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Development Path and Model Design of a New Energy Vehicle in China

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Abstract: China has developed a preliminary policy system for the development of new energy vehicles regarding the law, electricity price, grid-connected standards, project management, and financial support, however, defects remain in the policy and market environment, market mechanism, control technology, infrastructure, etc. We analyze new energy vehicles based on the analysis of basic data such as the number of electric vehicles and charging facilities, focusing on industrial development strategies, related subsidies, and tax policies. First, this paper summarizes the development status of China's new energy vehicles in different scenarios. In 2021, China's new energy vehicle production was 3545 thousand, and sales amounted to 3521 thousand. According to preliminary estimates, the number of new energy vehicles will exceed 15 million in 2030. The research route for the development of new energy vehicle bottlenecks is proposed. Secondly, we analyze foreign and Chinese policies on different stages and construct the implementation path for the healthy and stable development of China's new energy vehicles. By comparing the basic indicators, related policies, and related innovation activities of new energy vehicles in China, we conclude that the development of the national electric vehicle industry needs to be increased in terms of government policies, business model innovation, and public awareness.

Keywords: new energy vehicle; industry status; development obstacle; development model design



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1. Introduction

Fuel vehicles play an important role in transportation because of their endurance [1]. Due to the rapid increase in resource demand and the increasingly serious air pollution caused by fuel vehicles, the speed of development of fuel vehicles is limited [2]. Thus far, many countries have announced that they intend to stop selling fuel vehicles between 2025 and 2030 [3]. For example, the UK decided to ban the sale of fuel vehicles in 2030, while Norway plans to ban the sale of fuel vehicles in 2025. Under the goal of “peak carbon dioxide emissions and carbon neutrality”, many countries have formulated the time nodes for the transition from traditional fuel vehicles to new energy vehicles [4]. In recent years, China's new energy vehicles have developed rapidly, but there are still some obstacles because they are still a relatively new technology [5]. Therefore, this paper combines the advantages of new energy vehicles such as low emissions and adjustability, to design a development model from the perspective of policy, commerce, and technology. China's new energy vehicles include electric vehicles, plug-in hybrid electric vehicles, and fuel cell electric vehicles. With the promotion of the policy, the production and sales of new energy vehicles are increasing gradually. However, the scale effect of standardized production, quality control, and cost control of new energy vehicles must be improved.

In the power market environment, the charging and discharging of electric vehicles can meet the demand and provide auxiliary services such as peak shaving, frequency modulation, and rotating standby, which can improve the safety and reliability of the system, reduce system operating costs, etc. [6–9]. The demand response (DR) of electric vehicles

is mainly divided into the price-based demand response and incentive-based demand response [10]. An orderly charge control method for electric vehicle charging stations based on a dynamic time-sharing price has been proposed [11,12]. The electricity price mechanism considering the volatility factor proposes a DR strategy for the schedulable load and the electric vehicle cluster load, which can stabilize the load fluctuation of the system [13]. The real-time electricity price model of the electric vehicle cluster response has been established, and the charging behavior of large-scale electric vehicles can be guided in an orderly manner through real-time electricity prices. Frequent changes in electricity prices will lose the guiding effect on users [14]. Lingfei Qi et al. (2020) focused on a novel mechanical and electrical dual-pathway braking energy recovery system (BERS) based on coil springs for energy-saving applications in electric vehicles [15]. Ying Hao et al. (2020) proposed an extended power-forecasting-based coordination dispatch method for a PV power generation microgrid with plug-in electric vehicles to improve the local consumption of renewable energy in the microgrid by guiding the orderly charging of electric vehicles [16].

Demand-response price-guided charging and discharging behavior has become a new model for the development of new energy vehicles [17]. In addition, the emission reduction effect of electric vehicles has also received extensive attention. The charging and discharging scheduling model of electric vehicles based on demand-side discharge bidding is proposed for the purpose of peak filling. An automatic demand response method for electric vehicle charging and discharging has been proposed, which is coordinated on both sides of the power system's supply and demand [18,19]. A distribution model based on the charging characteristics of electric vehicles was set up, and the proposed optimization algorithm reduces losses and improves the power supply and quality of the system [20]. Shi Xiaoqing et al. (2014) used life cycle theory in their study. An improved fuel emissions model of a pure electric vehicle was set up, and the simulation results showed that it had great emission-reduction potential [21]. Dai Z. et al. (2022) and Bai, S. et al. (2022) analyzed the energy consumption and emissions of electric vehicles and traditional vehicles, and the simulation results showed that electric vehicles could save energy and reduce emissions [22,23]. Tan Zhongfu et al. (2013) considered the influence of the thermal power structure and line loss rate on average coal consumption, and established a model for the energy-saving and emission-reduction potential of electric vehicles [24]. Brady et al. (2011) considered many factors, such as oil prices, national policy, and the development of electric vehicle technology, and applied a logistics curve to simulate the emissions of electric vehicles for different situations, and the results showed that electric vehicles could effectively reduce carbon dioxide emissions [25]. Integrated operational planning of hydrothermal power and natural gas systems with large-scale storage was set up, and the economics of the system was analyzed [26,27].

