Chapter 8
Parallel Hybrid Electric Vehicles

As one of the most effective low-carbon solutions in the automotive industry, parallel hybrid electric vehicles (PHEVs) play an important role in promoting energy conservation and carbon reduction in the automotive industry in the short to medium term during its transformation and development. PHEVs can meet consumers' diverse application scenarios and usage needs, and the market demand has shown a rapid growth trend since 2021. With PHEVs as a research perspective, by comparing the industry policies and market overview of PHEVs at the national and local levels and deeply exploring the operation conditions of PHEVs and typical urban vehicle operation characteristics, this chapter summarizes vehicle operation rules and user usage habits to promote the technological progress and healthy development of PHEV products.

8.1 Development Status of PHEV Industry

8.1.1 Industrial Support Policy Tightening at the National Level

Compared to traditional fuel vehicles, PHEV products achieve a dual balance between power and economic performance and can meet the diverse usage needs of consumers. From a market perspective, PHEV products have a certain degree of market competitiveness, and the industrial support policies for promoting PHEVs at the national level are gradually tightening.

1. **Ease the intensity and pace of subsidy reduction, and continue the fiscal subsidy policy until the end of 2022**

In order to ease the intensity and pace of subsidy reduction, the subsidy policy, originally scheduled to expire at the end of 2020, has been reasonably extended until the

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end of 2022. On April 23, 2021, the Ministry of Finance, the Ministry of Industry and Information Technology, the Ministry of Science and Technology, and the National Development and Reform Commission of PRC jointly issued the *Notice on Improving the Financial Subsidy Policy for the Promotion and Application of NEVs* (CJ [2020] No. 86), intending to maintain support for the NEV industry, implementing precise policies, and promoting high-quality development of the industry. From 2020 to 2022, the subsidy funds were reduced by 10, 20, and 30% from the previous year (Table 8.1). In order to speed up the electrification of vehicles in public transport and other fields, the subsidy funds for conforming vehicles for urban public transport, road passenger transport, taxi service (including E-taxi service), environmental sanitation, urban logistics distribution, postal express, civil aviation airports and the official business of party and government agencies didn't decline in 2020. The subsidy funds were reduced by 10% and 20% respectively from the previous year. In principle, up to 2 million vehicles will be subsidized annually; In addition, we should underpin outstanding enterprises, optimize technical thresholds appropriately, and promote advantageous enterprises to become bigger and stronger.

On December 31, 2020, and December 31, 2021, the four ministries and commissions jointly issued the *Notice on Further Improving the Financial Subsidy Policy for the Promotion and Application of NEVs* (CJ [2020] No. 593) and the *Notice on the Subsidy Policy for the Promotion and Application of NEVs in 2022* (CJ [2021] No. 466), both of which stipulate that under the condition that $R \geq 50$ (NEDC condition)/$R \geq 43$ (WLTC condition), the subsidy amount for PHEV passenger cars will continue to decline.

2. **Encourage the purchase of NEVs and exempt them from vehicle purchase taxes for consecutive years**

In order to support the development of the NEV industry and promote consumption in the NEV market, relevant national ministries and commissions successively issued policy documents on exempting NEV purchase taxes. Such documents include the *Announcement on Exemption of New Energy Vehicle Purchase Tax* (Announcement No. 53, 2014 of the Ministry of Finance, the State Taxation Administration, the Ministry of Industry and Information Technology) issued by the Ministry of Finance, the State Taxation Administration, and the Ministry of Industry and Information Technology on August 1, 2014, with its valid period from September 1, 2014 to December 31, 2017, and the *Announcement on Exemption of New Energy Vehicle Purchase Tax* (2017 No. 172) jointly issued by the Ministry of Finance, the State

Table 8.1 Subsidy program for PHEV passenger cars in 2021 and 2022

Year	Non-public field		Public field	
	Reduction percentage (%)	Subsidy amount (10,000 yuan)	Reduction percentage (%)	Subsidy amount (10,000 yuan)
2021	20	0.68	10	0.9
2022	30	0.48	20	0.72

Taxation Administration, the Ministry of Industry and Information Technology and the Ministry of Science and Technology on December 26, 2017. New energy vehicles purchased were exempt from vehicle purchase taxes from January 1, 2018, to December 31, 2020.

