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Development and Countermeasures of China's New Energy Vehicles within the Great Power Game

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Abstract: In light of contemporary developments, fostering advancements in renewable energies has assumed paramount importance. New energy vehicles (NEVs) have progressively emerged as primary modes for transportation worldwide; their proliferation serves as a barometer reflecting each nation's overall capabilities. The evolution trajectory for electric vehicles (EVs) in China has been riddled with challenges amid global power dynamics at play. It is imperative to delve into recent trends shaping this sector comprehensively to gain deeper insights into its trajectory over time. This study encapsulates how EVs in China have evolved within an overarching framework emphasizing conservation efforts alongside emission reductions. Furthermore, it scrutinizes persisting technical hurdles faced by Chinese NEVs, such as uneven charging infrastructure deployment, as well as limitations related to range anxiety due to suboptimal battery performance. Intense market competition among domestic EV manufacturers has inadvertently precipitated quality concerns impacting consumer loyalty adversely. The article also delves into the remedial measures being taken by Chinese NEV companies, including pioneering research efforts focused on improving the safety features of lithium-ion battery technology. On this basis, this paper discusses the government initiatives such as "plan-pilot-promotion-subsidy-development" aimed at supporting the NEV industry in China.

Keywords: new energy vehicles, efficiency and safety, lithium battery.

1. Introduction

The degree of progression of the new energy industry is an important consideration to judge a country's comprehensive national strength. Now in the case of multinational competition, China's energy industry's evolution is largely reflected in new energy vehicles (NEVs). Therefore, the development of energy vehicles in China is not only the key measure of Chinese energy problems but also reflects the competition between great power and the global environmental issues. On the one hand, how cutting-edge technological innovation including artificial intelligence and big data algorithm can help China's NEV improvement will become the perfect technical orientation for NEVs in the future. On the other hand, some study has discussed that new NEVs in China are having some technical problems such as the growing pressure of Energy security and natural environment pollution [1]. The issue that also needs attention is the increasing public concern about the energy-saving emission reduction and low-carbon policy.

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In this study, the problems came across by China's NEVs industry and countermeasures are discussed. In addition to the problems widely discussed by previous scholars, this paper also focuses on some new problems such as the issue of China's trade war with other countries and China's reliance on technology from other countries for new energy vehicles. While seeing China's growing industrial level, foreign blockades of automation technology and China's own shortcomings in materials science cannot be ignored. In the long term, innovative energy technologies and the automation industry including pure electric fuel and fully automated factory with efficient production are the ideal directions for the future [2]. In the short term, technology improvements in fuel types such as hydrogen batteries will now be the way forward. Based on precious discussion, this paper will compare different problems now China's NEV industry is being up against and both existing and developing solutions it has [3]. To make it more comprehensive, the advantages and disadvantages of these approaches like introducing the big data and artificial intelligence technologies into NEVs, including the impact of the current environment is discussed and make a prediction of the China's NEV future.

2. Current Situation of NEV Industry in China

The NEVs are mainly composed of pure electric vehicles, plug-in hybrid electric vehicles and fuel tram vehicles. NEVs have become the main direction of energy transformation in the field of transportation due to their environmental friendliness and higher efficiency of energy use. China has a huge market potential for new energy vehicles, and through statistical analysis, China has a huge market and procurement volume. As of 2016, there were more than 146 million private cars in China being registered. At present, there are 49 cities in China with over 1 million cars, of which 18 are cities with over 2 million cars. These cities are Ningbo, Foshan, Shanghai, Shenzhen, Beijing, Dongguan, Shijiazhuang, Chongqing, Nanjing, Qingdao, Guangzhou, Wuhan, Hangzhou, Xi 'an, Zhengzhou, Tianjin and Suzhou. These cities have a relatively large population density and a lot of travel demand. Under the general trend of energy conservation and emission reduction, these cities will become the vanguard of the NEV industry's progression and lay the foundation for further growth in the future. In this context, according to the statistics of the China Electric Vehicle Charging Infrastructure Promotion Alliance, as of the beginning of 2024, the total number of public electric piles reported in China was 2.726 million. Among these public charging piles, there are 1.203 million direct current charging piles, 1.523 million alternating current charging piles, and nearly 6 million private charging facilities [4]. At present, in the central and eastern parts of the country concentrate most of the China's charging facilities. By the end of February 2024, the public charging pile facilities built in Sichuan, Henan, Beijing, Anhui, Shandong, Guangdong, Zhejiang, Jiangsu, Shanghai, Shandong, Hubei and other places accounted for 71% of the country's total, which was related to electric vehicle charging facilities. Based on this premise, the Chinese government is focusing on supporting new energy automobile enterprises through technology introduction and tax policies.