The influencing factors of the development of new energy vehicles involve policies, markets, technologies, and other aspects. Ramadhani et al. (2020) proposed state-of-the-art approaches to each of these components. They were discussed comprehensively, including suggestions for preferred modeling methods specifically for distribution systems with PV generation and electric vehicle charging [28]. Secinaro et al. (2020) focused on business model decisions for charging technologies, driver services, electricity management, commercial contracts, and plants [29]. Jun Yang et al. (2020) proposed a novel analytic framework for the charging demand of electric vehicles, which considers charging demand to be primarily determined by travel behavior [30]. Lefeng et al. (2020) measured the substitution rate of sharing electric vehicles to urban internal combustion vehicles (ICVs), in which the substitution rates of the two typical sharing modes, i.e., self-service electric vehicles and ride-sourcing electric vehicles, were measured separately [31]. Akinlab et al. (2020) investigated and reviewed air-cooled BTMS techniques (passive and active) and design parameter optimization methods (either via iteration or algorithms) for improving various BTMS design objectives [32].

According to the literature review, the research on the development mode of new energy electric vehicles in China needs to be deepened. The advantages and disadvantages of new energy vehicles need to be analyzed from many perspectives. Moreover, the problems faced by the development of new energy vehicles have not been effectively solved. Therefore, this paper investigates the status of China's new energy development for electric vehicles and the development of electric vehicles based on different scenarios. Notably, in order to promote the development of new energy vehicles, China launched policies supporting infrastructure construction, the introduction of social capital, new energy cost concessions, and R&D (research and development) investment in new energy vehicles. The main innovation and contribution of this study is that the advantages and disadvantages of the development of new energy vehicles are analyzed from the perspective of policies, markets, and other aspects, which improves the competitiveness of the development of new energy vehicles. The development mode of new energy vehicles is also designed, not only using the policy mechanism, but also the business model and technical support, which solves the key problems faced by new energy vehicles.

In this paper, we will first provide a comprehensive review of the concept, characteristics, and framework of new energy vehicles in China. This paper is organized as follows. Section 2 describes the current development status of new energy vehicles and the subindustry. New energy vehicles have just been implemented in China and are still affected by many factors. Based on this, Section 3 introduces the obstacles to and advantages of the development of new energy vehicles in detail. Due to the high cost, low performance, battery recycling, and other major influencing factors of new energy vehicles, new energy vehicles have been unable to be introduced into the market quickly. Section 4 focuses on the related obstacles presented in the development process of new energy vehicles, and presents a new energy vehicle development model, which includes the policy framework, business model design, and technical support. Finally, the research prospects and main technical challenges of new energy vehicles are discussed in Section 5.

2. Current Development Status of New Energy Vehicles

2.1. Analysis of the Development Path

At present, there are few studies on the differences in market performance between newcomers and incumbents from the perspective of business models. However, the research on the business model of the electric vehicle industry tends to find suitable business models at the industrial level, and pays more attention to product power supplement methods and content such as sales methods. New energy vehicles are powered by clean energy. The power battery is the core component and the most critical part of the new energy vehicle industry chain. Figure 1 illustrates the new energy vehicle industry chain. Figure 2 illustrates the traditional automobile industry chain.

Compared with traditional vehicles, new energy vehicles increase the production of raw materials, batteries, and motors in the industrial chain; however, the cost of new energy vehicles restricts the expansion of their market. Plug-in hybrid electric vehicles are a strategy choice for the medium-term industrialization of China. The key technologies, such as the fuel cells and batteries, will be further researched and developed. If a breakthrough is achieved, it will increase the speed of the industrialization of fuel cell vehicles and electric vehicles. For the battery, motor, electronic control, and other key technologies, China will construct an infrastructure platform and integrated demonstration platform on the basis of science and system integration; through the platform, construction will gradually enhance the R&D of new energy vehicles' industrialization [33].