On April 16, 2020, the Ministry of Finance, the State Taxation Administration, and the Ministry of Industry and Information Technology of China jointly issued the *Announcement on the Relevant Policies for the Exemption of New Energy Vehicle Purchase Tax* (Announcement 2020 No. 21) (referred to as the "Announcement"). The Announcement stipulates that from January 1, 2021, to December 31, 2022, new energy vehicles purchased will be exempt from vehicle purchase taxes. NEVs exempt from vehicle purchase taxes refer to EVs, PHEVs (including EREVs), and FCEVs. New energy vehicles exempt from vehicle purchase taxes shall be managed by releasing the *Catalogue of New Energy Vehicle Models Exempted from Vehicle Purchase Taxes* by the Ministry of Industry and Information Technology and the State Taxation Administration.

3. **Increased investment threshold for the PHEV industry**

Before January 10, 2019, investment projects in the PHEV industry fell into the category of new energy vehicles.

On January 6, 2017, according to the Decree of the Ministry of Industry and Information Technology of the People's Republic of China (No. 39), the *Regulations on New Energy Vehicle Manufacturing Enterprises and Product Access Management* were reviewed and approved on the 26th Ministerial Meeting of the Ministry of Industry and Information Technology on October 20, 2016. They will be implemented as of July 1, 2017. EVs and PHEVs are new energy vehicles, and the Ministry of Industry and Information Technology is responsible for implementing the supervision and management of new energy vehicle manufacturers and product access.

The Provisions for the Administration of Investment in the Automotive Industry of NDRC incorporate PHEV industry investment projects into the investment scope of fuel vehicles.

On December 18, 2018, the National Development and Reform Commission issued the *Provisions for the Administration of Investment in the Automotive Industry* (referred to as the "Provisions"), which was officially implemented on January 10, 2019. These Provisions explicitly state that the investment projects for automobiles are divided into two types based on the powertrain: fuel vehicles and electric vehicles, which means that all future automobile investment projects must be classified into these two types (Fig. 8.1). FCEVs, EVs, and EREVs are included in electric vehicle investment projects, while traditional fuel vehicles, hybrid electric vehicles, and PHEVs are included in the investment scope of fuel vehicles. This provision means that only enterprises with fuel vehicle production qualifications can produce PHEVs, while enterprises with electric vehicle production qualifications (such as new vehicle manufacturers) can only produce electric vehicles rather than PHEVs.

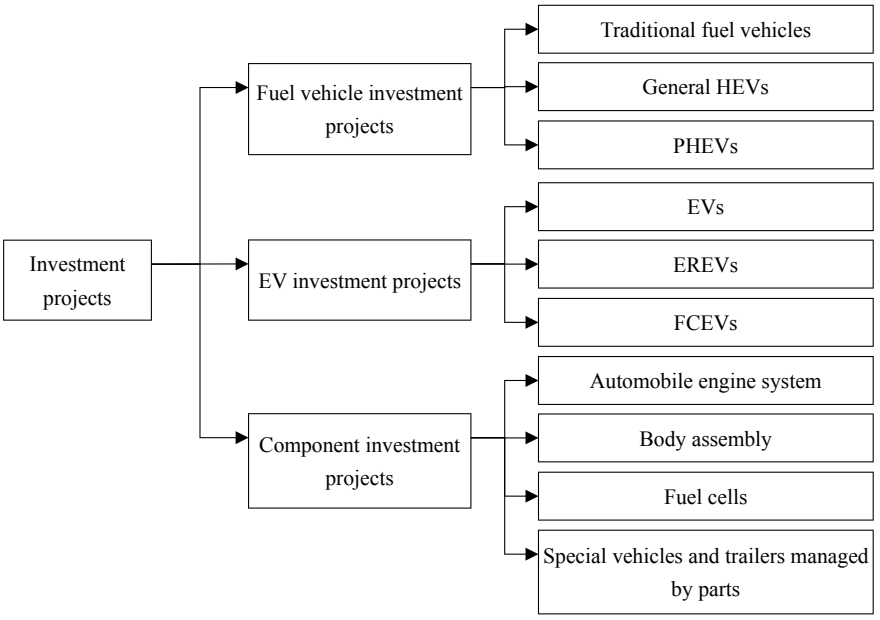

Fig. 8.1 Classification of investment projects in the Provisions for the *Administration of Investment in the Automotive Industry* (2018)

The *Provisions* issued on December 18, 2018, regulate the direction of production capacity investment and do not conflict with the current national support policies for new energy vehicles.

