BRIEFING

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A statistical view of public charging infrastructure for electric vehicles in China through 2021

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China is one of the leaders in the global transition to electric vehicles (EVs).[1] Tracking and measuring China's vehicle electrification progress is important and many data-driven analyses of its EV market development have been published in recent years. However, few studies have quantitatively examined China's EV charging infrastructure development, even though developing such infrastructure is needed for EVs to succeed in the mainstream market. As an initial attempt to fill this gap, this briefing uses the best available data to provide a statistical portrait of public charging infrastructure for EVs at the end of 2021; while the focus is on China, we include some comparisons to the infrastructure in other regions.[2]

In this paper, public charging infrastructure refers to wired stationary chargers that are accessible to the general public. Private chargers that are only accessible to one or a few specific vehicle owners, such as home chargers in houses and apartments, workplace chargers, and depot chargers for commercial vehicle fleets, are not included. Alternative methods and devices used to recharge EVs, including wireless charging, battery swapping, and overhead catenary charging facilitities, are also outside the scope of this paper.

1 Hongyang Cui and Dale Hall, "Annual Update on the Global Transition to Electric Vehicles: 2021," (ICCT: Washington, DC, 2022), https://theicct.org/publication/global-ev-update-2021-jun22/.

2 The data sources are China Automotive Technology and Research Center (China data), Eco-movement (Europe data), PlugShare (U.S. data), and the International Energy Agency (rest of the world data).

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PUBLIC CHARGING INFRASTRUCTURE PROGRESS GLOBALLY

China has installed more publicly accessible electric vehicle supply equipment (EVSE) than anywhere else in the world.[3] By the end of 2021, China's public EVSE stock reached 1.0 million and that was 56% of the global total (Figure 1). China's stock was 2.3 times larger than the public EVSE stock of Europe and 5.7 times that of the United States. Among China's public EVSE, 48% were direct current (DC) and the other 52% were alternating current (AC). The share of DC EVSE in China was significantly higher than in Europe (14%) and the United States (14%). Of all public DC EVSE installed worldwide by the end of 2021, 81% were in China.

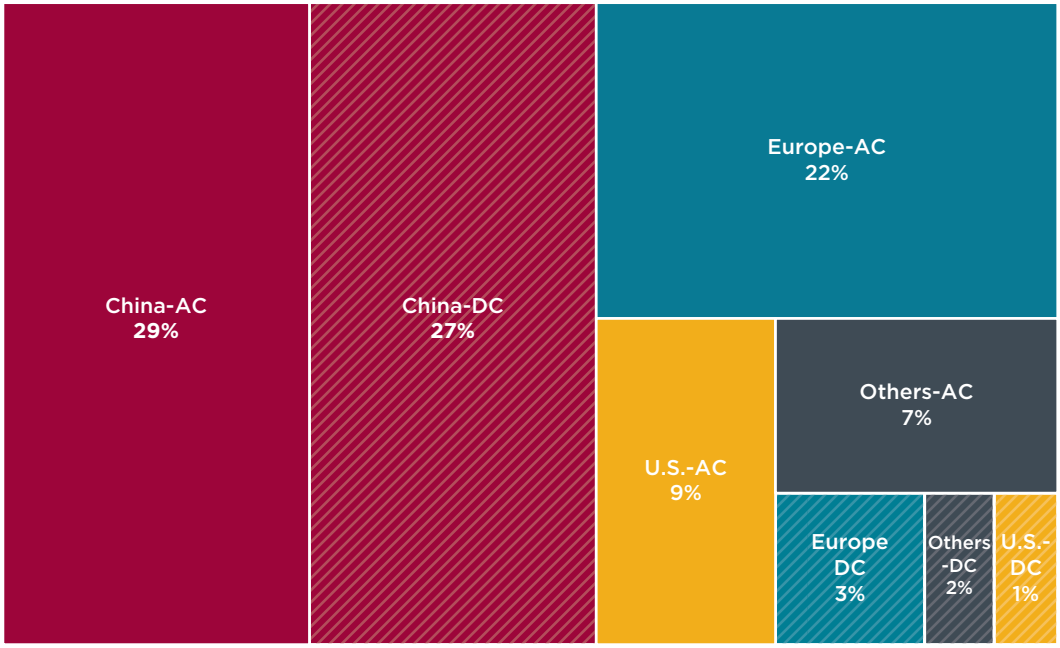

Figure 1. Share of global public EVSE stock by the end of 2021 by market and technology.

