

Original Research Article

Analysis on the Influencing Factors of the Planning and Layout of New Energy Vehicle Charging Infrastructure

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Abstract: Although China's new energy vehicle charging infrastructure has a certain scale, the problem of charging difficulties still exists, mainly due to the unreasonable layout of the charging infrastructure. The article relates to the factors affecting the planning and layout of the charging infrastructure after sorting out the literature and analyzing the process of formulating charging infrastructure plans in various regions at home and abroad. Combined with field research, it is determined that the main influencing factors affecting the planning and layout of charging infrastructure are: market factors, traffic factors, and administrative factors, and carry out in-depth analysis of them. The analysis will provide a basis for the reasonable layout of charging infrastructure in various places in the future.

Keywords: Charging Infrastructure; New Energy Vehicles; Planning Layout; Influencing Factors; Inventory

1. Introduction

The environmental protection and low energy consumption properties of new energy vehicles are destined to be the best choice for future ecological civilization construction and replacement of fuel vehicles. The mass popularization of new energy vehicles requires a complete charging infrastructure to ensure it. In the first half of 2020, China identified the construction of charging piles as one of the seven major areas of new infrastructure construction, reflecting the government's emphasis on the construction of charging infrastructure. Wu (2018)^[1] also reflected the emergence of charging infrastructure from the side and the unreasonable layout. The article will analyze the factors affecting the spatial layout of new energy vehicle charging infrastructure from three aspects: market factors, traffic factors and administrative factors.

2. Literature review and experience reference

2.1 Literature review

When planning the layout of the charging infrastructure, it is necessary to find the factors that affect the reasonable layout of the charging infrastructure, and after analyzing various factors, determine the best layout plan. Davidov (2017)^[2] uses an ensemble model to represent the road network and the driving trajectory of electric vehicles, and analyzes the impact of roads on the layout of charging infrastructure. Dharmakeerthi (2013)^[3] proposed that the construction of new energy vehicle charging infrastructure is affected by new energy vehicle owners and the power system. Kazmierkowski (1998)^[4] considered the layout optimization of the charging station while considering the distribution network planning, and realized the comprehensive planning of the distribution network and charging station with the goal of minimizing investment and operating costs.

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doi: 10.18282/ff.v9i4.1628

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2.2 Experience reference

When planning the layout of the charging infrastructure in the United States, after multi-element analysis of the factors, such as target population's life behaviors and drivers' driving habits, different layouts were formulated according to the characteristics of different regions^[5]. Germany proposed layout during the layout planning of the charging infrastructure that the public charging infrastructure should be laid out based on the location of street lights and the distribution of parking spaces around the street lights; Beijing is in the process of developing new energy vehicle charging infrastructure to improve the charging pile. It proposes the construction of an online charging infrastructure service platform of "Internet + charging facilities"; Shanghai proposes a regional differentiation strategy + local conditions and intensive construction strategies when planning new energy vehicle charging infrastructure; When relevant municipal departments of Shenzhen province planned and constructed charging infrastructure, they found that the complexity of land approval procedures is the biggest factor restricting the progress of Shenzhen's new energy vehicle charging infrastructure construction. In order to improve the construction progress of new energy vehicle charging infrastructure, relevant departments of Shenzhen's all regions are required to open green channels, simplify the approval process, and speed up the construction of charging infrastructure in Shenzhen.

Table 1. Comparison of factors affecting the layout of charging infrastructure in various countries and cities

Learn from countries and cities	Demand for charging infrastructure	Traffic conditions around charging infrastructure	The difficulty of charging infrastructure construction	User convenience
United States	Multi-factor analysis layout	Not considered	Not considered	Consider the customer's travel habits
Germany	Multi-factor analysis layout	Not considered	Street lamp charging pile mode	Not considered
Beijing	Analyse demand according to administrative area	Not considered	Not considered	Proposed "Internet + charging facilities"
Shanghai	Regional differentiation + local conditions, intensive construction strategy	Not considered	According to the number of new energy vehicles, there are three types of land, and different land uses have different incentive policies for charging infrastructure construction.	Not considered
Shenzhen	Determine the demand according to different users	Not considered	Simplify the process and open a green channel	Not considered

3. Analysis of factors affecting the planning and layout of new energy vehicle charging infrastructure

3.1 Market factors

The market factors that affect the spatial layout of new energy vehicle charging infrastructure mainly include the number of new energy vehicles in the region and the types of users of new energy vehicles.

3.1.1 The number of new energy vehicles in the region

It usually refers to the number of new energy vehicles in a certain area and it is one of the factors that affect the number of new energy vehicle charging infrastructure construction. The greater the number of new energy vehicles in a unit area and the greater the demand for charging infrastructure are, the smaller the service radius of the charging infrastructure will be. Therefore, in order to achieve a balance between supply and demand of new energy vehicles and charging infrastructure, when determining the number of new energy vehicle charging infrastructure, it should be determined proportionally based on the number of new energy vehicles in the area.

3.1.2 User types of new energy vehicles

The users of new energy vehicles are mainly divided into three categories: private passenger car users, online car-hailing users and logistics special-purpose vehicle users.

(1) After purchasing a car, private passenger car users mostly use it for commuting to work. The frequency of using the car is low. Most of the charging is in residential and working places. The charging time is fixed at the charging location. Such users will be charged in the living area and work place. The infrastructure requirements are relatively high. Most of the public charging infrastructure in other areas on both sides of the traffic arteries is used for emergency charging, and the requirements for the spatial layout and quantity of this type of charging infrastructure are relatively low.

