChina and Sinopec should shoulder the heavy responsibility of construction, increase investment in the construction of hydrogenation facilities, and undertake more social responsibilities from the height of supporting emerging strategic industries. Policies should be introduced to clarify the development expectations of fuel cell vehicles, and social capital should be encouraged to participate in the operation of hydrogenation facilities. It is possible to consider granting exclusive operating licenses to enterprises in a certain area and within a certain period of time, so as to enhance the profit expectations of enterprises.

5 Conclusion

This paper summarizes the development of the new energy vehicle industry from the perspectives of development history, strategic choice and development effectiveness, and deeply analyzes the problems existing in the development of fuel cell vehicles. Lacking of top-level design, lagging infrastructure construction, lagging behind key technologies and low industrialization capacity are the main bottlenecks restricting the development of fuel cell vehicles. By learning from the development experience of new energy vehicles and guided by the existing problems in the development of fuel cell vehicles, this paper puts forward suggestions on the development path of fuel cell vehicles.

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