Chinese cities are also leading the world. Figure 2 depicts the share of global public EVSE stock in cities by the end of 2021 (left), with a specific focus on the top 20 cities (right). As shown, the top 20 cities with the largest public EVSE stock were 35% of the global public EVSE stock by the end of 2021, and 17 of these cities were in China (red). Two of the cities are in Europe (blue) and one is in the United States (yellow). Shenzhen ranked first with 7% of the entire global stock, and was followed by Shanghai (4%), Guangzhou (3%), Wuhan (3%), and Beijing (2%). With 125,000 public EVSE in place, Shenzhen was the only city in the world that had a public EVSE stock of over 100,000 by the end of 2021.

3 An electric vehicle supply equipment (EVSE) can have one or multiple connectors. When it has multiple connectors, it provides power to only one connector to charge only one vehicle at a time.

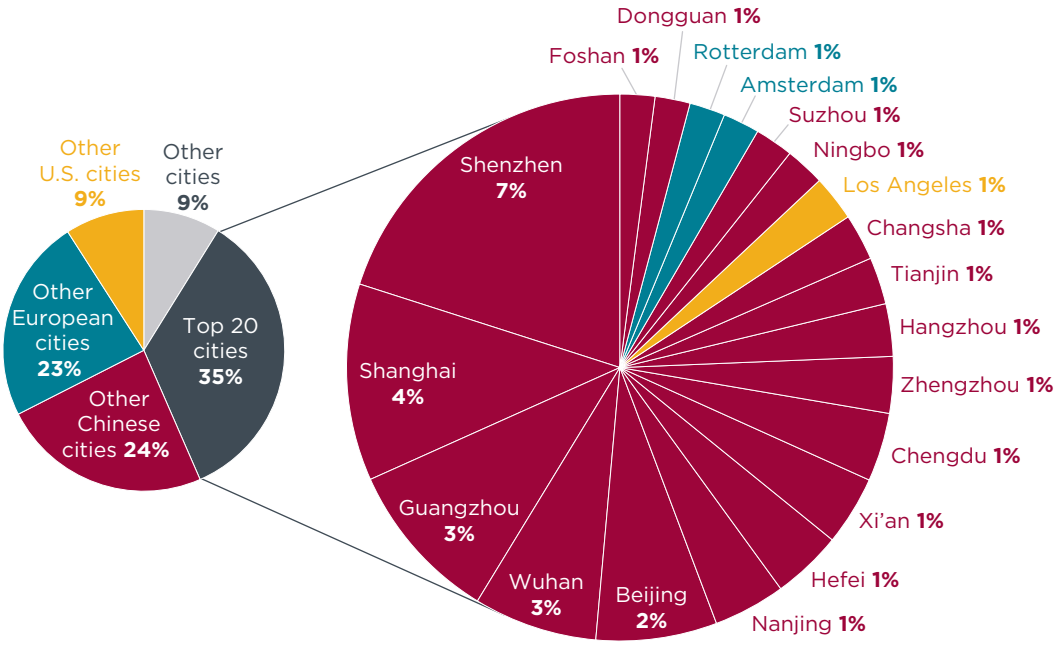

Figure 2. Share of global public EVSE stock in cities by the end of 2021 with a specific focus on the top 20 cities (right).

