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The Impact of Charging Infrastructure on the Promotion of New Energy Vehicles

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Abstract: In the context of the current situation, with the rapid development and expansion of new energy vehicles, the accompanying charging equipment industry has also experienced significant growth. The construction and operation of charging infrastructure play a crucial role in the promotion and development of new energy vehicles. However, the charging facility industry also faces certain challenges. From a holistic perspective, the lagging development of the charging infrastructure industry hinders the growth of new energy vehicles. Simultaneously, it greatly influences the execution and development of China's long-term energy-saving and environmental protection strategies. Therefore, this paper first proposes the research questions to be explored. By analyzing the current status of the development of charging infrastructure for new energy vehicles and considering practical needs, scientific development trends and solutions are formulated. This aims to promote the healthy development of the industry and pave a new path for the growth of the charging infrastructure for new energy vehicles. Additionally, an analysis of the main factors influencing individual users' decisions to purchase or not to purchase new energy vehicles in China, along with policy recommendations aligned with the country's vigorous promotion of new energy vehicles, emphasizes the importance and urgency of charging infrastructure. The ultimate goal is to foster a healthier development of new energy vehicles in China.

1. Introduction

As the most widely used means of transportation, automobiles consume a significant amount of finite resources. Electric vehicles (EVs) were first designed by engineers in the early 20th century. However, due to technological limitations at the time, they did not gain widespread popularity. Currently, an increasing number of countries recognize the importance of replacing traditional fossil fuel vehicles with new energy vehicles and have made plans for their development. The extent to which new energy vehicles can be developed depends largely on the acceptance by the market, with individual car users being the key representative of the market.

2. Relevant Policies on New Energy Vehicles in China

In 2001, China initiated the "863 Program" major project for electric vehicles, which clearly

prioritized the development of new energy vehicle technology. The program identified pure electric vehicles, hybrid electric vehicles, and fuel cell vehicles as the "Three Verticals" and powertrain systems, drive motors, and power batteries as the "Three Horizontals" for research and development layout. From 2009 to 2013, the Chinese government organized the "Ten Cities, Thousand Vehicles" energy-saving and new energy vehicle demonstration projects. The promotion of EVs in 25 pilot cities amounted to only 39,000 vehicles, including a portion of hybrid electric energy-saving vehicles. Among these pilot cities, only about half achieved a completion rate exceeding 50%, indicating less than satisfactory demonstration results. After summarizing the experience of new energy vehicle development, the Chinese government released several policies in 2014, such as the "Notice on Exemption of Vehicle Purchase Tax for New Energy Vehicles," the "Notice on Financial Support Policies for the Promotion and Application of New Energy Vehicles from 2016 to 2020," and the "Notice on Electric Vehicle Electricity Pricing Policy Issues." These policies aimed to encourage private users to purchase new energy vehicles through measures like vehicle subsidies and tax exemptions.

3. Major Factors Influencing Individual Users' Purchase of New Energy Vehicles

3.1 Cost Factors

Most new energy vehicles primarily use electricity, which offers a significant price advantage compared to traditional fossil fuel vehicles. The cost of electricity required per kilometer is even less than one-third of that for conventional vehicles, resulting in a significant reduction in direct operating costs for individual users. Moreover, electric vehicles eliminate the need for an internal combustion engine, simplifying the vehicle's structure and substantially reducing maintenance costs. Additionally, in congested traffic, traditional fuel-powered vehicles have poor fuel economy during low-speed driving, making it challenging to maintain an economical speed for an extended period on urban roads. In contrast, new energy vehicles are less affected by traffic congestion, leading to significantly reduced energy consumption [1].

3.2 Policy Factors

In cities with heavy traffic congestion, such as Beijing and Shanghai, measures such as license plate restrictions have been implemented as urban governance measures. This restricts the registration and usage of conventional vehicles, making it challenging to meet the growing demand of individual users. In contrast, there are no such restrictions on the purchase of new energy vehicles by individual users. Moreover, new energy vehicles enjoy tax exemptions and reductions in the majority of provinces and cities nationwide. Manufacturers also receive substantial government subsidies, making new energy vehicles more accessible to the general public.