According to statistics, around the globe, there were 1,089 hydrogen refueling stations until October, 2023, of which China had built more than 376 hydrogen refueling stations and operated 352 hydrogen refueling stations, accounting for 34.5% of the global total [5]. Although the number of hydrogen refueling stations in China ranks first in the world and is also the country with the largest number of hydrogen refueling stations in the world, the situation of China's hydrogen refueling stations is similar to that of new energy vehicle charging facilities, which is reflected in the uneven distribution of hydrogen refueling stations, mainly concentrated in the Yangtze River Delta, the Pearl River Delta and the Beijing-Tianjin-Hebei region. China's hydrogen energy industry shows a trend of collective development, and the development speed is fast. At present, due to the slow construction of relevant infrastructure, the promotion and application of hydrogen energy vehicles are limited. In addition, the calorific value of hydrogen is larger. As an unstable and explosive fuel, the transportation

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and storage of hydrogen is also a major problem, requiring more capital costs [5]. As a result, there is still much room for amelioration in fuel cell technology and hydrogen production and storage technology.

The technical challenges have consistently posed a central issue for new energy vehicles; their fundamental technologies encompass power lithium batteries, motors, and electric control systems. A crucial measure for assessing vehicle excellence lies in its driving range. Among these key technologies, power lithium batteries serve as determinants for this aspect by virtue of being primary sources for propelling new energy vehicles forward. Simultaneously influencing both cost considerations and overall vehicular safety aspects, this technology has undergone continuous innovation over recent years emerging as a focal point. The lithium ion batteries are a crucial part that consumers scrutinize prior to purchase a factor that directly impacts developments within the burgeoning sector of new energy automobiles worldwide. Especially with regard to lithium batteries; Global car companies are still working on advanced battery technology. Many new energy vehicle companies have established special facilities to focus on research and development of these important components. Corresponding to industrial development, China has also issued relevant policies to support industry. Energy saving, emission reduction and environmental protection have become the mainstream trend [5]. In order to lessen the air contamination, the Chinese government has established policies including carbon quota policies, credit management policies and fuel consumption regulations to limit emissions. The carbon quota policies are used to ensure that all industrial production will not increase carbon emissions by limiting the amount of carbon they can produce. The policy encourages companies to take various measures to meet the carbon quota, such as planting trees or, more importantly, switching to new energy vehicles.

3. Challenges in China's NEV Industry

3.1. The Limited Driving Range of NEV

Recently, the range of pure electric cars has significantly increased, but it still cannot meet the needs of users for long-distance travel. The results are shown in Figure 1.

