

Visual research on data distribution of electric vehicle charging piles in China

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Abstract. With the popularity of electric vehicles, the demand for charging piles is also increasing. It is of great significance that the distribution of electric vehicle charging piles is studied for urban planning, traffic management and energy policy. This paper discusses the distribution of charging piles in China using visual charts, analyzes in detail the growth in the number of charging piles of different companies, the characteristics of geographical distribution, and the types of charging pile. Meanwhile, the differences in the distribution of charging piles in different types of cities are discussed using Shanghai and Nanchang as examples. Through the analysis of these data, the charging pile network structure can be further optimized, a valuable reference basis is provided for urban planning and the development of electric vehicles.

Keywords: charging pile; new energy vehicles; visual analysis.

1. Introduction

In today's era of rapid global economic growth, there has been a significant increase in the consumption of fossil energy. Moreover, gasoline and diesel vehicles account for 14% of total carbon emissions[1], which contributes to global warming and climate change. In order to reduce the impact of fossil energy and solve environmental problems such as global warming, more and more countries are exploring new energies and new technologies to ensure their sustainable development. As a result, new energy vehicles are more and more widely recognized by the public[2-4]. Meanwhile, charging piles, as supporting facilities for electric vehicles, are developing very rapidly[5-7].

In China, the increase in the number of motorized vehicles has led to vehicle emissions becoming a major threat to the ecological environment and the sustainable development of energy. In September 2020, the Chinese government announced that it would strive to reach carbon peak before 2030 and achieve carbon neutrality before 2060[8-9]. Because new energy vehicles can well reduce carbon dioxide emissions, the government vigorously supports the new energy vehicle industry. At the same time, the charging infrastructure that provides charging and switching services for electric vehicles has also been developed on a large scale[10]. However, the current charging infrastructure still exists in the layout is not perfect, the structure is not reasonable enough, the old charging pile technology is outdated, the service is not balanced enough, the operation is not standardized enough and other issues need to be upgraded. The General Office of the State Council issued the Guiding Opinions on Further Building a High-Quality Charging Infrastructure System on June 6, 2023. In the document, it is proposed to accelerate the construction of a new development pattern, focus on promoting high-quality development, adhere to the goal-oriented and problem-oriented, strengthen the overall planning, implement the main responsibility, continue to improve the network, improve the capacity of the facilities, enhance the level of service, and further build a high-quality charging infrastructure system[11-12].

Based on this background, the team used python crawler to obtain the relevant data of charging pile. After integrating and classifying the data, we used the visual tools to make the data more intuitive. At the same time, considering the problem that the data may not be updated in time, we

also conducted a field investigation, which really strengthened our understanding of the distribution of charging pile.

2. Distribution of charging piles

In this section, the general situation of charging piles will be introduced from the aspects of the distribution, geographical distribution characteristics, type and power of charging piles. In order to make it easier to understand, we use various visualization charts to make the data more intuitive.

2.1 Distribution profile of charging piles

By November 2023, the number of charging infrastructure in China has reached 8.264 million units, an increase of 67.0% year on year to meet the charging needs of different users. From Table 1, it is not difficult to find that the construction of charging piles is mainly dominated by several leading companies, which are special called Star charging and State Grid, which occupy more than 50% of the share of charging piles. From October 2022 to September 2023, an average of about 69,000 new public charging piles were added every month. These data sheets show that the construction of charging piles in China is in advance.

Table 1: Number of charging piles / 10,000 from 2020 to 2023

Number of charging piles per operator from 2019 to 2023 / million units					
	operator	2020	2021	2022	2023
1	星星充电	20.5	24.6	34.3	38.7
2	特来电	20.7	23.5	36.3	41
3	国家电网	18.1	18.5	19.2	19.6
4	云快充	5.7	13.6	25.9	32.6
5	依威能源	2.6	3.5	4.2	7.1
6	上汽安悦	2	2.2	2.4	2.5
7	中国普天	1.5	1.8	2.3	2.4
8	深圳车电网	1.5	1.9	6.9	7.7
9	万马爱充	1.3	1.9	2.6	2.9

2.2 Geographic distribution characteristics

From Figure 1, it is not difficult to find obvious regional differences in the distribution of charging piles. Guangdong, Zhejiang, Jiangsu, Shanghai, Hubei, Beijing, Shandong, Anhui, Henan and Sichuan are the main areas for charging pile construction. These data show that charging piles have a great relationship with the economic development of the city. The more developed the economy is, the more the number of charging piles, and the regional government focuses on supporting the development of new energy vehicles, which also have a promoting role in the development of charging piles.