8.1.2 Differentiation of Support Policies at the Local Government Level

The policies for promoting PHEVs in key cities nationwide have significant differences. Beijing and Shanghai are gradually tightening their regulations on PHEVs, while Guangzhou and Shenzhen have relatively loose policies on PHEVs, occupying the quota of new energy vehicles.

1. **Beijing: PHEVs do not enjoy policies such as exemption from traffic restrictions**

In Beijing, PHEVs occupy fuel licenses and do not enjoy the "no restrictions" preferential policy.

According to the *Implementation Rules of the Interim Regulations on the Control of the Quantity of Small Passenger Cars in Beijing* (revised in 2017), new energy small buses refer to small electric buses. The quotas of small new energy buses are

allocated through waiting mode. After selling or scrapping small new energy buses, entities or individuals can apply for updating the quotas of small new energy buses. According to the regulations on vehicle management in Beijing, there is a difference between JAD and JAF in the green license plates for new energy vehicles. Users can apply for green license plates starting from JAF for PHEVs (including EREVs) but do not enjoy the right-of-way privilege.

2. **Shanghai: from 2023, PHEVs will withdraw from the free license plate offer**

In February 2021, the Shanghai Municipal Government issued the *Regulations on Encouraging the Purchase and Use of New Energy Vehicles in Shanghai* (referred to as the "Regulations"). The NEVs referred to in the Regulations refer to electric vehicles, PHEVs (including EREVs), and FCEVs that have been included in the national *Catalog of Recommended Models for Promotion and Application of New Energy Vehicles* or other relevant model catalogs, sold and used in the city, and comply with the management regulations of this city. From January 1, 2023, dedicated license plates will no longer be issued for consumers who purchase PHEVs (including EREVs). Consumers who purchase NEVs for non-business purposes and have not registered using the city's dedicated license quota under their username will be granted free dedicated licenses under the principle of controlling the total number of non-business buses in this city. Consumers who purchase PHEVs (including EREVs) should apply for a dedicated license plate and also meet the following requirements: a charging facility that meets the requirements of intelligent technology and safety standards has been provided in this city; There is no proof of nonbusiness bus quota under the personal username, and there are no motor vehicles (excluding motorcycles) registered with non-business bus quota.

From the perspective of policy trends, the Shanghai government encourages consumers who do not own cars to purchase any type of new energy vehicle and can enjoy the free green license plate policy. From 2023, PHEVs (including EREVs) and small electric buses will withdraw from the list of free license plates.

3. **Guangzhou: enjoy the green license plate policy for PHEVs**

In July 2018, the Guangzhou Municipal Government issued the Regulations on the Control of the Total Quantity of Small and Medium-sized Buses in Guangzhou. NEVs refer to small and medium-sized Buses (including EVs, PHEVs, and FCEVs) listed in the *Catalog of Recommended Models for Promotion and Application of New Energy Vehicles* issued by the Ministry of Industry and Information Technology, as well as imported new energy small and medium-sized buses marked by relevant national departments. Units and individuals who need to register new energy vehicles can directly apply for their quotas based on vehicle information.

4. **Shenzhen: enjoy the green license plate policy for PHEVs**

In July 2019, the Shenzhen Municipal Government issued the *Rules for the Control and Management of Increased Cars in Shenzhen.* New energy vehicles refer to electric cars, PHEVs (including EREV), and fuel cell cars that comply with the automotive

product announcement catalog of the Ministry of Industry and Information Technology of the People's Republic of China and original imported electric cars licensed by relevant national regulations. The incremental quotas are allocated through lottery, bidding, or directly applying according to regulations. There is no limit on the incremental quotas for hybrid and electric cars, which are directly allocated after application and qualification review.

On December 14, 2021, the Transport Bureau of Shenzhen Municipality proposed matters related to adjusting the incremental quotas of new energy cars. According to the *Notice of the General Office of the People's Government of Guangdong Province on Printing and Distributing Several Policies and Measures to Promote Urban Consumption* (YFB [2021] No. 36), non-Shenzhen registered residence persons with valid Shenzhen residence permits and overseas Chinese and residents of Hong Kong, Macao, and Taiwan with valid identity certificates who have gone through temporary accommodation registration for foreigners following the provisions of the municipal public security organ, as well as foreigners applying for visas or residence permits in this city, are not required to make payments (excluding supplementary payments) of basic medical insurance in this city for more than 24 consecutive months for the incremental quotas of new energy cars (including PHEVs and BEVs).