PUBLIC CHARGING AVAILABILITY IN CHINA

The maps in Figure 3 illustrate public charging availability at the end of 2021 in Chinese cities using four metrics. In addition to showing EVSE stock, we normalize charging infrastructure by geographic size, population, and EV stock. Regardless of the metric used, we find that public charging availability varied significantly. In general, cities in eastern and southern China were ahead of those in western and northern China. As most of the cities that lead in number of EVs deployed are also concentrated in eastern and southern China, this implies a synergetic development of EVs and public charging infrastructure at the city level.[4]

That the city rankings differed considerably when using different metrics emphasizes the necessity of considering a comprehensive set of metrics when evaluating public charger availability. Shenzhen and Wuhan were the only two cities that ranked among the top 10 in all four metrics. Shenzhen ranked first in three metrics—the absolute number of public EVSE, the number of public EVSE per square kilometer of built-up area, and the number of public EVSE per 10,000 population—and this indicates a strong leading position. On average, China had 21 public EVSE per square kilometer of built-up area, 0.73 public EVSE per thousand population, and 0.12 public EVSE per electric passenger vehicle registered by the end of 2021. Comparatively, Europe and the United States had 0.85 and 0.43 public EVSE per thousand population and 0.08 and 0.06 public EVSE per electric passenger vehicle registered, respectively, by the end of 2021.

4 Yidan Chu and Hui He, "Leading New Energy Vehicle City Markets in China: A 2021 Update," (ICCT: Washington, DC, 2022), https://theicct.org/publication/ev-china-city-markets-2021-update-nov22/.

