

Development and Legal Challenges of New Energy Vehicle Charging Facilities from the Perspective of Energy Law

Yongji Zeren

Beijing Normal University, Beijing, China

2441404524@qq.com

Abstract: Against the backdrop of increasingly severe global energy crisis and environmental pollution, new energy vehicles (NEVs) have attracted widespread attention as a green and environmentally friendly means of transportation. As a key link in the NEV industrial chain, the development of charging facilities should also be correspondingly constructed and improved. Energy law can ensure the safety, reliability and efficiency of these facilities by formulating standards for their construction, operation and maintenance, thereby promoting the popularization and use of NEVs. Therefore, this study decides to conduct an in-depth exploration on the definition, legal status, current situation and development trends of charging facilities from the perspective of energy law. The research focuses on analyzing the legal challenges faced by NEV charging facilities in terms of the unification of laws and regulations, approval and land use management, safety management, data privacy and cybersecurity, power supply, and operation and management models, and then puts forward corresponding coping strategies and predicts future development trends. The purpose of this study is to provide legal protection and policy suggestions for promoting the healthy development of NEV charging facilities, improve the provisions of energy law on NEV charging facilities, and promote the realization of green transportation and sustainable development.

Keywords: Energy Law; New Energy Vehicles; Charging Facilities; Legal Challenges.

1. New Energy Vehicle Charging Facilities Under the Framework of Energy Law

1.1. Definition and Legal Status of New Energy Vehicle Charging Facilities in Energy Law

New energy vehicles refer to vehicles that partially or completely replace traditional internal combustion engines with electric drive systems, mainly including battery electric vehicles (BEVs), plug-in hybrid electric vehicles (PHEVs) and fuel cell vehicles (FCVs). [6]NEV charging facilities refer to equipment and systems that provide electrical energy supply for NEVs. These facilities charge the vehicles battery energy storage system by providing electrical power to ensure the normal operation of the vehicle. NEV charging facilities usually include charging piles, charging stations, mobile charging equipment and wireless charging devices.

Charging piles are the most common type of charging facilities, divided into AC charging piles and DC charging piles. AC charging piles, also known as slow charging piles, provide AC power, take a long time to charge, and are suitable for homes and office places; DC charging piles, also known as fast charging piles, provide DC power, charge at a fast speed, and are suitable for public charging stations and highway service areas. Charging stations are set up in urban public areas, parking lots, highway service areas, etc., providing a variety of charging piles to provide charging services for various types of NEVs. Special charging stations provide charging services for specific user groups (such as buses, taxis, logistics vehicles, etc.), and are generally established and operated by enterprises or government agencies.

Mobile charging equipment, such as mobile charging vehicles or mobile power banks, can provide temporary charging services for NEVs anytime and anywhere, which is suitable for emergency situations or areas with few charging facilities. Wireless charging facilities realize the technology of wireless charging of vehicles during parking or driving through electromagnetic induction or magnetic resonance principles. Although they are still in the experimental and promotion stage, they have good application prospects. Battery swapping stations provide battery replacement services, which can quickly supplement electrical energy by replacing pre-charged battery packs, and are suitable for vehicles that need efficient operation, such as taxis and online car-hailing.[1]

In terms of layout and planning, charging facilities are mainly laid out in urban areas, highways and specific places. Urban areas are mainly laid out in residential communities, office buildings, commercial centers, public parking lots, etc., to meet daily use needs; highways set up fast charging stations at nodes such as service areas and toll stations to ensure charging needs for long-distance travel; specific places such as bus stations, logistics centers, taxi dispatching stations, etc., set up special charging facilities to support the efficient operation of specific types of vehicles.

NEV charging facilities include various types of charging piles, charging stations and their supporting power equipment and systems. These facilities are not only related to the supply and use of energy, but also closely related to power networks, land use, urban planning and other aspects. Energy law ensures their safety, reliability and efficiency by formulating standards for their construction, operation and maintenance, thereby promoting the popularization and use of NEVs.