8.2 Promotion of PHEVs

8.2.1 Current Situation of the PHEV Market

PHEVs are gradually shifting from a supply side drive to a dual supply and demand drive, and the domestic market maintained a high growth demand trend in 2021.

PHEVs have shown a fluctuating growth trend in the past five years. After selling 267,000 PHEVs in 2018, the overall decline in the new energy vehicle market in 2019 resulted in a significant decrease in market sales compared with 2018. Since 2021, new models supplied by vehicle manufacturers have been diversified and abundant, such as BYD Qin, BYD Song PLUS, Li ONE, BYD Tang/Han, and BMW 5 Series. On the demand-side level, due to consumer demand for upgrades in fuel consumption, mileage, and other aspects, the sales of PHEVs in the domestic market increased from 79,000 to 603,000 from 2015 to 2021, the demand has increased by 7.6 times, and the market demand shows a rapid growth trend (Fig. 8.2).

Since 2021, with the successive launch of the new generation of domestic PHEV benchmarking products, some domestic proprietary brand PHEV products have been successively launched on the market, and some product functions have reached or exceeded the level of joint venture products, providing a variety of product specifications for the domestic consumer market, which is more in line with the actual needs of consumers in the domestic market. The TOP5 PHEV models in China in 2021, including the Qin PLUS DM-i, Li ONE, Song Pro DM, Tang PHEV, and Han

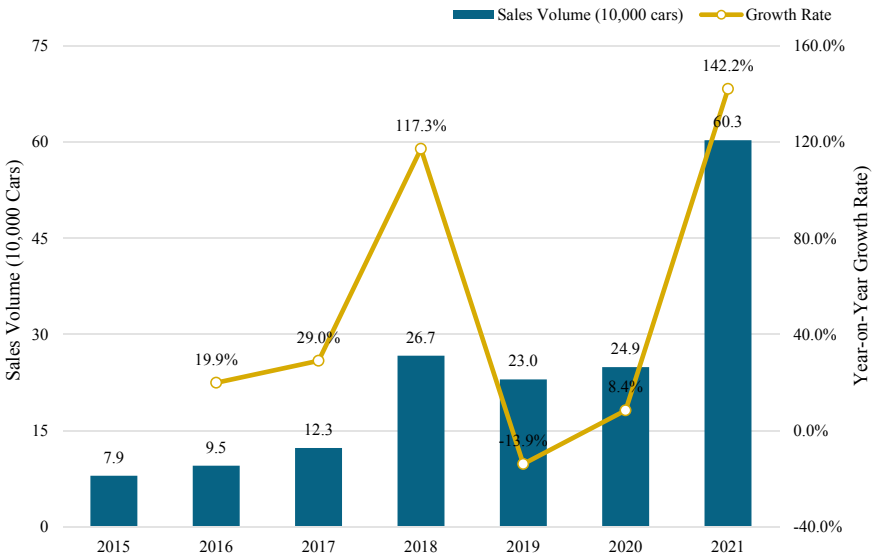

Fig. 8.2 Sales and growth of PHEVs over the years. *Source* China Association of Automobile Manufacturers

Table 8.2 TOP5 models of PHEV sales in 2021

Model	Sales volume (vehicles)	Vehicle level	NEDC (km)	Maximum battery capacity (kWh)	Guide price
Qin Plus DM-i	113,656	Class A car	120	18.30	132,800–148,800
Li ONE	90,491	Class C SUV	188	40.50	338,000
Song Pro DM	79,508	Class A SUV	81	15.70	169,800–219,800
Tang PHEV	48,152	Class B SUV	100	23.98	236,800–286,800
Han DM	30,476	Class C sedan	81	15.30	219,800–239,800

DM, are all domestic proprietary brands. Such models have set benchmarks in the domestic market Regarding mileage, price, and battery power and have received positive feedback from the market (Table 8.2).

8.2.2 *Access of PHEVs*

1. **Cumulative PHEV access characteristics**

The access quantity of PHEVs is rapidly increasing, and a total of over 1.1 million PHEVs have accessed the National Monitoring and Management Platform.

As of December 31, 2020, 1.1065 million PHEVs have been accessed to the National Monitoring and Management Platform, including 1,068,300 PHEVs passenger cars, accounting for 96.55% of PHEVs (Fig. 8.3). 875,800 private passenger cars have been accessed, accounting for nearly 80% of PHEV passenger cars.