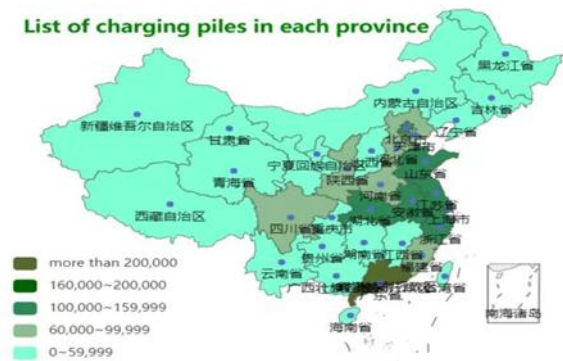


Figure 1 Distribution of charging piles in provinces

Compared with urban areas, the construction of charging piles in rural areas lags behind. It may be because the economic development is relatively backward, the number of electric vehicles is relatively small, and the power facilities may be somewhat backward, not enough to meet the

standards of installing charging piles, and the maintenance of charging piles has also become a relatively big problem.

2.3 Charging pile type and power

According to different charging methods, charging piles are divided into DC charging pile and AC charging pile. DC charging pile is suitable for fast charging, which can shorten the charging time and improve the charging efficiency, while AC charging pile is suitable for slow charging, which can provide a more stable current for electric vehicles. From Figure 2, we can see that AC charging piles in China occupy a relatively large market share, while DC charging piles are relatively few.

In terms of power, the public charging piles are mainly divided into different power levels, such as 30kW, 60kW and 120kW. Among them, 60kW and 120kW charging piles are mainly used for fast charging services in public places such as expressways and urban main roads. The 30kW charging pile is mainly used for slow charging services such as residential areas and commercial places.

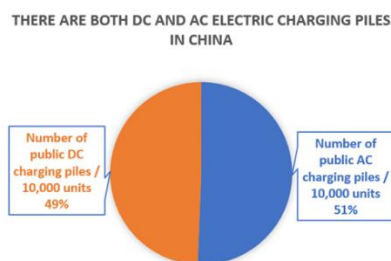


Figure 2: DC and AC electric charging piles in China

2.4 Public charging piles and private charging piles

Different from the installers, charging piles are also divided into public charging pile and private charging pile. As can be seen from Figure 3, in terms of ownership, from the end of 2021 to March 2023, the number of public charging piles reached 5.638 million, with a year-on-year increase of 51.7%; the number of private charging piles reached 5.638 million, with a year-on-year increase of 75.2%. This indicates that the demand for private charging piles is greater than the number of public charging piles. Public charging piles are widely distributed, generally located in parking lots and shopping malls, and the head aggregation effect is obvious. The number of charging piles operated by the top 10 operators accounts for more than 80%, but the distribution is unreasonable and occupied by fuel vehicles. Private charging piles are usually installed in private accommodation, which can be easily used by users. Moreover, in more remote areas, the use of private charging piles is an indispensable part, but the installation cost is relatively high, and it is difficult to maintain in the later stage.

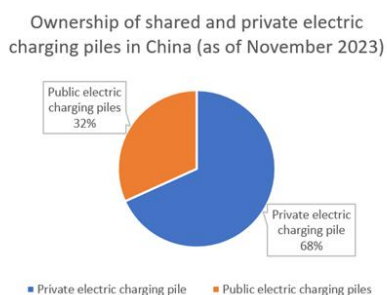


Figure 3: shared and private electric charging piles in China

Through the analysis of the above, it is easy to get China charging pile is in a high-speed development road, it is very good for the development of new energy vehicles, but in the development we also learned some problems, such as charging pile layout distribution: many cities of new energy electric vehicle charging pile number is small, the distribution is relatively scattered

and remote, especially some traffic dense area, charging pile. There are also problems such as difficult maintenance and poor user experience, which are the factors that limit the development of charging piles and we need to solve them.

Comparison of charging pile distribution in the two cities

In order to further analyze the distribution of charging piles, this section selects the distribution of charging piles in Nanchang and Shanghai, and obtains experience from the mature distribution network of charging piles in Shanghai, so as to give some inspiration to Nanchang, an emerging city.