The legal status of NEV charging facilities is clearly defined in energy law. As infrastructure for energy supply,

they enjoy certain policy support and legal protection. For example, the government can promote the construction and development of charging facilities through financial subsidies, tax incentives, land use policies and other means. At the same time, the operation of charging facilities must comply with the relevant provisions of energy law to ensure that they meet legal requirements in terms of safety, environmental protection and efficiency.

1.2. The Role of Energy Law in Promoting the Development of NEV Charging Facilities

Energy law regulates the development and utilization of new energy and plays a crucial role in promoting the development of NEV charging facilities, which is specifically reflected in policy support and incentive measures, standard formulation and technical specifications, supervision and management, and data management and privacy protection.

In terms of policy support and incentive measures, the government reduces the economic burden of enterprises and individuals in building charging facilities through various means and encourages social capital to invest in the construction of charging infrastructure.[2] Financial subsidy policies can directly reduce construction costs, while tax incentive policies improve market participation enthusiasm by reducing operating costs. In addition, the government gives priority to charging facilities in urban planning and land use, simplifies the approval process, and ensures the timely supply of land for charging facility construction.

In terms of standard formulation and technical specifications, the government formulates unified technical standards for charging facilities to ensure the interoperability between charging equipment of different brands and types, and improve user convenience. At the same time, the government formulates safety norms for the construction and operation of charging facilities to ensure the safety of personnel and equipment during charging and prevent safety accidents such as fires and electric shocks.

In terms of supervision and management, the government strengthens the supervision and management of the charging facility construction process to ensure project quality and construction safety. It conducts strict supervision on the operation of charging facilities to ensure that they meet the requirements of environmental protection and energy conservation, and at the same time protect the legitimate rights and interests of users.

In terms of data management and privacy protection, the government collects and analyzes the operation data of charging facilities through intelligent management systems to optimize resource allocation and improve charging efficiency. At the same time, the government formulates data privacy protection policies to prevent the leakage of users personal information and ensure users data security.

1.3. Relevant Provisions of Current Energy Law on Charging Facilities

The "Energy Law of the Peoples Republic of China" provides a basic legal framework for national energy management and regulates the development and utilization of new energy. As an important part of new energy utilization, charging facilities are supported and protected by energy law. The "Electric Power Law of the Peoples Republic of China" comprehensively regulates the production, transmission, distribution and use of electric power. As an important link in power use, charging facilities need to comply with the

relevant requirements of the Electric Power Law, including safety standards and electricity use specifications. The "Renewable Energy Law of the Peoples Republic of China" encourages and supports the development and utilization of renewable energy, including new energy such as solar energy and wind energy. If charging facilities use renewable energy for power supply, they can enjoy preferential treatment and support from laws and policies.

The "New Energy Vehicle Industry Development Plan (2021-2035)" clearly proposes to vigorously develop new energy vehicles and their supporting infrastructure, including the construction of charging facilities.[8] The plan requires strengthening the standardized construction of charging facilities and promoting the integrated development of charging facilities and smart grids. The Guiding Opinions of the General Office of the State Council on Accelerating the Promotion and Application of New Energy Vehicles (Guo Ban Fa [2014] No. 35) proposes to improve urban planning and corresponding standards, land use policies for charging facilities, and electricity price policies; encourage public institutions to accelerate the construction of charging facilities in internal parking lots. The Guiding Opinions of the General Office of the State Council on Accelerating the Construction of Electric Vehicle Charging Infrastructure (Guo Ban Fa [2015] No. 73) proposes to improve the layout of independently occupied charging infrastructure, clarify the construction ratio or reserved construction and installation conditions for charging facilities in parking lots supporting various buildings and public parking lots; construct charging facilities in users residential areas, internal unit parking lots, public service field, urban public charging facilities, and inter-city fast charging networks; encourage charging service enterprises to innovate the business cooperation model for charging infrastructure construction through cooperation with vehicle manufacturers, crowdfunding and other methods; simplify planning and construction approval; improve financial and price policies; increase land support.[5]