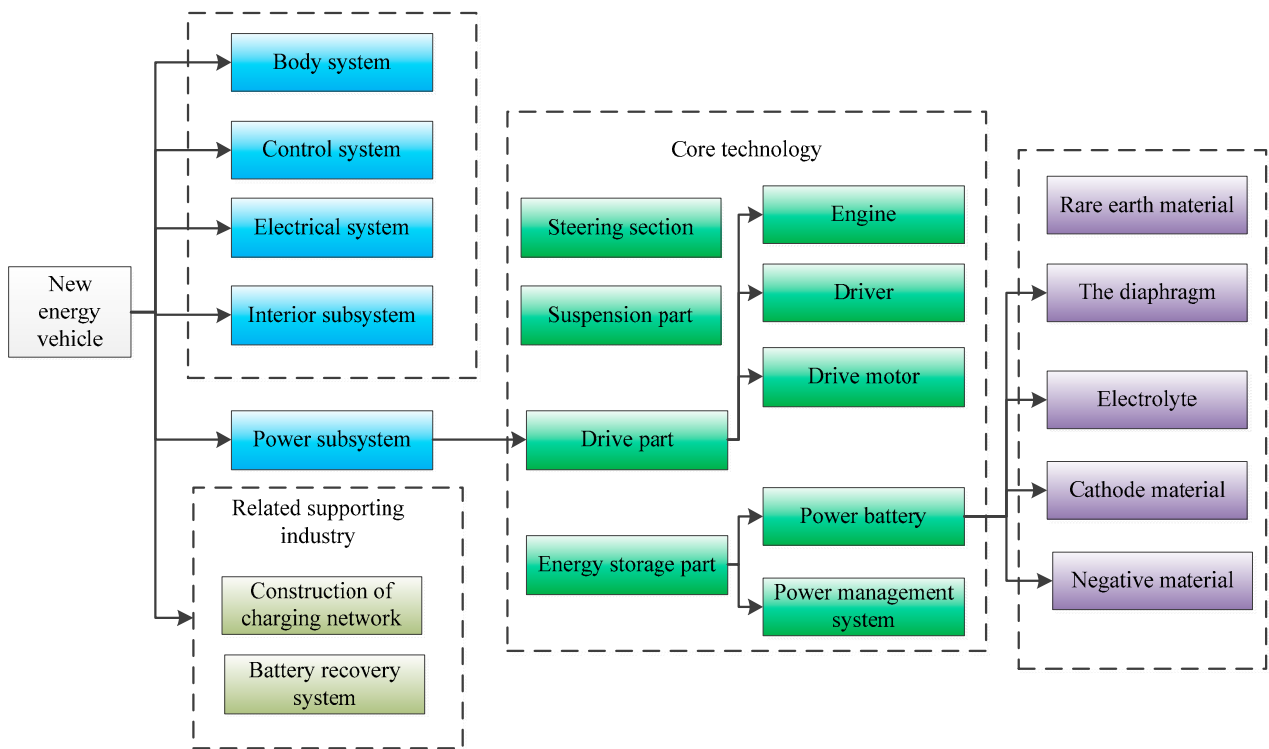


Figure 1. New energy vehicle industry chain.

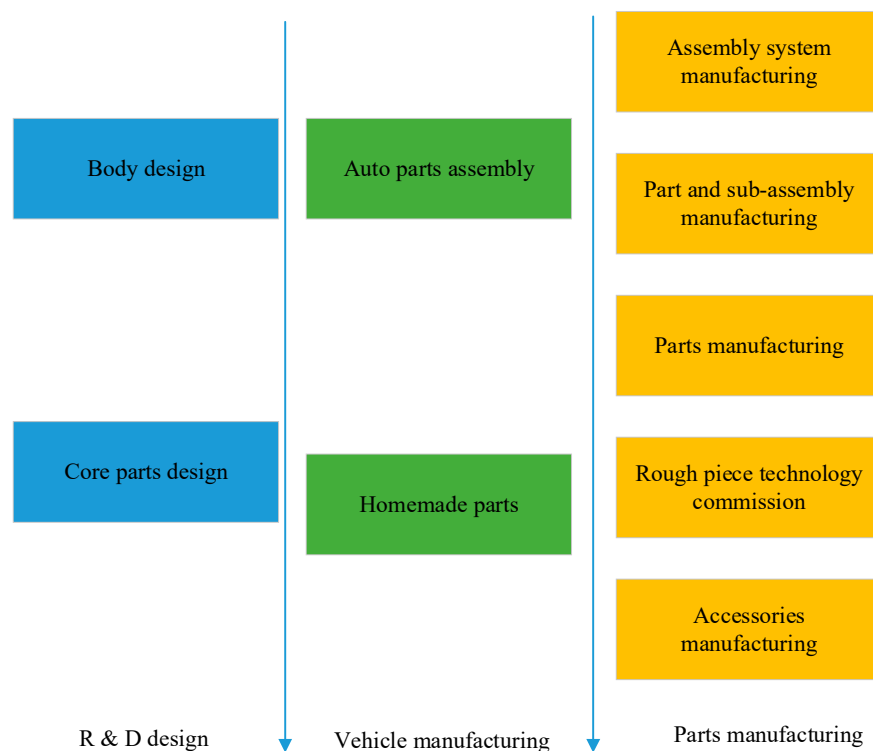


Figure 2. Traditional automobile industry chain.

2.2. Development Status of the Industry

2.2.1. Energy Consumption in the Field of Transportation

According to data released by the Statistics Bureau, in 2020 the energy consumption of China’s transportation field was 413.09 million tons of standard coal, accounting for 8.29% of total energy consumption. Figure 3 presents China’s 2011–2020 energy consumption in the transportation field [34].

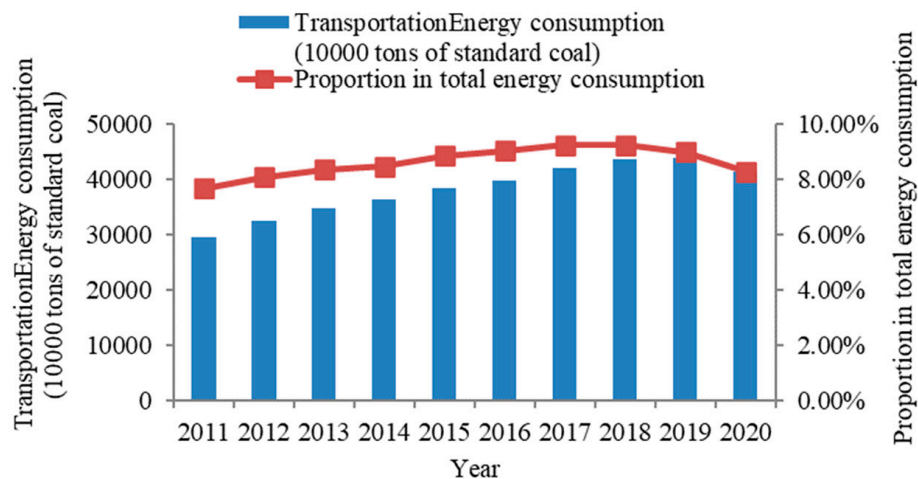


Figure 3. Energy consumption in the transportation sector, 2011–2020 (data source: China Statistical Yearbook 2021).