The concentration of PHEVs in provinces is relatively high, with Shanghai and Guangdong provinces taking the lead.

From the cumulative access situation of PHEVs in various provinces (Fig. 8.4), the cumulative PHEVs in Shanghai and Guangdong are 245,900 and 240,000, ranking in the top two and accounting for 22.22 and 21.69% nationwide, both of which exceed 1/5, indicating a high concentration. Regarding the proportion of PHEV passenger cars in various provinces, the PHEV passenger cars in the TOP15 provinces account for more than 85% of local PHEVs, of which the PHEV passenger cars in Shanghai, Guangdong, and Tianjin account for more than 99%.

The passenger car promotion effect in Shanghai and Guangdong is significant; the cumulative registered PHEV buses in Zhejiang Province, Jiangsu Province, and Shandong Province account for over 10% of the total PHEVs in China.

From the perspective of the promotion concentration of PHEV passenger cars in various provinces (Fig. 8.5), Shanghai and Guangdong are far ahead in the cumulative access volume of PHEV passenger cars nationwide. As of December 31, 2021, the cumulative access volume of PHEV passenger cars in Shanghai and Guangdong has reached 245,200 and 238,600, accounting for 22.95 and 22.33% of the total in China; The cumulative access volume of PHEV passenger cars in Zhejiang Province has

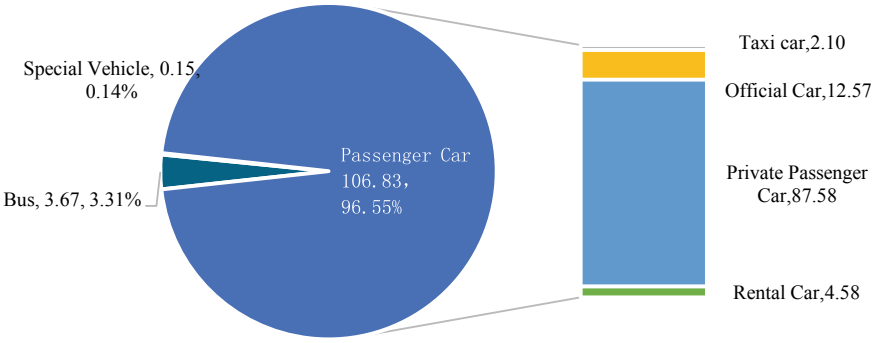

Fig. 8.3 Cumulative access and proportion of PHEVs—by type

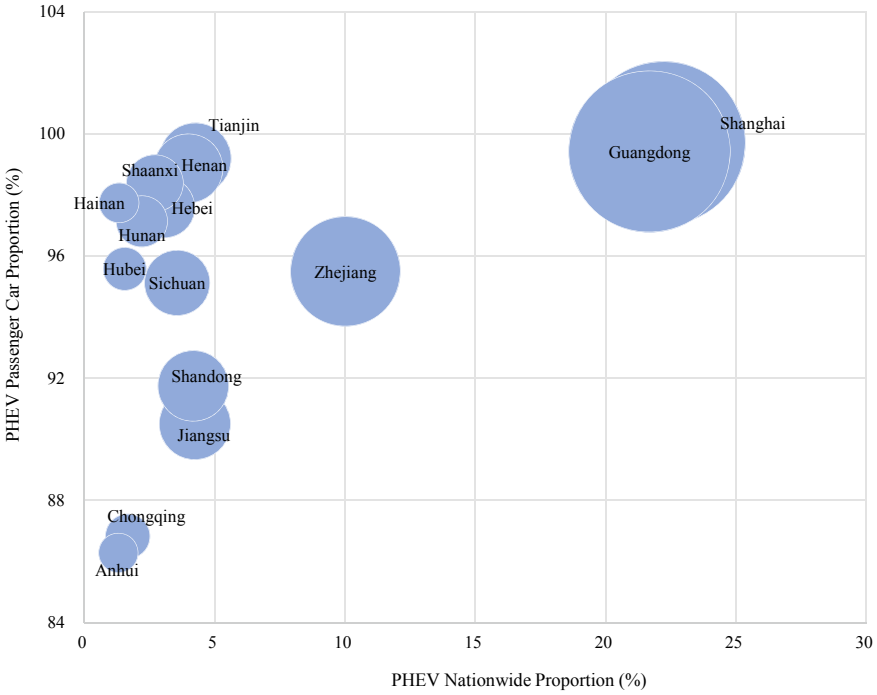

Fig. 8.4 Cumulative access and proportion of PHEVs in the TOP15 provinces. *Note* The bubble size indicates the cumulative access volume of PHEVs in each city by the end of 2021

exceeded 100,000, reaching 105,900, accounting for 9.91% of the total in China; The promotion quantity of PHEV passenger cars in other provinces is less than 100,000.