All regions have also formulated specific regulations on the construction and management of charging facilities according to actual conditions. For example, the Notice of the General Office of the Peoples Government of Beijing Municipality on Printing and Distributing the Implementation Opinions on Further Strengthening the Construction and Management of Electric Vehicle Charging Infrastructure (Jing Zheng Ban Fa [2017] No. 36) requires strictly implementing the supporting indicators for charging facilities in new buildings; promoting the construction of charging facilities in existing residential communities; promoting the construction of charging facilities in internal units; promoting the construction of charging facilities in public service fields; promoting the construction of urban public charging facilities; strengthening the construction of charging facilities in key areas; improving the management and service system of charging infrastructure; simplifying the procedures for planning and construction approval; increasing support for the construction and operation of charging infrastructure. The Notice of the Interim Provisions on the Construction and Management of Electric Vehicle Charging Facilities in Shanghai (Hu Jiao Ke [2015] No. 553) requires that in accordance with the principle of "self-use (special use) first, public use as supplement, combining slow and fast charging, and classified implementation", gradually form a charging service network in the city with self-use and special charging facilities in residential communities and office places as the main body,

and public charging facilities such as public parking spaces, road parking spaces and independent charging stations as supplements, and form a public charging facility service corridor along the radial inter-city highways on the external channels.

2. Current Situation of NEV Charging Facilities

The development of NEV charging facilities has experienced a stage of rapid expansion and technological progress, and has become an important support for the global NEV industry. According to data from the International Energy Agency (IEA), as of the end of 2023, the number of public charging piles worldwide has exceeded 1.7 million, of which China accounts for about 65% of the global total. According to the report of the China Electric Vehicle Charging Infrastructure Promotion Alliance (EVCIPA), as of 2023, China has built more than 1.1 million public charging piles. [6]The charging technology of NEVs has also made significant progress. The popularization of fast charging technology enables the latest fast charging equipment to charge electric vehicles to 80% of the battery capacity within 30 minutes. For example, Teslas Supercharger and Porsches Turbo Charging both adopt high-power fast charging technology. Wireless charging technology is also being gradually promoted. Although it is still in the experimental and small-scale application stage, it is expected to be widely popularized in the future. In terms of policy support, governments of various countries have introduced policies to support the construction of charging facilities. The European Unions "European Green Deal" proposes to build at least 1 million public charging piles by 2025. The Chinese government clearly proposes in the "New Energy Vehicle Industry Development Plan (2021-2035)" to accelerate the construction of charging infrastructure to meet the growing demand for NEVs.

At present, the main obstacles to the development of NEVs in China include battery technology limitations, insufficient charging infrastructure, high costs, range anxiety, and low consumer awareness and acceptance. Among them, insufficient charging infrastructure is a prominent problem. Although some cities have made certain progress in building charging piles and charging stations, the overall coverage rate is still very low, especially in remote areas and old urban areas. The lack of charging facilities makes it inconvenient to charge electric vehicles. Even in some large cities, the number and distribution of charging piles cannot meet the rapidly growing demand for NEVs, resulting in users having to wait in line to charge during peak hours. In addition, there are problems in the maintenance and management of charging piles. Some charging piles are unavailable due to damage or failure, which further affects the user experience. Due to the long charging time, many consumers are worried that they cannot charge quickly during long-distance travel or emergencies. This anxiety also hinders the popularization of NEVs. Insufficient charging facilities not only affects the convenience of using NEVs, but also weakens consumers confidence in them, becoming one of the main bottlenecks in the development of NEVs.

3. Development Trends of NEV Charging Facilities

The International Energy Agency predicts that by 2030, the

number of electric vehicles worldwide will reach 145 million, and the demand for charging infrastructure will increase significantly. It can be predicted that with the rapid growth of the number of NEVs, the market demand for charging facilities is increasing day by day. However, the construction of charging facilities is not synchronized with the development of NEVs. The construction speed of charging facilities has not yet fully kept up with the growth speed of NEVs, leading to a continuous expansion of the gap in demand for charging facilities.[2] This gap not only requires an acceleration in the growth rate of charging facilities in terms of quantity, but also requires changes in the form and improvement in the efficiency of charging facilities.