2.2.2. Current Status of Production of New Energy Vehicles

With the rapid development of China’s economy and the release of multiple policies that promote the new energy vehicle industry, China’s vehicle production and sales have achieved rapid growth. Figure 4 shows the current situation of vehicle production and sales in China [34]. Regarding industrial production, the production capacity increased from 18.41 million in 2011 to 25.67 million in 2019, an increase of 39.4%. Regarding the industrial sales, the sales capacity increased from 19.17 million in 2011 to 25.51 million in 2019, an increase of 33.04%.

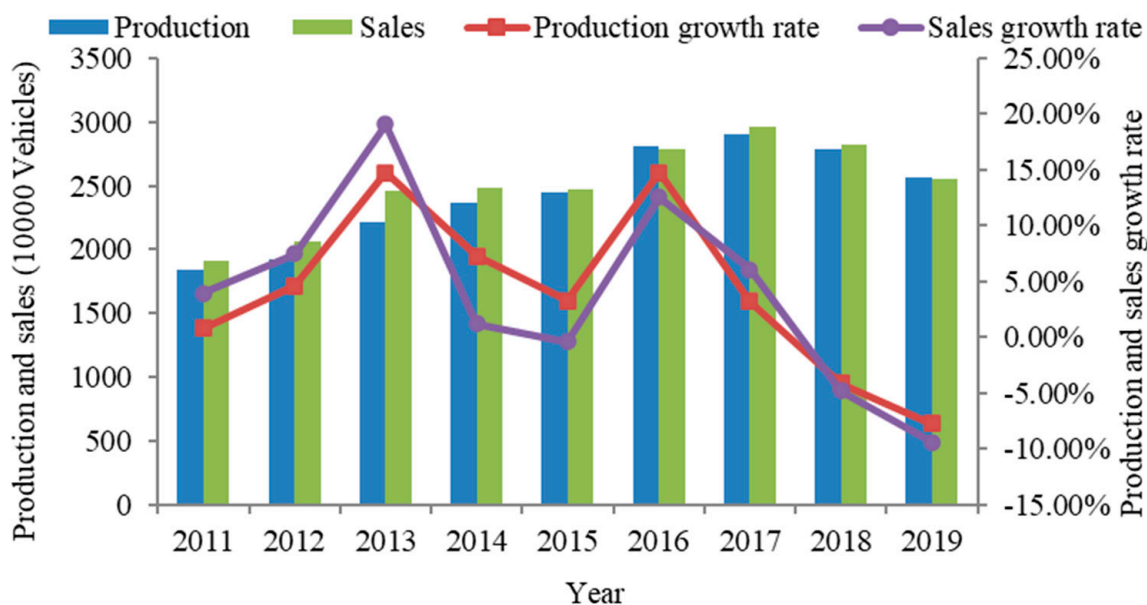


Figure 4. Vehicle production and sales in China (data source: China Statistical Yearbook 2021).

In 2021, China's new energy vehicle production was 3545 thousand, and sales amounted to 3521 thousand. According to China's "medium- and long-term development plan for the vehicle industry", the production of new energy vehicles is planned, and three scenarios are proposed. The production forecast is shown in Figure 5 [35].

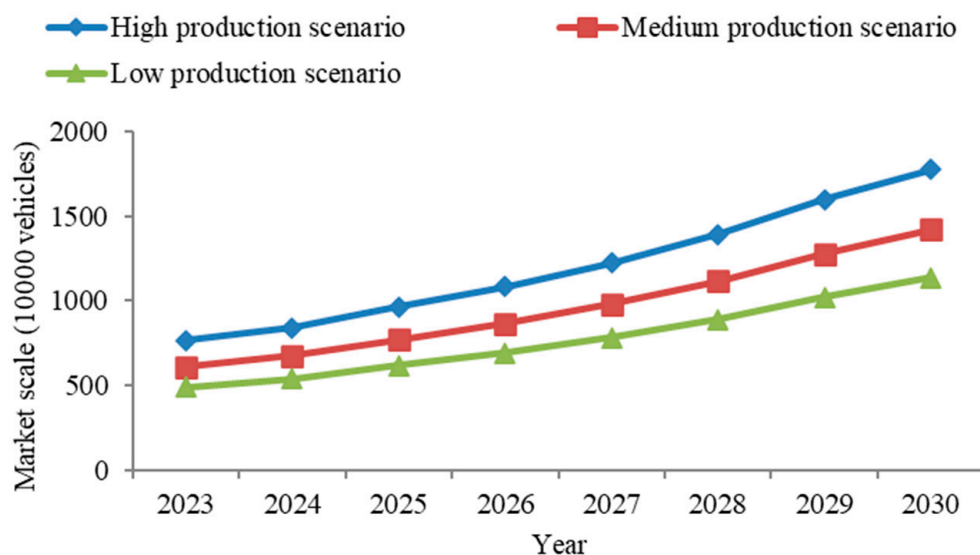


Figure 5. Scale forecast of China's new energy vehicle market (data source: medium- and long-term development plan for the vehicle industry).

2.3. Development Status of the Subindustry

The development of the new energy vehicle industry has a promoting effect on battery enterprises, namely, lithium battery enterprises. At present, the battery and motor of new energy vehicles in China rely on imports. Table 1 introduces the current investment status of the new energy industry chain.

Table 1. The order of investment of different products in the chain of new energy vehicles.

No.	Subindustry	Trade Barriers	Industrial Transfer Space	Demand Elasticity
1	Electrolyte	High	Higher	High
2	Diaphragm	High	Higher	High
3	Whole vehicle	Higher	High	Lower
4	Electrical control system	Higher	High	High
5	Lithium ore resources	Lower	High	Lower
6	Charging stations	Low	Higher	High

Data source: authors.