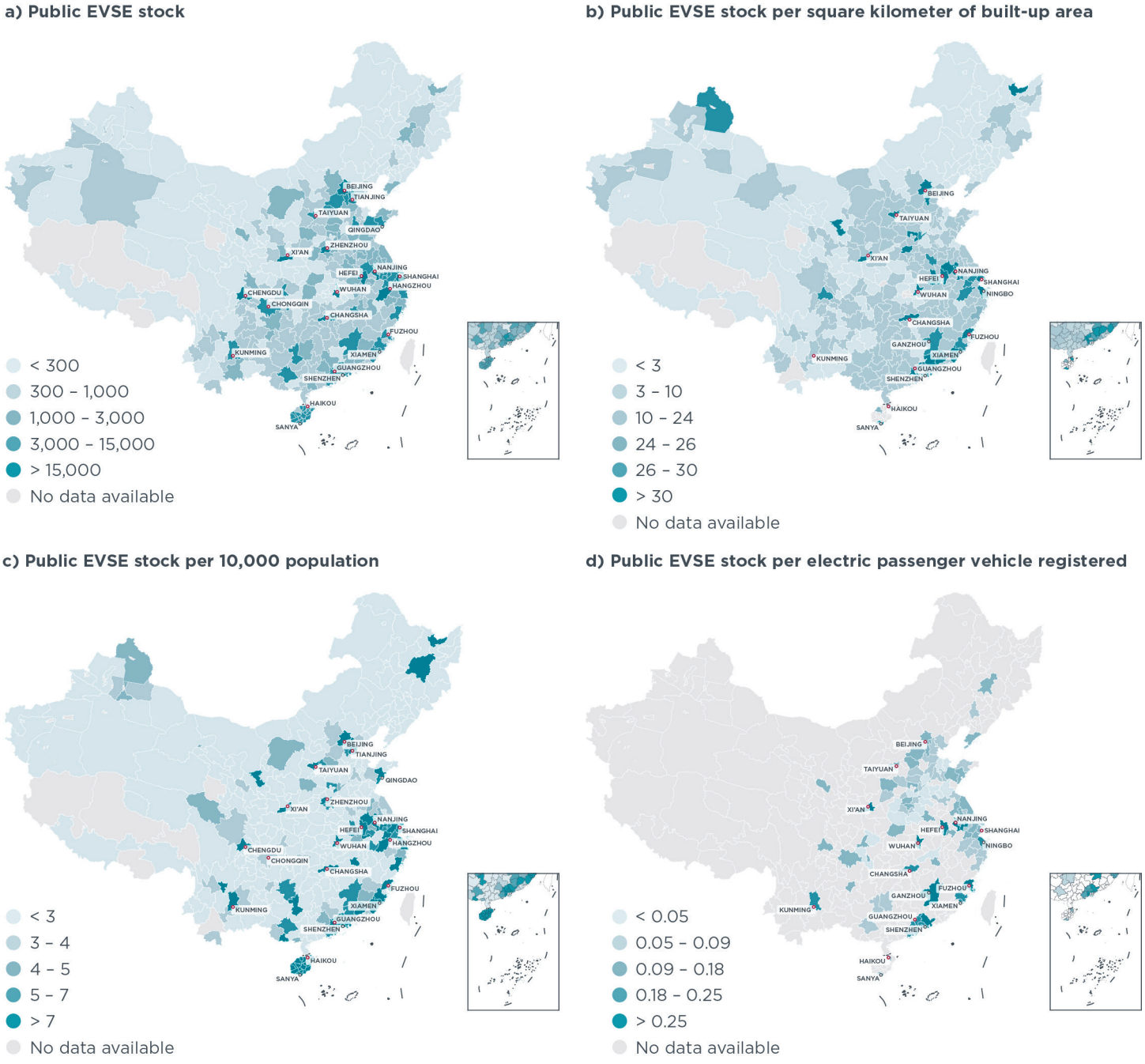

Figure 3. Public charging availability in Chinese cities by the end of 2021 according to different metrics. For (d), only cities with an electric passenger vehicle stock of over 20,000 by the end of 2021 were considered.

The above metrics are most frequently used by governments and researchers, but service radius is another metric, and it is increasingly emphasized in China when assessing public charger availability. Service radius is the minimum radius, measured in meters, within which an EV driver could find at least one public charger no matter where the driver is located in the city. Figure 4 explores this metric using Beijing, Chengdu, and Shenzhen as examples. By the end of 2021, Shenzhen, the city with the highest urbanization rate in China (99.8%), reached a 100% coverage rate when the radius was 2.6 km. This means that Shenzhen's service radius was 2.6 km, indicating that an EV driver located anywhere in Shenzhen could find a public charger within a 2.6 km radius. Although the urban centers of Beijing and Chengdu had coverage rates similar to Shenzhen, as these two cities cover a much larger geographic area and have a lower urbanization rate, they only achieved a 60% and 40% coverage rate,

respectively, when the radius was around 4 km. This indicates that the progress on public charging infrastructure deployment in suburban and rural areas of these large cities was relatively lagging.

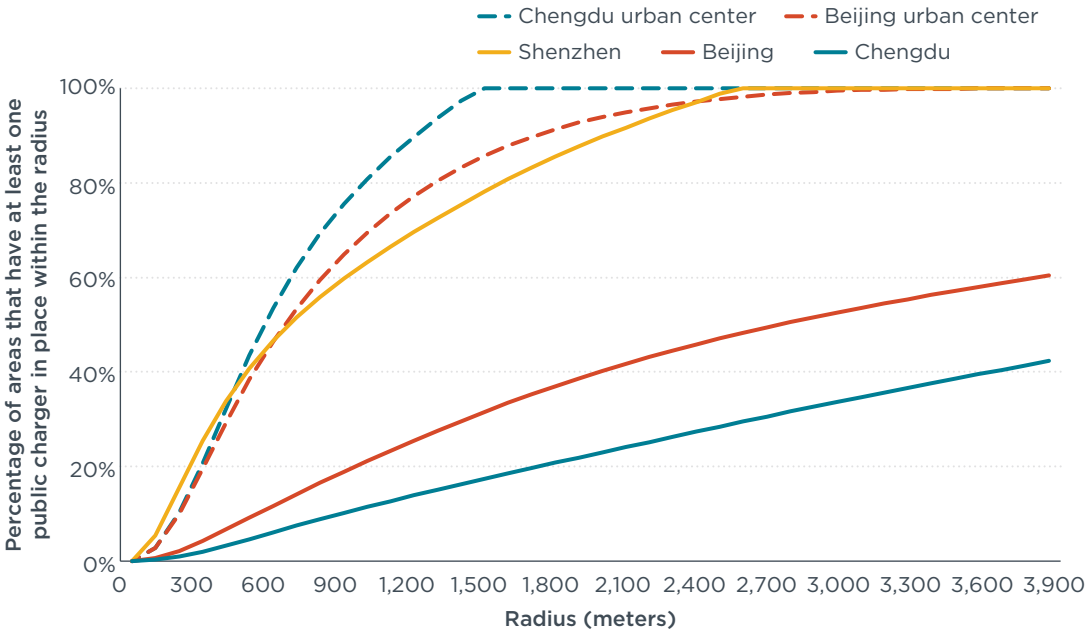

Figure 4. Percentage of areas that had at least one public charger in place within different radiuses in Beijing, Chengdu, and Shenzhen by the end of 2021.