The cumulative access volume of PHEV buses in Zhejiang Province, Jiangsu Province, and Shandong Province ranked in the top three, with cumulative access volumes of 5000, 4300, and 3800, accounting for 13.60, 11.82, and 10.42% in China (Fig. 8.6).

Regarding the concentration of passenger cars in various cities, Shanghai and Shenzhen are leading other cities in China, with cumulative access accounting for over 10% of the total access in China.

From promoting PHEV passenger cars in various cities (Fig. 8.7), Shanghai, Shenzhen, and Hangzhou ranked among the top three Regarding cumulative access. As of December 31, 2021, the cumulative access volume of PHEV passenger cars in Shanghai, Shenzhen, and Hangzhou reached 245,200, 140,900, and 79,000, accounting for 22.95, 13.19, and 7.40% of the total in China. The access volume of PHEVs in the TOP3 cities was 465,100, accounting for 43.54% of the total in China. The access volume of PHEVs in the TOP10 cities was 681,800, accounting for 63.82% of the total in China.

Autonomous brands accelerate the layout of hybrid products and promote the reshaping of the PHEV market pattern.

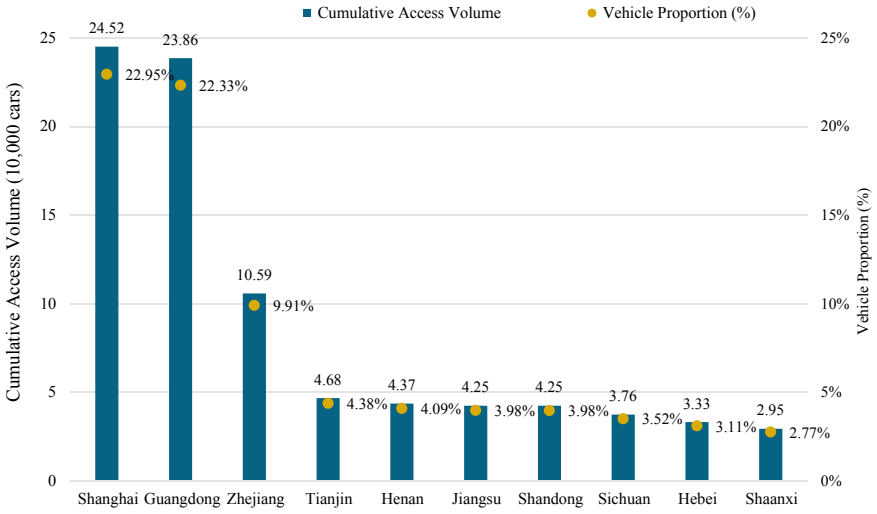

Fig. 8.5 Cumulative access and proportion of PHEV passenger cars in the TOP10 provinces