3. Obstacles to and Advantages of the Development of New Energy Vehicles

3.1. Obstacles to Development

3.1.1. Policy Issues

At present, the Chinese government has adopted financial subsidies and tax incentives to support the development of new energy vehicles. However, the expansion of the scale of new energy vehicles will aggravate the financial burden on the government, distort the market, and cause the loss of social welfare. The benign development of the new energy vehicle industry must introduce private capital into the market.

3.1.2. Basic Issues

The construction of charging stations and recycling of waste batteries are important factors in the development chain of the electric vehicle industry. The battery's cascade utilization and circulation are used to reduce the cost of the vehicle.

(1). The standard of construction infrastructure is not uniform

The new energy vehicle industry chain includes the National Power Grid Corp, vehicle enterprises, and battery enterprises. However, there are differences in the mode of charging, operation, and maintenance. Concerning the mode of charging, the National Power Grid Corp advocates the transferring mode, while other vehicle companies advocate the charging mode. In terms of construction standards, consumers want to adopt the fast-charging mode.

(2). High cost of battery construction

At present, the cost of the batteries accounts for more than half of the total cost of new energy vehicles; thus, reducing the cost of the power batteries is a prerequisite for the popularization and application of new energy vehicles. The fuel density of natural gas, hydrogen, ethanol, methanol, and other fuels is small, and the compression technology is not yet perfect, resulting in a storage risk for new energy vehicle charging stations [36].

3.1.3. Market Issues

At present, the industrialization and scale of the new energy vehicle market in China are insufficient, a good consumption environment has not formed, and there is a gap compared with the United States and Europe. High costs, poor awareness of energy conservation and environmental protection hinder the promotion of new energy vehicles.

3.1.4. Technical Issues

A substantial gap exists in China's new energy vehicle technology and that of foreign countries, such as insufficient R&D on key components, resulting in reliance on foreign enterprises. Regarding the low localization rate, single cells must be purchased from a foreign capital enterprise or Sino-foreign joint ventures.

3.2. Advantages of Development

3.2.1. Policy Advantage

In 2012, China issued the "Energy Saving and New Energy Vehicle Industry Development Plan (2012–2020)", which proposed the goals of the industrialization of the new energy vehicle industry, that is, by 2020, the production capacity of pure electric vehicles and plug-in hybrid electric vehicles should be 2 million vehicles, and the cumulative production and sales more than 5 million vehicles. Before 2015, China issued many policies to promote the development of the new energy vehicle industry, such as the "Energy Saving and New Energy Vehicle Industry Development Plan (2012–2020)"; "Notice on further promoting the promotion and application of new energy vehicles"; and "Guidelines for the development of electric vehicle charging infrastructure" (2015–2020). The policies mainly include vehicle purchase tax relief, government institutions' procurement, the electricity price, and charging infrastructure support [37].

3.2.2. Market Advantage

China's low-speed electric vehicles have similar product technology to its electric vehicles. After further regulation and policy encouragement, this low-speed version will become the run-up device for the growth of related enterprises in the industrial chain. China's high fuel prices and its increasingly serious air pollution problems cause consumers to buy new energy vehicles.

On the one hand, consumers are very sensitive to the higher vehicle costs brought about by the rising oil prices. They prefer relatively cheap electric energy and can also enjoy certain subsidies. The price of gasoline in China increased by CNY0.55/L in 2022. Compared with the gasoline price, the price of electricity is basically stable. Fuel vehicles

need 6 L of gasoline to drive 100 km. The price of gasoline is CNY7.82/L, and the cost is CNY46.9. The new energy vehicle needs 15 kWh to drive 100 km. The charging price is CNY0.88/kWh, and the cost is CNY13.2. For driving 100 km, new energy vehicles save CNY33.7 compared to fuel vehicles.

On the other hand, with the national emphasis on pollution prevention and ecological construction, and the improvement of residents' environmental awareness, consumers will pay more attention to the ecological value of new energy vehicles when they buy them. Because part of the electricity of new energy vehicles comes from wind power and photovoltaic sources, the carbon emissions are reduced. Fuel vehicles will emit about 14 kg of carbon dioxide when driving 100 km.

4. Design of New Energy Vehicle Development Model

Based on the analysis of the development status, disadvantages, and advantages, this study focuses on the design of the development model of new energy vehicles, with some important findings.

4.1. Design of Policy Framework

4.1.1. New Energy Vehicle Manufacturers

China needs to increase the subsidy for plug-in hybrid electric vehicles. The effect of the energy savings and emission reduction of plug-in hybrid electric vehicles is low and should be popularized. The available licenses for plug-in hybrid electric vehicles should be increased. In addition to the existing single-vehicle subsidy, the sales and subsidies should be linked to a certain number of subsidies, in order to promote the popularity of plug-in hybrid electric vehicles.

4.1.2. Charging Facility Market

(1). Expanding the Size of the Charging Facility Market

The sale scale of new energy vehicles in China is expected to reach 8 million in 2023. According to the international general requirements, the ratio of new energy vehicles to charging piles shall be at least 1:1. At present, the ratio of new energy vehicles to charging piles in China is about 3:1. In addition to expanding the market scale of new energy vehicles, it is also necessary to strengthen the construction of charging facilities. The Chinese government has liberalized the construction of urban charging piles. Due to the attraction of the market, the expectation is that private enterprises will dominate. Local governments have launched policies on the development of charging piles and set up relevant construction plans. The charging mode is divided into two main types: slow and fast charging. Table 2 describes the technical features of the two model types.