(2) The higher the using frequency of car-hailing users is, the higher the frequency of charging will be. Due to the long operating mileage of online car-hailing in a single day, the uncertainty of the operating route and the randomness of the charging location and charging time will bring great problems for this type of users. , So, this type of customers is expected to have a relatively large number of public charging infrastructures in various areas such as both sides of the traffic artery, bringing them convenience. High requirements for the coverage of the charging infrastructure in the city are eagerly to be needed.

(3) The users of special logistics vehicles also have a very large daily mileage, but the routes run by such users are relatively fixed, and the charging locations are relatively fixed. Most of the charging takes place in the departure and destination areas. The number of charging infrastructure in the park is relatively high. Similar to private passenger car users, the logistics dedicated vehicles use public charging infrastructure in other areas such as both sides of the traffic artery as emergency charging. Therefore, this type of charging infrastructure has low requirements on the layout and quantities.

3.1.3 Average cruising range of new energy vehicles

The cruising range of various models of new energy vehicles in the area determines the charging cycle of new energy vehicles, and it will affect the number of new energy vehicle charging infrastructures in the area.

3.2 Traffic factors

3.2.1 Accessibility of regional traffic

It mainly refers to the accessibility to the charging infrastructure in the area, and the traffic jams directly determine the time for new energy vehicle customers to reach the charging infrastructure and the utilization rate of the charging infrastructure. If there is better traffic accessibility around the new energy vehicle charging infrastructure, it will attract more neighboring new energy vehicle customers to choose it for charging services. At the same time, users can also enjoy better charging services, and charging can be more convenient. If the traffic accessibility around the charging infrastructure is low, customers will increase the time cost of charging when charging^[6]. To save time, customers may choose farther charging infrastructures for charging. This will result in very few customers using charging infrastructure with low regional traffic access and low utilization. The spatial layout of this type of charging infrastructure is very unreasonable. Therefore, in the spatial layout of new energy vehicle charging infrastructure, the accessibility of regional traffic should be fully considered, and the layout planning of the charging infrastructure should be combined with the accessibility of regional traffic. The built charging infrastructure can not only be used for new energy; Car customers who also been provide with convenient charging services but also can increase the utilization rate of charging infra-

structure.

3.2.2 Allocation of parking space around new energy vehicle charging infrastructure

The role of the new energy vehicle charging infrastructure is similar to the gas station of a fuel vehicle, but unlike gas stations, the new energy vehicle requires a longer time to charge and requires the vehicle to stay in the parking space next to the charging infrastructure for a long time. Therefore, whether there is a parking space in the construction location of the charging infrastructure during the construction of the new energy vehicle charging infrastructure, it is also one of the factors that affect the spatial layout of the charging infrastructure. At the same time, due to the long charging time of a single new energy vehicle, if there are two or more vehicles charging, there is a need for alternate parking spaces. According to the survey, new energy vehicle customers consider that the charging time of new energy vehicles is relatively long, so when there is only one new energy vehicle in front of them, new energy vehicle customers will queue up for charging. Therefore, a single charging infrastructure needs to be equipped with one or two parking spaces.

3.3 Administrative factors

3.3.1 The government's policy and financial support for the construction of charging infrastructure

At this stage, as new energy vehicles are still in their infancy, most areas have a small number of new energy vehicles. These areas are not very enthusiastic in the construction of new energy vehicle charging infrastructure, and the lack of charging infrastructure is also very serious. It has largely hindered the promotion of new energy vehicles, forming a vicious circle between new energy vehicles and the charging infrastructures. In response to the current situation, the government has issued a large number of encouragement and reward policies to encourage regions to carry out appropriate and advanced charging infrastructure layout planning, and provide financial rewards for cities that have completed their established goals. Therefore, all regions are currently planning the layout of charging infrastructure under the leadership of the government. The increase in government funding for new energy vehicle charging infrastructure construction has increased the enthusiasm for the construction of charging infrastructure in each region. And the number of charging infrastructure layouts is also rising.

3.3.2 The planned number of charging infrastructure in various construction lands

At this stage, the customers of new energy vehicles mainly include private passenger car users, online car-hailing users and logistics special vehicle users. The charging needs of these three types of users occur in areas with different functions. There are residential areas, traffic arteries, commercial and service shopping malls, enterprises and institutions, industrial parks and logistics parks^[7]. However, in the current planning, new energy vehicle charging infrastructure is mostly planned in residential land and transportation facilities^[8]. In areas such as roads and commercial service shopping malls, the number of charging infrastructure planned in areas such as industrial parks and logistics parks is small, so the planned number of charging infrastructure in various construction land is also a factor that affects the layout and planning of new energy vehicle charging infrastructure one. When planning the layout of the charging infrastructure, the demand for the charging infrastructure of new energy vehicles on various construction lands should be fully considered, and the layout should be planned according to the demand.

4. Conclusion

The main factors affecting the planning and layout of charging infrastructure are market factors, traffic factors, and administrative factors. Therefore, when planning the layout of new energy vehicle charging infrastructure in various regions, they must fully consider the new energy vehicle ownership involved in these three factors. The planning and layout of charging infrastructure is determined based on various indicators such as the amount of electricity and the type of new energy vehicle users.

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