Besides availability, public charger capacity in terms of power output is also critical. China's public chargers were dominated by AC chargers with a rated power of 7 kilowatts (kW) and DC chargers with a rated power of 120 kW, 60 kW, and 150 kW (Figure 5).[5] These four types of chargers accounted for 49%, 13%, 11%, and 7% of the nation's public charger stock by the end of 2021, respectively. Among China's public AC chargers, 88% were 7 kW and 5% were 3.5 kW. Of China's public DC chargers, 30% were 120 kW, 24% were 60 kW, and 15% were 150 kW. By the end of 2021, the total rated power of China's public EVSE exceeded a gigawatt and the public power installed per electric light-duty vehicle in China was 4.9 kW, which was more than twice that installed in the European Union.[6]

5 A charger can be composed of one or multiple EVSE. If a charger is composed of multiple EVSE, the charger distributes power to each EVSE with a specific power distribution strategy. The power distribution strategies of different chargers vary. The rated power data analyzed in this study is charger power instead of EVSE power.

6 Marie Rajon Bernard, Michael Nicholas, Sandra Wappelhorst, and Dale Hall, "A Review of the AFIR Proposal: How Much Power Output is Needed for Public Charging Infrastructure in the European Union?," (ICCT: Washington, DC, 2022), https://theicct.org/wp-content/uploads/2022/03/europe-ldv-review-of-afir-proposal-how-much-power-output-needed-for-public-charging-infrastructure-in-the-eu-mar22-2.pdf.

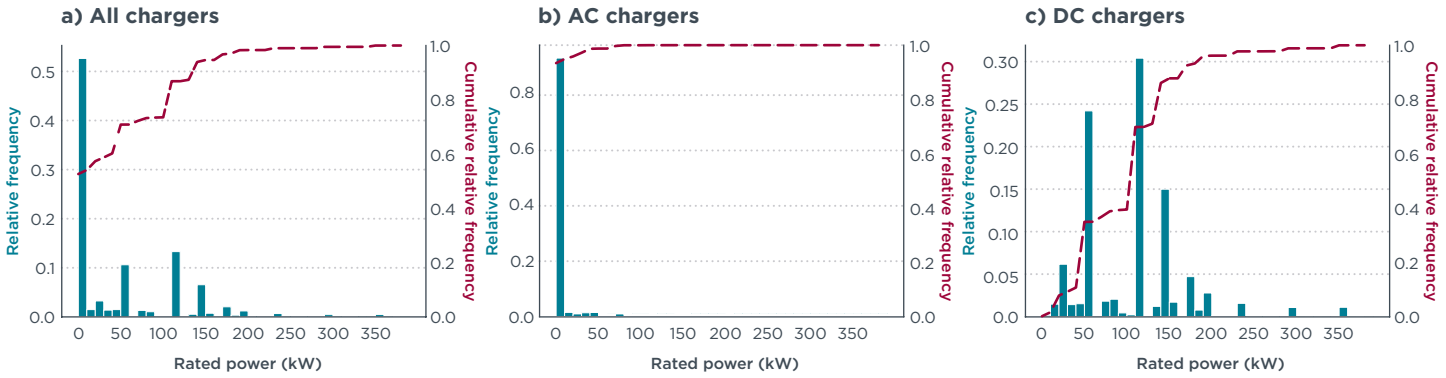

Figure 5. Rated power distribution of China's public chargers by the end of 2021.