In the future, intelligent charging networks will become an important development trend of NEV charging facilities. Through in-depth integration with smart grids, intelligent charging networks realize intelligent scheduling and optimized management of charging facilities. Intelligent charging can adjust charging time according to grid load and electricity prices, reduce charging costs and improve grid stability. The latest intelligent charging systems can also predict user charging demand and optimize the allocation of charging resources through big data analysis and artificial intelligence technology.[4]

In addition to intelligence, the wide application of green energy will be another important development trend of charging facilities in the future. In the future, charging facilities will be more combined with green energy, such as solar energy and wind energy, to reduce dependence on traditional energy and reduce carbon emissions. For example, Teslas SolarCity project has equipped solar panels in many charging stations. Governments of various countries are also promoting the construction of green charging stations. For example, policies in California, USA require that new public charging stations must be equipped with a certain proportion of renewable energy facilities.

With the global development of the NEV market, cross-regional and international cooperation will be further strengthened. Countries will jointly formulate and promote internationally unified technical standards and legal frameworks to promote the global interconnection of charging facilities. For example, the Sino-European Electric Vehicle Charging Cooperation Program, a cooperation project between the European Union and China, has been launched, aiming to promote the unification and interoperability of charging standards.[3]

The rise of mobile charging solutions will also become one of the future development trends. Mobile charging vehicles and portable charging equipment will provide flexible charging services for vehicles that cannot easily access fixed charging facilities. For example, SparkCharge, a US startup, has launched portable charging equipment that can provide on-site charging services for electric vehicle owners. In large-scale events or remote areas, mobile charging solutions can be quickly deployed to provide temporary charging services, improving the convenience and flexibility of charging.

In addition, more innovative business models will emerge in the field of charging facilities. For example, the shared charging pile model will gradually become popular. Car owners can share their own charging piles with others to increase the utilization rate of charging piles. Charging service platforms will also grow and realize the search, reservation and payment of charging piles through smartphone applications to improve user experience. At

present, Chinas "Teld" platform has realized the information sharing and intelligent management of charging piles nationwide.

4. Legal Challenges and Coping Strategies of NEV Charging Facilities

4.1. Imperfection and Lag of Laws and Regulations

There are many problems of inconsistent standardization in NEV charging facilities. The most prominent performance is in charging interfaces and communication protocols. Due to the independent formulation of charging standards by various countries and regions, there is a lack of unity in charging interfaces and communication protocols. Taking China as an example, in the early stage, the charging interfaces and protocols of new energy vehicles of different brands were different, making it inconvenient for users to use them between different charging stations. Although the national standard "Connecting Devices for Conductive Charging of Electric Vehicles" (GB/T 20234) issued in China in 2016 standardized charging interfaces and communication protocols, it still needs to be continuously improved and promoted. Secondly, there are differences in charging standards between different regions and operators. When users use NEV charging facilities across regions, they often encounter problems of cost differences. The fragmentation of local regulations hinders the unified planning and cross-regional interconnection of charging facilities, increasing the compliance costs and operational difficulties of enterprises. Enterprises need to spend a lot of resources to adapt to the laws and regulations of different regions, which affects the large-scale development of charging infrastructure. For example, the charging rates in Beijing and Shanghai may be different, which not only affects the user experience, but also hinders fair market competition.

In addition to the imperfection of laws and regulations, the rapid development of new energy vehicles and their charging technologies makes the current laws and regulations lag behind in some aspects. This lag leads to legal obstacles in the promotion of new technologies and models. For example, while wireless charging technology has gradually matured, the relevant laws, regulations and technical standards have not yet been improved, affecting the large-scale application of this technology. In addition, with the development of high-power fast charging technology, the existing safety standards and environmental protection laws cannot fully cover the new technical requirements, and legal provisions need to be revised and supplemented in a timely manner. There are also issues related to new battery technologies and their recycling and disposal brought about by the popularization of new energy vehicles, and the current relevant laws are not perfect enough.

The series of lagging legal problems reflect the poor adaptability of the legal system related to NEV charging facilities, because the existing legal system is often formulated for traditional vehicles and gas stations, and lacks targeted provisions for the special needs of new energy vehicles and charging facilities. For example, in terms of land use, construction approval, and electricity price policies for charging facilities, the existing laws and regulations lack clear guidance and support, leading to many difficulties and

uncertainties for enterprises in practical operations.