3.3 Strong Technological Appeal

Electric vehicles have instant acceleration without any delay. Under constant power conditions, the torque determines a vehicle's acceleration performance. Electric motors deliver a strong initial burst of power, providing maximum torque from the start. In contrast, traditional internal combustion engines require a startup process, and torque gradually increases with rising speed until reaching maximum torque, after which it decreases relatively slowly. Electric new energy vehicles generally exhibit fast acceleration, meeting the performance expectations of some individual users.

New energy vehicles based on electric power often incorporate more high-tech elements and intelligent features. They often integrate with the Internet of Things, providing a sense of

technological advancement that attracts a large group of loyal individual users.

4. Main Factors Why Individual Users Choose Not to Purchase New Energy Vehicles

4.1 Insufficient Charging Infrastructure

Currently, there is a severe lack of public charging infrastructure in most cities. Charging stations are often remote and scarce, leading to long queues during peak charging periods. Moreover, the time required for a single charge is far longer compared to refueling a traditional vehicle. The policies supporting the development of new energy vehicle charging infrastructure in cities are also inadequate. The construction of charging stations and charging piles often requires multiple approvals from property management, fire departments, city authorities, and property owners, resulting in lengthy approval processes and unclear outcomes. This discourages social investors from entering this sector [2].

4.2 Inadequate Range to Meet Harsh Operating Conditions

Harsh operating conditions generally refer to long-distance driving and driving in adverse weather conditions. During long-distance trips, the displayed range of new energy vehicles often does not match the actual range, leading to range anxiety and the risk of running out of power during the journey. This is particularly risky on highways and can pose significant safety hazards. In winter, electric new energy vehicle batteries have limitations due to low temperatures. Even with a full charge, it is challenging to achieve the ideal operating conditions, resulting in a rapid decrease in range. In summer, the use of air conditioning during the journey significantly depletes the battery's energy, further reducing the already limited range, as personal users prioritize comfort.

4.3 Unpredictable Maintenance Costs

In the initial usage period, new energy vehicles do have lower electricity costs compared to fuel-powered vehicles. However, due to technological constraints, the lifespan of the battery is quite limited. After a few years, the cost of replacing the battery pack can reach tens of thousands of dollars, which is comparable to the price of an economy-class traditional fuel-powered car. This cost is often difficult for individual users to understand and accept.

5. Analysis of the Impact of Charging Infrastructure on the Development of New Energy Vehicles

Firstly, new energy vehicles require the support of charging infrastructure. The biggest difference between new energy vehicles and traditional vehicles lies in their energy source. Traditional vehicles primarily rely on the conversion of thermal energy to mechanical energy, while new energy vehicles are driven solely by electric power. Therefore, new energy vehicles require more frequent and efficient charging services than traditional vehicles. Without well-established charging infrastructure, the widespread acceptance and popularity of new energy vehicles may be hindered. Furthermore, the construction and improvement of charging infrastructure can provide more convenient charging services to new energy vehicle users, enhance the user experience, and further boost people's confidence in purchasing these vehicles [3].

Secondly, the current status and issues of charging infrastructure construction. China's new energy vehicle market has developed rapidly and has become the world's largest market for new energy vehicles. However, the lag in charging infrastructure construction has become a crucial

factor restricting the development of new energy vehicles. As of the end of 2021, there were approximately 1.19 million charging piles for new energy vehicles in China, with an average of only 0.5 charging piles per vehicle. The shortage of charging facilities, particularly in major cities like Beijing, is a prominent issue. Additionally, there are various problems related to the construction and operation of charging infrastructure, such as unreasonable planning of charging piles, high costs of establishing charging piles, and the maintenance and upkeep of charging facilities.

Lastly, the impact of charging infrastructure on the development of new energy vehicles. The level of charging infrastructure construction is one of the bottlenecks restricting the development of new energy vehicles. However, accelerating the construction of charging infrastructure can unlock the development potential of new energy vehicles. The improvement of charging infrastructure can lower the barriers to vehicle ownership, further promoting the popularization of new energy vehicles. Moreover, the lower operating costs of new energy vehicles compared to traditional vehicles create increased market demand for charging infrastructure investment and construction. From another perspective, the construction of charging infrastructure will also drive the development of new industry chains, including manufacturing, operation, and maintenance of charging piles. The growth of these industries will further strengthen the competitiveness and market position of the new energy vehicle industry.