Figure 6 displays the rated power distribution (nuclear density) of public chargers at the city level using Beijing, China's capital city, Chengdu, a key logistics center in southwest China, Nanning, a leading city in electric microcar deployment, and Lhasa, a city in a less-developed region, as examples. It is clear that the rated power distribution of public chargers varied sharply by city. Although over 60% of public chargers in Beijing and Nanning were 7 kW AC chargers, the rated power of public chargers in the other two cities was more evenly distributed. The larger share of 7 kW AC chargers in Beijing is probably because it is one of the most densely populated cities in the world and residents face more challenges in installing home chargers; as a result, there is more demand for public AC chargers. The larger demand for 7 kW AC chargers in Nanning is a result of the Wuling Hongguang Mini EV's dominant role in the city's EV sales. The 7 kW AC charger is sufficient to meet the charging needs of this microcar model, whose battery capacity is only 10–20 kWh. As shown, most of the public chargers in the four cities had rated power below 200 kW; still, Beijing and Chengdu had a small number of higher-power chargers in place (Nanning and Lhasa did not). This is reflective of Beijing and Chengdu's leading position in deploying more innovative technologies and their initial attempts to construct a charging network for electric heavy-duty vehicles.

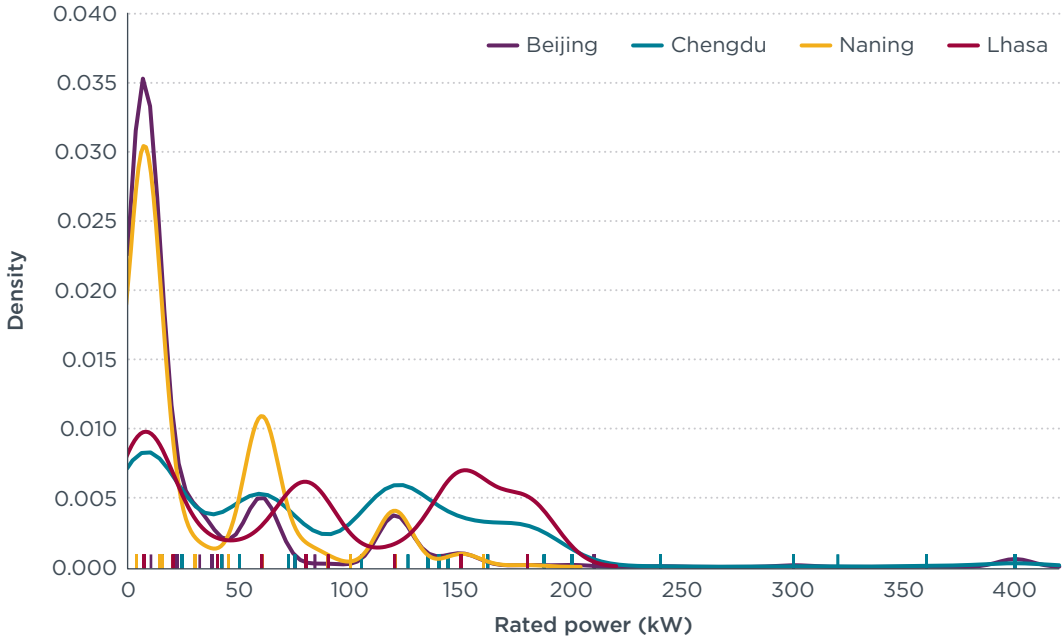

Figure 6. Rated power distribution (nuclear density) of public chargers in Beijing, Chengdu, Nanning, and Lhasa by the end of 2021.

FINAL REMARKS

The electric share of new vehicle sales in China exceeded 25% in 2022.[7] As China continues its rapid transition to EVs, establishing a charging infrastructure network that fulfills the needs of EV drivers will be more and more important. Tracking and measuring charging infrastructure development progress is also important for success. This briefing is an initial attempt to assess the availability and capacity of China's public charging infrastructure at the national and city levels. It demonstrates that China on the national level and Chinese cities are leading the world in public charger stock and highlights the importance of using a full set of metrics to comprehensively evaluate charging infrastructure development progress. Continued and more in-depth analysis is needed to better guide policy efforts. In 2023, the ICCT intends to investigate China's public charging infrastructure development based on more recent data and to compare China's progress with Europe and the United States, with an aim of mutual learning.

7 China Association of Automobile Manufacturers, 2022年汽车工业产销情况[*Vehicle Production and Sales in 2022*], http://www.caam.org.cn/chn/4/cate_32/con_5236639.html.