The corresponding coping strategies include establishing unified national standards and regulations, and formulating national norms for the construction and operation of charging facilities. On the premise of maintaining local innovation, reduce the differences in local regulations through policy coordination and regulatory unification. For example, formulate unified charging interface standards, construction approval processes and operation and management norms, and promote the standardization and interconnection of charging facilities nationwide.

4.2. Legal Challenges in the Approval and Land Use Management of Charging Facilities

The construction of NEV charging facilities needs to occupy public or private land, which involves the issue of land use rights. In cities, public land resources are tight, and the process of obtaining land use rights is complex and time-consuming. Especially in old residential communities and urban centers, due to limited land resources and complex property rights, it is difficult to build charging piles.

In addition to the tight land use, the construction of charging facilities needs to go through approval by multiple departments such as planning, construction, and environmental protection. The approval process is cumbersome and takes a long time. Taking Beijing as an example, the construction of charging piles needs to go through approval in multiple links, including the Urban Planning Bureau, Construction Bureau, and Fire Department, resulting in a long construction cycle and affecting the market response speed. Difficulties in land use approval, cumbersome approval processes, and lack of transparency lead to long construction cycles and high costs of charging facilities, which in turn affect the promotion of new energy vehicles and user experience. To simplify the approval process, the Beijing Municipal Government has implemented a "one-stop" approval service in recent years, which has achieved certain results but still needs further optimization.

Secondly, China has a vast territory, and charging facilities need to be built to adapt to different terrains, but there are considerable difficulties in this process. Taking National Highway 318 as an example, it spans the eastern, central and western parts of China, covering plain, hilly, basin and plateau landscapes. Although new energy vehicles account for only about 3% of the equivalent traffic volume, the only more than a dozen charging piles along the line cannot meet the charging needs of more than 200 vehicles per day. In addition to the "more vehicles than piles", there is also the uneven distribution of charging piles due to topographical reasons. For example, more than 85% of the charging stations in popular self-driving areas are distributed in 5 counties such as Kangding and Yajiang, and 2 larger towns such as Xinduqiao and Shangri-La. There are only 5 charging stations outside the towns, such as Muya Holy Land, Muya Tibetan Village, and Cuopugou. Between Litang and Daocheng counties, the distance between two adjacent charging stations even reaches 155 kilometers. All the above situations have caused the problem that new energy vehicles cannot travel smoothly on National Highway 318.

The corresponding coping strategies include simplifying the approval process, establishing a "one-stop" approval service, and reducing the administrative costs and time for enterprises in obtaining land use rights and construction

approval. For example, through policy reforms, parallel approval and the "one-stop service" reform can be implemented to reduce approval links and improve approval efficiency. At the same time, land use management should be optimized, and the construction of charging facilities should be included in the urban master plan through the formulation of special plans to ensure the land demand for charging facilities. The government can solve the land problem by allocating public land and encouraging private land owners to provide land.

4.3. Legal Considerations in the Safety Management of Charging Facilities

The safety management and maintenance of NEV charging facilities need to comply with strict safety standards, but in practical operation, safety accidents of charging facilities still occur from time to time, such as overheating and electric leakage of charging piles. On April 28, 2020, a fire and explosion occurred when a vehicle was charging at the Tangwei New Energy Vehicle Charging Station in Shenzhen, and a total of 5 new energy vehicles were damaged to varying degrees, exposing loopholes in the safety management of the charging facility. According to the "Big Data Safety Supervision Achievement Report of the National New Energy Vehicle Supervision Platform" once released by the National Big Data Alliance of New Energy Vehicles, the proportion of new energy vehicles catching fire in the charging state from 2016 to 2019 was 20.93%, 30.77%, 32.50% and 18.75% respectively, indicating that charging facilities have a significant impact on the safety of new energy vehicles.