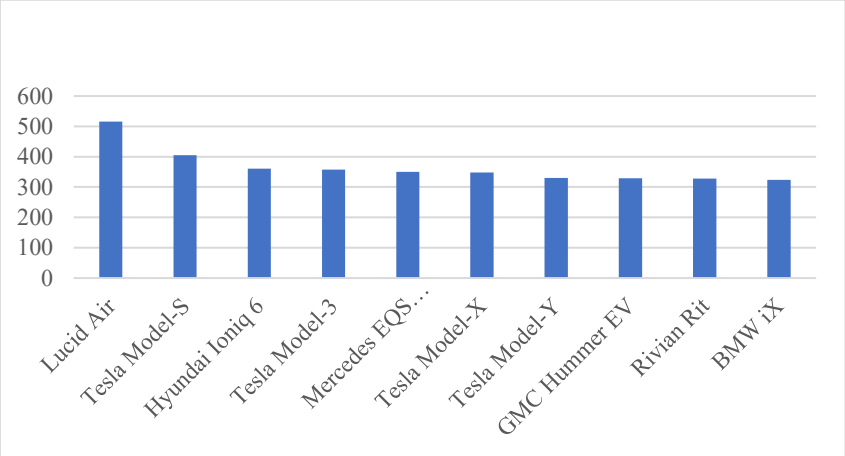

Figure 1: Longest driving range of NEVs in 2023.

Many companies have adopted special designs to compensate for this. For example, Tesla uses a single-pedal mode to enhance range performance. Driving range has also become a major concern for consumers when purchasing new energy vehicles. This is primarily due to limitations in battery energy density, battery management systems, and charging speed. The range of most traditional fuel vehicles is generally 300 to 400 miles, and the longer range of fuel family vehicles is as high as 745

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miles, which is still far greater than that of NEVs. The endurance capacity of NEVs is a bit inaccurate, that often the actual mileage is less than the mileage marked by the manufacturer, coupled with the limited distribution of charging piles. Thus, fuel vehicles are still the first choice to meet consumers' long-distance travel.

3.2. Inadequate Charging Infrastructure

Statistics show that by early 2024, China reached 8.86 million of the charging facilities, a big increase of 63.7% compare to previous year, with a year-on-year increase of 26.6%. There are 2.458 million private charging piles, and 929,000 public charging piles, increased by 42.7% compared to last year [6]. Currently, the development of charging infrastructure for NEVs is inadequate and unevenly distributed, with a concentration in coastal areas and a sparse distribution in the northwest. In some key transportation routes in the northwest, the severe shortage of charging piles exacerbates the insufficient range issue of pure electric vehicles. This also leads to significant resistance in promoting new energy vehicles in the northwest region. Moreover, the inadequacy of charging piles may lead to a decline in the user experience of electric vehicle owners, further affecting consumer purchasing desire.

3.3. Intensive Competition

As of 2024, the number of companies related to the new energy vehicle industry in China has reached 926,800. This signifies the rapid development and expansion of China's NEV market, but it also indicates intensified competition within the industry. This increased competition will indirectly affect the production of new energy vehicles.

The production and maintenance costs of NEVs are relatively higher compared to traditional gasoline vehicles. A significant amount of funding is required for the research and development of their core technologies. Additionally, foreign technology blockades on China further increase the acquisition costs of NEVs, thereby limiting market expansion. The cost of the power system in NEVs accounts for 70% of the total vehicle cost, with lithium battery prices having a significant impact on the overall cost due to the price of raw materials [7]. To compete with traditional gasoline vehicles, the price of NEVs will become one of the decisive factors.

4. Current Solutions to the Challenges

The Chinese government has established "plan-pilot-promotion-subsidy-development" policy for NEVs [8]. In the development process of new energy vehicles, government subsidies and incentives are extremely important. This is also reflected in the coherence of markets and policies. However, relying only on government subsidies cannot promote the sustainable development of new energy vehicles. The NEV industry should increase the role of the market rather than relying on the government for a long time. The company should focus on and solve the practical problems of consumers in the use of new energy vehicles, provide more diversified and perfect services, more compatible charging facilities and after-sales solutions.