Table 2. Classification of charging piles.

	Current Type	Charging Time	Advantages	Shortcomings	Scope of Application
Slow charging	Constant voltage or constant current mode of small current	5–8 h	Low cost of charger installation and charging	Difficult to meet the requirements of vehicle emergency operation	A family, a parking lot, a public charging station
Fast charging	High current	20 min–2 h	Short charging time	High installation cost, high requirements for the safety of charging technology	Special charging station

4.1.3. Design of the Zero-Emission Vehicle Integrated Mechanism

In addition to the demand-side incentives, such as subsidy policy, a zero-emission vehicle (ZEV) integration trading mechanism has been applied to promote the development of new energy vehicles. The specific design in this study is illustrated in Figure 6.

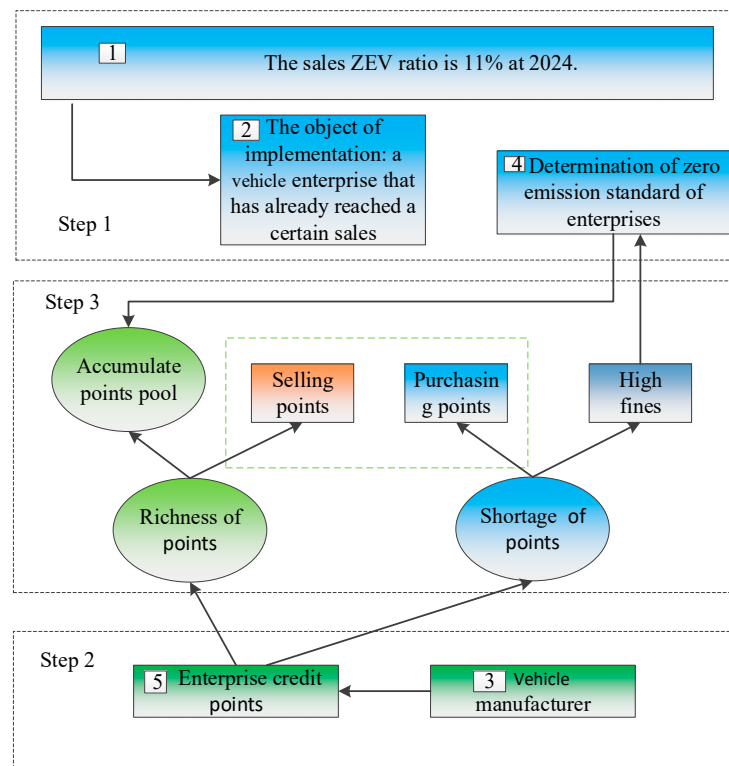


Figure 6. Zero-emission vehicle integration mechanism.

Step 1: The local government determines the long-term goal of new energy vehicle development. Based on that goal, it determines the share of new energy vehicles sold in the region in the past year by enterprises with a sales volume of more than ten thousand. The specific execution process is as follows:

[1→2→3→4→5]

Step 2: Vehicle companies must sell enough new energy vehicles to meet the ZEV policy requirements. The supply chain and infrastructure businesses will also benefit from the growth of the electric vehicle market demand, and all types of new energy vehicles will receive different points. The specific process is as follows:

[1→2→3→4→5]

Step 3: The automobile enterprise must submit enough ZEV points to the government administration to prove it fulfills the policy requirements. For unregulated enterprises:

- (1). Pay a fine.
- (2). Purchase ZEVs with the surplus of the enterprises (the buyers and sellers negotiate to buy; the price will be lower than the government fines).

For compliant enterprises:

- (1). The surplus integral can be sold.
- (2). The integral can also be stored for future compliance (as the policy is strict, the price of the integral is rising). The government announces the integral and integral stock for the year.

4.2. Business Model Design

4.2.1. New Energy Vehicle Profit model

- (1). Short term: low cost plus service fees

At present, China's charging station operators charge users a price that includes electricity and service fees, and the profit is mainly from the service fees. The charging service fee is guided by the local governments. Due to the limited charging time, charging stations need a waiting area; thus, the cost of land is relatively high. The government

reduces the operation cost through financial subsidies, free allocation of electric facilities, etc. [38].

(2). Mid-term: wholesale, retail electricity plus charging service fees

The large-scale promotion of new energy vehicles must ensure that the cost of electric vehicles is lower than that of fuel (or gas) vehicles, as higher charging service fees will reduce users' purchasing intention and affect the charging facility industry. The entry of social capital into the new energy vehicle industry will lead to a decline in charging service fees. The charging service fee mode is suitable for the initial industry cultivation period. With the reform of China's electricity market, the charging station operators can buy electricity in the retail market, and reduce operation costs and the payback period of the project.

(3). Long term: wholesale, retail electricity plus charging service plus adding value

The smart grid and energy internet are the foundation of charging stations. Electricity information can be collected through the energy internet. The operation of the charging stations can provide the charging service, as well as vehicle detection and vehicle maintenance. Additional value can be excavated through cooperation with vehicle companies, such as apps (applications), online payment, maintenance, and other services. Taking the charging station as an agent of electric vehicles, optimizing charging and discharging will weaken the negative impact on large-scale electric vehicle access to the power system, increase participation in grid auxiliary services, reduce spare time, and stabilize the volatility of the renewable energy output.

4.2.2. Construction of Management Platform

(1). Government New Energy Vehicle Platform

New energy vehicles are introduced into the official vehicle system, which indicates the Chinese government's attitude to new energy vehicles, and popularizes the concept of energy conservation and environmental protection. By cooperating with the internet rental platform, the government can reduce the cost of public service vehicles.