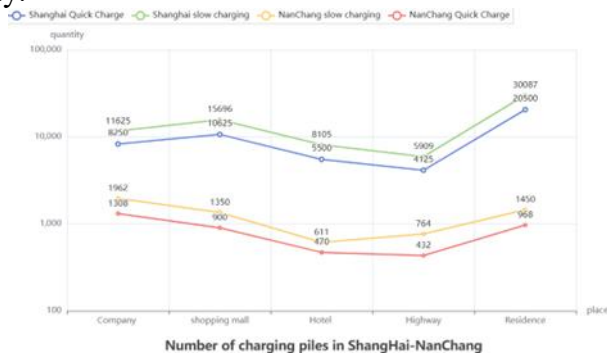


Figure 4. charging pile distribution in Nanchang and Shanghai

From Figure 4, differences in the distribution of charging piles between Nanchang and Shanghai:

1. Shanghai as a first-tier cities, charging pile distribution density is higher, the public pile density of 73.2 / square kilometers, ranked in major cities, covers the main areas of the city, including highway service area, urban business district, public parking lot, etc., and Nanchang as an emerging city, the charging pile is mainly concentrated in the center of the city.

2. Shanghai as a science and technology city, the development history of charging pile is long, the charging pile technology more mature, charging pile more diversified, such as slate built a super charging pile in Shanghai, production with liquid cooling fast charging technology V 3 super charging pile, can achieve the goal of 42% charge 10 minutes, can meet the needs of different users. However, the technology of charging pile in Nanchang is relatively backward, mainly slow charging, and some new charging requirements have not yet matched.

3. Shanghai and Nanchang may also differ in their policy and support for charging pile construction. As a key city in the development of new energy vehicles, the government has given great policy and financial support to the construction of charging piles, and encouraged all sectors of society to actively participate in the construction of charging piles. And Nanchang may be relatively weak in this respect, the lack of sufficient policy support and capital investment.

4. There may also be differences in the use and operation of charging piles in Shanghai and Nanchang. The utilization rate of charging piles in Shanghai may be relatively high, and the operation and management are also more standardized and mature. The utilization rate of charging piles in Nanchang is relatively low, and there may also be some problems in the operation and management.

From the perspective of the distribution of charging piles in Shanghai, Nanchang can obtain the following enlightenment in the development of charging piles:

1. Nanchang can refer to the experience of Shanghai and rationally layout the location and density of charging piles according to urban planning, traffic flow and population distribution, so as to ensure that citizens can easily charge them.

2. Nanchang can also increase the investment, strengthen the infrastructure construction, and improve the quality and safety of charging piles. Only by ensuring safety, can more citizens be willing to use it.

3. Nanchang can also take similar measures to encourage some large companies to locate in cities and attract more social capital to enter the charging pile market. For example, in order to encourage the construction of private charging piles, Shanghai encourages the existing charging piles in the community to carry out intelligent transformation by installing energy routers and

replacing facilities, and gives a financial subsidy of 300 yuan / pile for charging equipment. Nanchang can also take similar measures to improve the construction of the charging pile network.

4. New energy vehicles account for a relatively high proportion of taxis, so Shanghai has introduced support to support the construction of demonstration stations. It is planned that taxi charging demonstration stations will be built every year according to certain construction standards, continue the 30% equipment subsidy policy for the demonstration stations,. Nanchang can also introduce relevant policies to encourage and support the construction and operation of charging piles.

3. Economic effect brought by the charging piles

the charging pile has the following economic effects:

(1) The construction and popularization of charging piles provide the necessary charging services for new energy vehicles. With the continuous expansion of the new energy vehicle market, the demand for charging piles will also continue to increase, thus driving the economic growth of the entire charging pile industry. From January to November 2023, the production and sales of new energy vehicles were 8.426 million units, respectively, with a year-on-year growth of 34.5% and 36.7%, respectively, and the market share reached 30.8%

(2) It is not difficult to find that there are 176,300 charging pile related enterprises in China, with 60,700 enterprises in 2021,80,000 enterprises in 2022 and 111,400 in 2023, showing an overall trend of continuous growth. The charging pile industry is in full swing, involving battery manufacturing, new energy intelligent manufacturing, charging equipment manufacturing, and other market segments, deeply cultivate the supply chain, promote industry reform and promote the innovation and progress of the new energy industry.