The challenges faced by the safety management of charging facilities generally include three aspects. First, equipment quality and installation safety. The quality of charging equipment produced by different manufacturers is uneven, and there is a lack of unified safety standards and norms in the installation process, which is prone to potential safety hazards. For example, loose electrical connections of charging piles may lead to electric leakage or short circuit accidents. Second, insufficient operation and maintenance: in the process of operation and maintenance of charging facilities, there are problems such as poor management and inadequate regular inspections, leading to equipment aging, frequent failures, and increased safety risks. Third, imperfect emergency response mechanisms: when a safety accident occurs in charging facilities, there is a lack of effective emergency response mechanisms, which delays accident handling and causes greater losses.[7]

The corresponding coping strategies include formulating and implementing strict quality standards for charging equipment to ensure that the charging facilities sold and installed in the market meet safety requirements. The law should clearly stipulate the production, testing and certification processes of charging equipment to ensure the safety performance of the equipment. Clarify the technical specifications and acceptance standards for the installation of charging facilities through laws and regulations to ensure the safety of the installation process. Relevant departments should supervise and accept the installation of charging facilities to eliminate potential safety hazards. Do a good job in operation and maintenance management. The law should stipulate the maintenance responsibilities of charging facility operators, requiring them to regularly inspect and maintain charging equipment to ensure that the equipment is always in good condition. Formulate regular inspection and

maintenance standards for charging facilities to ensure the safety of the operation process. Finally, establish an emergency response plan for safety accidents of charging facilities. Through laws, require operators to formulate and implement emergency response plans, conduct regular emergency drills, and improve accident handling capabilities.

4.4. Legal Risks of Data Privacy and Cybersecurity

NEV charging facilities collect a large amount of user data during operation, including charging records, location information, payment information, etc. The collection and processing of these data are of great significance for improving service quality and operational efficiency, but they also bring problems of data privacy protection.

Both improper protection of user data and legal gaps in data management are challenges faced by charging facilities. If the privacy data such as users charging behavior data and location information are not properly handled, they may be leaked or abused, infringing on users right to privacy. The current law lacks clear provisions on the collection, storage and use of charging facility data, leading to legal risks for enterprises in the process of data management.

The corresponding coping strategies include formulating and implementing strict data protection laws and regulations, clarifying the legal responsibilities for data collection, storage and use, and protecting user privacy. For example, drawing on the experience of the European Unions General Data Protection Regulation (GDPR), formulate data protection laws applicable to NEV charging facilities to ensure the security and privacy protection of user data during collection and use. Transparent data policies require charging facility operators to formulate transparent data collection and use policies, clearly inform users of the scope, purpose and use method of data collection, and obtain users informed consent. For data anonymization processing, the law should require charging facility operators to anonymize user data when processing it to ensure that the data does not involve personal privacy information during transmission and analysis.

4.5. Legal Challenges of Power Supply

As large electricity consumers, the stability and reliability of power supply for NEV charging facilities directly affect user experience and the promotion and application of NEVs. During peak hours, the problem of insufficient power supply is more prominent, which restricts the effective use of charging facilities.

The challenges of power supply to NEV charging facilities include both grid load pressure and insufficient power supply guarantee. With the increase in the number of new energy vehicles, the load pressure of charging facilities on the power grid has increased significantly, especially during peak power consumption periods, which is prone to the problem of tight power supply. On the other hand, in remote areas and areas with poor power grid infrastructure, the power supply guarantee capacity is insufficient, which restricts the layout and promotion of charging facilities. For example, in the western Sichuan region, due to extreme weather, the battery life of new energy vehicles will decrease, and the driving distance is complex, so the demand for charging facilities will be greater, and the power supply challenge is severe.

In response to grid load pressure, legal means can be used to optimize the allocation of power resources, promote the construction of smart grids, and improve the carrying capacity

of the power grid for charging facilities. For example, formulate power demand side management laws, promote the implementation of time-of-use electricity price policies, guide users to charge during off-peak hours, and alleviate grid load pressure.

In response to insufficient power supply guarantee, the law should require power companies to strengthen the construction of power grid infrastructure in areas with dense charging facilities to ensure the stability and reliability of power supply. Especially in remote areas, policy support should be provided to improve power supply guarantee capacity and support the construction and operation of charging facilities.