(2). Intelligent new energy vehicle rental platform

The intelligent new energy vehicle sharing platform is manipulated by mobile internet technology. The sharing of new energy vehicles is an innovative exploration of the internet, vehicle, and internet travel sectors. The platform provides a new rental experience. Through sharing and enhancing the efficiency of resource utilization, the platform can become a model of vehicle sharing and innovation. The specific pattern designed in this study is shown in Figure 7.

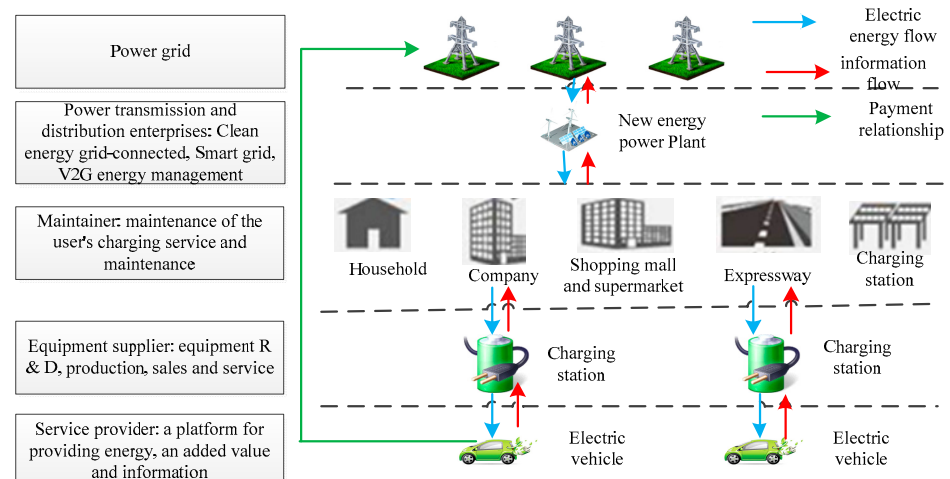


Figure 7. Hierarchical structure diagram of a charging station.

(3). New energy vehicle cloud platform

The charging facility is the entry to the current and data flow. Through the charging process, to obtain the vehicle operation data, the platform will provide the opportunity for subsequent vehicle sales, maintenance, and other system value-added services. Regarding the new cloud platform of new energy vehicles, including location services, payment services, internet finance, and other internet business opportunities, the user, through mobile apps and cloud platforms, can conduct new energy vehicle leasing, sales, maintenance, and other omnidirectional services.

4.2.3. Equipment Manufacturing Mode

High safety, a large capacity, a long cycle life, and low cost are the key factors in the development of new energy vehicles. Chinese battery enterprises have basically solved the problem of the safety and life of single cells, but are not mature in group technology, BMSs (battery management systems), and system integration technology. Most enterprises adopt the mode of independent R&D and production; thus, realizing the sharing of resources is difficult, and the production equipment and manufacturing level is not high. To master the core technology of the battery and reduce the cost, the major world vehicle enterprises have adopted a cooperative relationship with battery production enterprises. Table 3 summarizes the cooperation relationship between international vehicle enterprises and battery enterprises.

Table 3. Cooperation mode of battery and vehicle enterprises.

Enterprises	Cooperation Model	Cooperative Partner
Toyota	Joint R&D + independent R&D	Panasonic
Volkswagen	Joint R&D	SANYO motor, BYD, Toshiba
Suzuki	Procurement + joint R&D	Sanyo
General Motors	Procurement + independent R&D	LG CHEMICAL LTD
Ford	Procurement + independent R&D	LG CHEMICAL LTD

The joint venture or alliance relationship between power battery enterprises and vehicle enterprises has become the main development model for the international new energy vehicle industry. China's power battery industry should explore the development and production of new models, set up the relevant departments of the research industry alliance, improve battery safety, promote commercial application, and cultivate the core competitiveness of the products. Cooperation platforms can enhance the battery industry's independent innovation and industrialization.

4.2.4. Sales Model of Vehicle Power Battery

The sales model of power batteries is as follows:

(1). Sales model of full vehicle battery

In this model, all types of problems that consumers experience in vehicle operation are solved by vehicle manufacturers. The advantage of this model is that it has sufficient technology to provide consumers with vehicle maintenance service. In the vehicle rental model, the ownership of the battery system belongs to the leasing company.

(2). Naked vehicle sales plus battery replacement

In this model, consumers pay rent to the leasing company. When the life of the power battery is running out, it can be replaced at the company's battery switching site, and consumers only need to pay the charging and battery depreciation fees. This model reduces the cost for consumers to buy a new energy vehicle.

4.2.5. Management Model of Vehicle Power Battery Recycling

At present, the development of new energy vehicles in China is in the initial stage, and batteries are not in large-scale production; thus, no waste battery collection and recycling system has been established.

(1). Producer recovery system model

This model mainly sets up the waste battery recycling as the center of the power battery production enterprise and new energy vehicle production enterprise. The power battery manufacturer is responsible for collecting the waste power batteries, and the vehicle manufacturers cooperate with the battery manufacturers to recycle the power batteries of the new energy vehicles. Through logistics system transport, the waste power battery travels to the qualified recycling enterprise. Figure 8 shows the recovery process of the producer recovery system designed in this study.