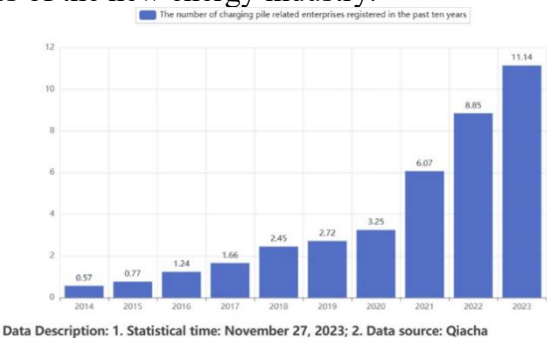


Figure 5: Number of new enterprises related to charging piles

(3) The construction and operation of charging piles can become a new business field, drive a series of investment and enterprise participation, and provide a large number of jobs while obtaining income, which can not only alleviate the severe social employment situation, promote consumer demand, but also promote the stable and sustainable development of the real economy.

(4) The use of charging piles can reduce the dependence on traditional energy sources and promote the transformation of energy structure. The emissions of electric vehicles are lower than those of fuelled vehicles, which is conducive to protecting the environment and thus bringing higher economic benefits.

4. Conclusion

Charging pile of the distribution structure for the development of new energy vehicles has a pivotal role, reasonable charging pile network structure makes the development of new energy vehicles have better prospects, after the distribution of charging pile data climbing and visual analysis, we from the distribution of charging pile, combined with the specific situation of the two cities and economic effect three aspects of in-depth analysis, generally get the following conclusions.

1. China should make reasonable planning in combination with the distribution of existing charging piles to avoid uneven distribution of charging piles and further reduce the idle rate of charging piles. Combine the public charging pile mode with the private charging pile mode to further reduce the installation and maintenance cost of private charging piles, and also reduce the congestion of public charging piles during peak hours. The government has issued encouraging policies in batches, in which the subsidy amount is determined according to the development location. High subsidies are given in remote areas with relatively backward development. At the same time, the installation authority of private charging piles is liberalized, and at the same time also provides certain assistance policies for the later operation and maintenance.

2. The scale of charging pile industry is expanding year by year, and the market impact on China is multifaceted in the long run: from promoting the development of electric vehicle market to increasing employment opportunities, driving economic growth and expanding GDP; from promoting the development of new energy to improving China's energy structure consumption, reducing carbon emissions and promoting carbon neutrality. Charging pile industry will bring more possibilities to China's electric vehicle market.

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References

- [1] Hossain L, Hannan M A, Aini H, et al. A review of state of health and remaining useful life estimation methods for lithium-ion battery in electric vehicles: Challenges and recommendations. *Journal of Cleaner Production*, 2018, 205: 115-133.
- [2] Shi Y, Zhang Q, He A, et al. A real-world investigation into usage patterns of electric vehicles in Shanghai. *The Journal of Energy Storage*, 2020, 32: 101805.
- [3] Zhang Y, Liu X, Wei W, et al. Mobile charging: A novel charging system for electric vehicles in urban areas. *Applied Energy*, 2020, 278: 115648.
- [4] Geng J, Bai B, Hao H, et al. Assessment of vehicle-side costs and profits of providing vehicle-to-grid services. *eTransportation*, 2024, 19: 100303.
- [5] Ma S C, Fan Y. A deployment model of EV charging piles and its impact on EV promotion. *Energy Policy*, 2020, 146:111777.
- [6] Wu H. A survey of battery swapping stations for electric vehicles: Operation modes and decision scenarios. *IEEE Transactions on Intelligent Transportation Systems*, 2021, 23(8): 10163-10185.
- [7] Savari G F, Sathik M J, Raman L A, et al. Assessment of charging technologies, infrastructure and charging station recommendation schemes of electric vehicles: A review[J]. *Ain Shams Engineering Journal*, 2023, 14(4): 101938.
- [8] Wang Y, Guo C, Chen X, et al. Carbon peak and carbon neutrality in China: Goals, implementation path and prospects. *China Geology*, 2021, 4(4): 720-746.
- [9] Wei Y M, Chen K, Kang J N, et al. Policy and management of carbon peaking and carbon neutrality: A literature review. *Engineering*, 2022, 14: 52-63.
- [10] Yan Fu Jing, Chen Weiwei. Power force crack "find a pile difficult". *Caijing Daily reported*.2023
- [11] Wang He. The construction of charging facilities will be accelerated to break the bottleneck of new energy vehicles to the countryside. *The Economic Information Daily*.2023.
- [12] Xie D, Gou Z, Gui X. How electric vehicles benefit urban air quality improvement: A study in Wuhan. *Science of The Total Environment*, 2024, 906: 167584.