As the core energy source of new energy vehicles and electronic products, the characteristics of power lithium battery storage and charging are directly reflected in the performance and service life of lithium battery. Lithium battery storage generally uses a special charging pile, because non-standard charging such as oversaturation will cause damage to the lithium battery. Generally, it is necessary to test the total capacity retention rate of the battery after 2.5 hours of charging, that is, after the battery is fully charged, its capacity can return to 100 percent [9]. At present, the charge and discharge test of lithium battery pack is usually carried out in two ways: constant current - constant voltage (CC/CV) charging and constant-current (CC) discharge. This step is very critical to detect the

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storage efficiency and endurance of the battery that limited by the speed of lithium ions to pass through electrolyte to reach electrode [10]. The insufficient retention rate of lithium batteries after overcharging is one of the main reasons for the insufficient battery life of new energy vehicles and even electronic devices that also use lithium batteries.

What's more, when the long-term use of lithium batteries in new energy vehicles leads the health of its batteries to decay to a certain extent, and the retention rate of lithium batteries is not enough to support its continued use in new energy vehicles, how to deal with discarded lithium batteries has become a big problem. At present, there is no way to properly recycle lithium batteries, and directly discarding lithium batteries with a low retention rate will also lead to energy waste and environmental damage, which not only deviates from the original intention of new energy vehicles to protect the environment, but also increases the maintenance cost of consumers for new energy vehicles and reduces their desire of consumption. In this context, the safety of power lithium batteries is also a big problem, mainly reflected in the face of harsh environments or vehicle accidents, power lithium batteries can continue to play a role. Currently, the main solution is to carry out safety testing on the battery, such as acupuncture test, salt spray test, extreme temperature, wet environment, and low-voltage electrical stability test and crash test. Through these tests to determine whether the lithium battery will cause structural problems due to strong impact, performance degradation or even more serious, leading to fire.

Now China's new energy vehicles are booming, but there are still many problems waiting to be overcome in lithium batteries. Compared with continuously improving the performance of lithium batteries, it is also very important to break through the material science of batteries. New energy power battery companies can try to use new materials to manufacture batteries to extend the service life of batteries. For example, graphene batteries are a choice, which have higher charging efficiency and nearly four times longer service life than lithium batteries. At present, many companies have begun to apply graphene batteries in cars.

5. Conclusion

The development of new energy has become more and more crucial. NEVs have gradually become the main means of travel for people, to a certain extent, the development of new energy vehicles reflects the comprehensive national strength of today's countries. There are many problems and deficiencies in the development process of China's NEV under the game of great powers. This paper reviews and examines the recent background and progress of the NEV industry. The development is driven by environmental protection, energy conservation, and emission reduction policies such as the "dual carbon" targets, with government support provided through tax incentives and other measures.

At the same time, China has a huge market and potential consumers for new energy vehicles. Despite the strong support of the government and the huge market, the industry still faces technical problems such as unreasonable distribution of charging facilities, poor endurance, and short battery life. In the competition in the domestic market, China's NEV enterprises are fiercely competitive, which indirectly leads to the quality problems of NEVs, and also easily causes the loss of customer groups. Under the premise of foreign blockade of new energy technology and chip technology, the manufacturing and technology costs of new energy vehicles continue to rise, and the competitiveness of new energy vehicles is constantly weakened.

This paper discusses the current solutions adopted by Chinese NEV companies, including innovation and research on lithium battery technology and safety. The paper discusses the "plan-pilot-promotion-subsidy-development" policy of new energy vehicles developed by the Chinese government, and points out the shortcomings of the solutions. NEV companies could not completely rely on government support and subsidies, which they should pay attention to and solve the actual problems of consumers, improve product quality and improve after-sales service. New energy vehicle

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power batteries also need to make breakthroughs in material science, such as longer life graphene batteries. In the face of many difficulties, China's NEV industry is booming, but there are still some problems to be broken through.

This paper still has some shortcomings. Some of the data involves the business secrets of enterprises, such as the specific structure of the power lithium battery of each new energy vehicle company, which cannot be comprehensively analyzed. In addition, the reform suggestions for the battery materials of new energy vehicles may not be actually in place. Meanwhile, it lacks the latest statistics on the number of charging piles in China, and detailed suggestions on the distribution of charging facilities are not yet provided. Future research could complement discussions on NEV power battery materials and refine recommendations for consumers.

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