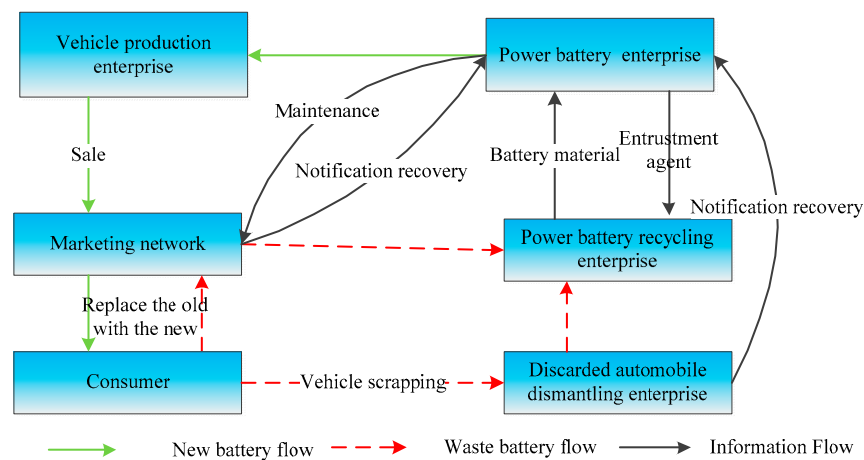


Figure 8. Recovery process of producer recovery system.

(2). Battery rental recovery system model

In the battery leasing recovery system model, battery rental enterprises own the power batteries, and consumers rent the power batteries. This model is advocated by the Power Grid Corp. In terms of scrap batteries, battery leasing companies collect them and turn them over to an enterprise authorized as a recycling business for harmless treatment and resource utilization. Figure 9 shows the recovery process of the battery lease recovery system designed in this study.

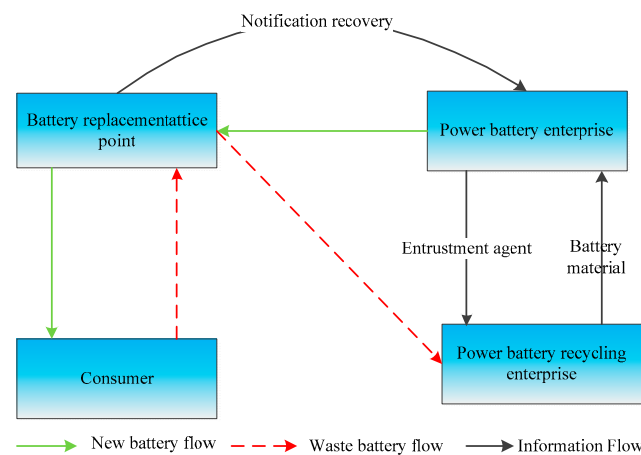


Figure 9. Process of battery rental recovery system.

4.3. Technical Support

4.3.1. System Intelligentization

An IT company is responsible for providing the high-tech platform and intelligent electric vehicle integrated design and manufacturing technology, and it relies on the accumulation of vehicle manufacturers in the marketing services, and the multifaceted cooperation partners. Notably, China has proposed the feasible “internet plus intelligent electric vehicle” business model.

4.3.2. Utility of the Charging Network

(1). Family conventional charging points used as an energy supply system

The electric vehicle charging service system, which is supplemented by the conventional charging of family parking, is the most likely mode of charging facilities in China. For family charging, the Chinese community has a high population density. There are exclusive garages that can be rebuilt into independent charging points and equipped with the corresponding measurement equipment to achieve the popularization and application of electric vehicle infrastructure.

(2). Improve the construction of charging networks

Reliance on residential quarters and business centers to build standardized charging stations will form a fast-charging network and fulfill users' charging needs, which will promote the purchasing desire for new energy vehicles. A new energy vehicle has a dynamically controllable load and can effectively relieve the peak load on the user side, which is conducive to the economic operation of the power grid.

5. Conclusions

The Chinese government attaches great importance to the sustainable development of the new energy vehicle industry, and it is clear that the new energy vehicle industry is a strategic new industry. The power battery is the core of a new energy vehicle, but it has many problems, such as a weak foundation, small scale, low output, lack of production experience, and an imperfect capital market. Aiming at the technical bottlenecks in the industry chain, the Chinese government should focus on improving technological innovation capability, such as power batteries and key materials, and strive to achieve breakthroughs in key technologies and common technologies. The suggestions are as follows:

- (1). Power battery monomers, modules, and management systems should be established, forming battery material technology research alliances with colleges and universities, and building a common technology platform to conduct joint research on the dynamic energy density, cell cycle life, and other common problems.
- (2). Technology alliances should be relied on to conduct research on the materials, system, and technology of power batteries and grasp the frontier technology of power batteries. The R&D of power batteries can improve the production efficiency and ensure the consistency of the products. Enterprises should be guided to increase investment in the research and development of key materials, such as power battery separators and electrolytes.
- (3). Investment funds in R&D should be set up to support technological innovation and transformation. The Chinese government must prioritize support for the power battery industry and key material industry alliances in the form of funding, and guide enterprises to increase investments in technology, engineering, standard setting, and market applications. Through the formulation and implementation of various preferential policies of talent, the Chinese government will increase the cultivation and introduction of a technological innovation team.

From the current development status of electric vehicles, battery life, and other technical factors, the development of electric vehicles faces large obstacles. Therefore, the users' understanding and recognition of electric vehicles are other important factors for

electric vehicles. Therefore, in order to realize the large-scale promotion of electric vehicles, it is necessary to raise the awareness of electric vehicles by cultivating the public's low-carbon awareness.

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