6. The Importance of Charging Infrastructure for the Development of New Energy Vehicles

There is no doubt that the development of new energy vehicles has garnered high attention from countries worldwide. In particular, for China's transition from being a major automobile country to becoming an automotive powerhouse, the development of new energy vehicles represents a shortcut for overtaking competitors. Although there is still a pressing need to improve core technologies such as batteries and fast charging in the development of new energy vehicles, the most urgent issue currently is the construction of charging infrastructure. Only through widespread and extensive deployment of charging infrastructure can new energy vehicles attract more individual users, as this is the primary bottleneck for the development of new energy vehicles.

According to data from the Ministry of Industry and Information Technology, China is expected to have 12,000 charging stations and 4.5 million charging piles by 2020. However, based on data from January 2015, there were only around 700 charging stations and 28,000 charging piles nationwide. The construction of charging infrastructure within a five-year timeframe is still a considerable challenge. Measures such as breaking the monopoly of the power sector, attracting private capital, providing subsidies for charging infrastructure construction, and removing barriers to its development have formed a broad consensus [4].

7. Trends in the Development of New Energy Vehicle Charging Infrastructure

7.1 Increased Intelligence of Charging Stations

Currently, charging stations still rely on manual services, leading to issues such as queues during peak periods. This has a significant impact on vehicle owners, especially considering the longer charging time for electric vehicles. To address this, it is necessary to follow a development path guided by scientific theories and explore the real-time deployment of nearby charging stations using mobile apps. By avoiding peak hours and adopting scientific usage practices, personalized development paths can be demonstrated. Standardizing charging infrastructure and improving its utilization rate is crucial. Collaboration between various companies' apps and mapping/navigation services such as Baidu Maps and Gaode Navigation can expand the scope of operations, allowing consumers to easily find available charging facilities. Additionally, multiple collaborations can

accelerate the deployment of home charging stations, incorporating them into the planning of power distribution networks and parking areas.

7.2 The charging infrastructure industry has entered the second stage

Transition from Reconstruction to Operation Focus for Charging Stations Based on the market demand in 2020, policy subsidies have gradually been phased out. The development of the charging infrastructure industry has entered the second stage, which requires implementation in reverse toward market-oriented development under the guidance of national policies. Most assets are still in the exploratory stage, providing advantages for future development. The main goal of the charging infrastructure industry's development is to expand scale and seize subsidy resources based on the concept of scientific development. This second transformation aims to explore more profitable models, such as selling car insurance or advertising through charging stations.

7.3 Diverse Approaches to Addressing Land Resource Issues and Enhancing Policy Support Systems

Different cities have abundant land resources in new urban areas that can be directly utilized for charging infrastructure. Scientific planning can present cheaper areas to ensure the affordability for charging companies. Additionally, charging stations can be added to existing gas stations to reduce initial capital requirements. It is essential to improve policy support systems and promote the healthy development of the industry. Attention should be given to private charging stations, clarifying the development direction, accelerating technological upgrades, and enhancing independent innovation capabilities. Active development of standards should be pursued to facilitate the healthy development of the charging infrastructure industry.

7.4 Diversified Payment Methods for Convenience and Efficiency

Charging companies should incorporate various third-party payment systems, such as Alipay and WeChat Pay, while maintaining existing payment methods. This approach can enhance efficiency, reduce costs, and facilitate the extension toward intelligent operations. Through multi-party collaboration, the realization of a unified card system can be achieved to improve the utilization efficiency of profitable charging facilities.

8. Conclusion

The development and nurturing of the Chinese new energy vehicle market require increased participation from individual users. The rapid construction of charging infrastructure can best promote the development of this industry. Only when more individual users have convenient access to charging facilities can the sales of new energy vehicles continue to grow rapidly. This, in turn, will compel more companies to engage in research, development, and design of new energy vehicles, ultimately allowing China to achieve a significant advantage in this field and transform from being a major automobile country to an automotive powerhouse.

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