4.6. Legal Challenges of Operation and Management

NEV charging facilities have various operation modes, including public charging stations, special charging stations, mobile charging equipment, etc. Different operation modes need to clarify their responsibilities and obligations in law to ensure the legality and standardization of operation. For example, the operation of mobile charging vehicles needs to consider road traffic laws and safety standards for mobile equipment. When Shenzhen piloted mobile charging vehicle services, it encountered some legal problems, such as how to define the parking area and service scope of mobile charging vehicles, which need to be solved through local regulations. In 2018, Shanghai issued the "Measures for the Administration of Electric Vehicle Charging Service Fees", which clarified the charging standards and management requirements for charging service fees, providing a reference for other regions.

The NEV charging facility industry involves the participation of multiple government departments in management. At present, the local regulations of different provinces and cities on the NEV charging facility industry are not uniform, and the responsibilities of the relevant government supervision departments will also be different. However, in general, the involved government departments include but are not limited to the National Development and Reform Commission, energy competent departments, land and resources competent departments, housing and urban-rural construction competent departments, market supervision competent departments, commerce departments, transportation departments, finance departments, urban management departments, fire supervision departments, and price competent departments.

The legal challenges of operation and management include legal challenges brought by multi-subject participation and charging management issues in the operation of charging facilities. Multi-subject participation will lead to unclear division of responsibilities, especially when charging facilities fail or safety accidents occur, it is difficult to determine the responsibility. For example, charging facilities are maintained by operators, but if there is a problem with power supply, the power grid company also has certain responsibilities. Secondly, there may be conflicts in interest distribution among various subjects, affecting the construction and operation efficiency of charging facilities. For example, property management companies may hinder the construction of charging piles in communities due to profit distribution issues. In addition, the charging standards and billing methods of some charging facility operators are not transparent, making it difficult for users to understand and

accept during use. For example, some charging piles have complex charging methods, including multiple fees such as electricity fees and service fees, which increases the users use cost and also brings challenges to charging facilities.

In response to the legal challenges brought by multi-subject participation, the responsibilities and obligations of each participating subject should be clarified through laws and regulations to ensure clear responsibilities in the operation process of charging facilities. For example, formulate standards for the division of responsibilities for the construction and operation of charging facilities, and clarify the responsibilities and obligations of each subject in different stages. At the same time, a cooperation mechanism should be established to encourage governments, enterprises and property management companies to establish a cooperation mechanism to jointly promote the construction and operation of charging facilities. For example, through the public-private partnership (PPP) model, guide multiple parties to jointly invest in and operate charging facilities to ensure that the interests of all parties are reasonably protected.[7] In response to the challenge of charging transparency, charging facility operators should be required to disclose charging standards and billing methods to ensure the transparency and fairness of the charging process. When using charging facilities, users can understand the specific charging situation through mobile phone apps or charging station displays.

5. Conclusion

As a key infrastructure at the intersection of energy transition and transport electrification, the development of new energy vehicle (NEV) charging facilities concerns not only technological evolution and market promotion but also systematic support and institutional guarantee under the energy rule of law. From the perspective of energy law, this paper systematically elaborates the definition, legal status, current development status and future trends of charging facilities, and focuses on analyzing the multiple legal challenges they face in the unification of laws and regulations, approval and land use management, safety management, data privacy and cybersecurity, power supply, as well as operation and management. The study shows that the sound development of charging facilities relies on a sound legal and regulatory system, clear division of rights and responsibilities, unified industrial standards, and efficient management mechanisms. At present, although China has achieved remarkable results in the construction of charging facilities, the systematizations, foresight and coordination of relevant legal arrangements still need to be strengthened. Faced with the continuous growth of NEV ownership and accelerated technological iteration, it is urgent to improve the energy law and its supporting regulations at the national level, promote cross-departmental collaborative governance, strengthen the guarantee of data security and grid carrying capacity, and build a fair, transparent, standardized and orderly market environment for charging services. Only through overall planning and scientific layout under the framework of the rule of law can we provide a solid guarantee for the sustainable development of the NEV industry and help achieve the goals of green transportation and carbon neutrality.

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