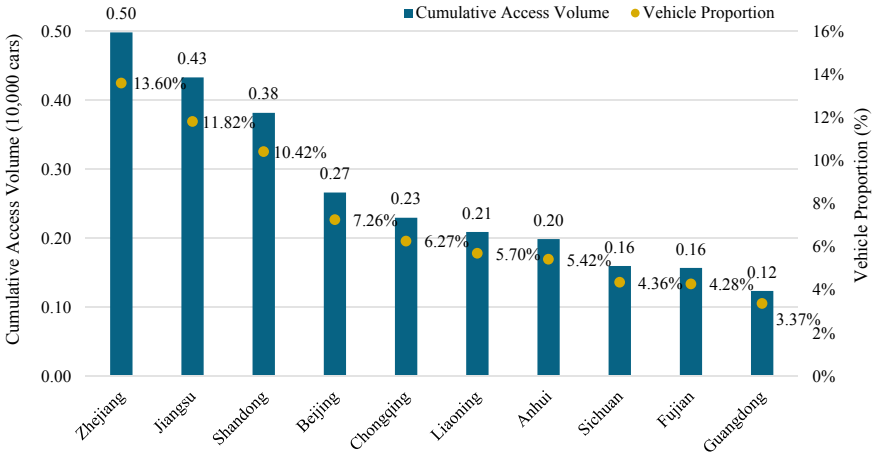

Fig. 8.6 Cumulative access and proportion of PHEV buses in the TOP10 provinces

From the perspective of the promotion concentration of all PHEV passenger car manufacturers (Fig. 8.8), as of December 31, 2021, the access volume of BYD Auto Automobile, SAIC Motor, and BYD Automobile Industry ranked first three, and the access volume of PHEV passenger cars reached more than 100,000. With the active deployment of hybrid technology by domestic brands, including the release of BYD DM-i, Great Wall Lemon DHT, Geely GHS2.0, Chery Kunpeng DHT, and Chang'an Blue Whale iDD platforms, the layout of domestic brand hybrid products has promoted the reshaping of the hybrid market pattern. The popular DM-i series

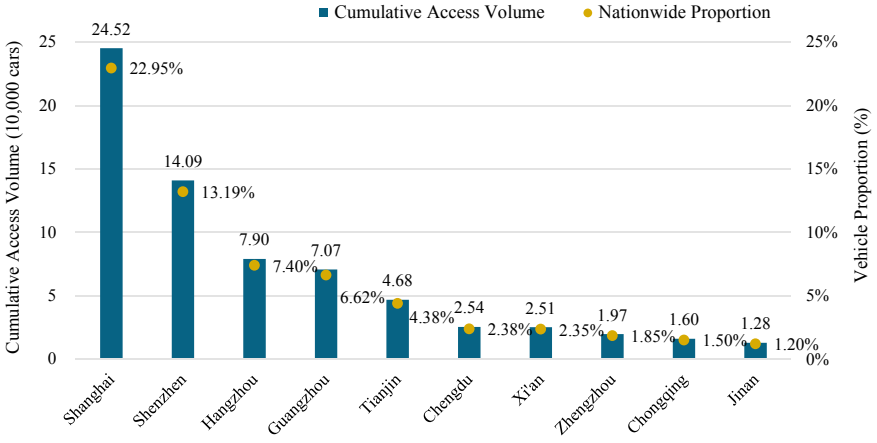

Fig. 8.7 Cumulative access and proportion of PHEV passenger cars in the TOP10 cities

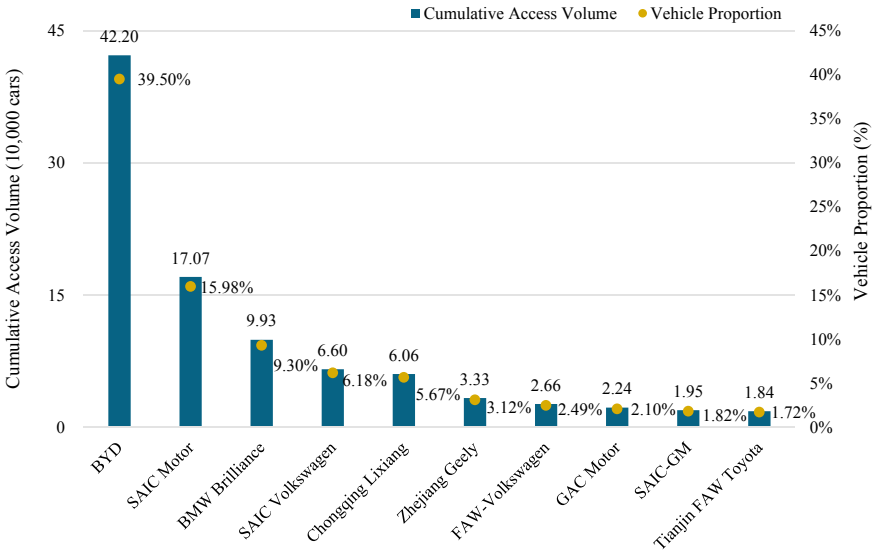

Fig. 8.8 Cumulative access characteristics of PHEV passenger cars from TOP10 manufacturers

has driven BYD's further breakthrough in the PHEV segment market. By the end of 2021, the cumulative access volume of BYD's PHEVs reached 422,000, accounting for 39.5% of the national market.

From the perspective of the promotion concentration of all PHEV bus manufacturers (Fig. 8.9), as of December 31, 2021, the access volume of Zhengzhou Yutong, Foton, and Golden Dragon ranked first three reached more than 9200, 5600, and

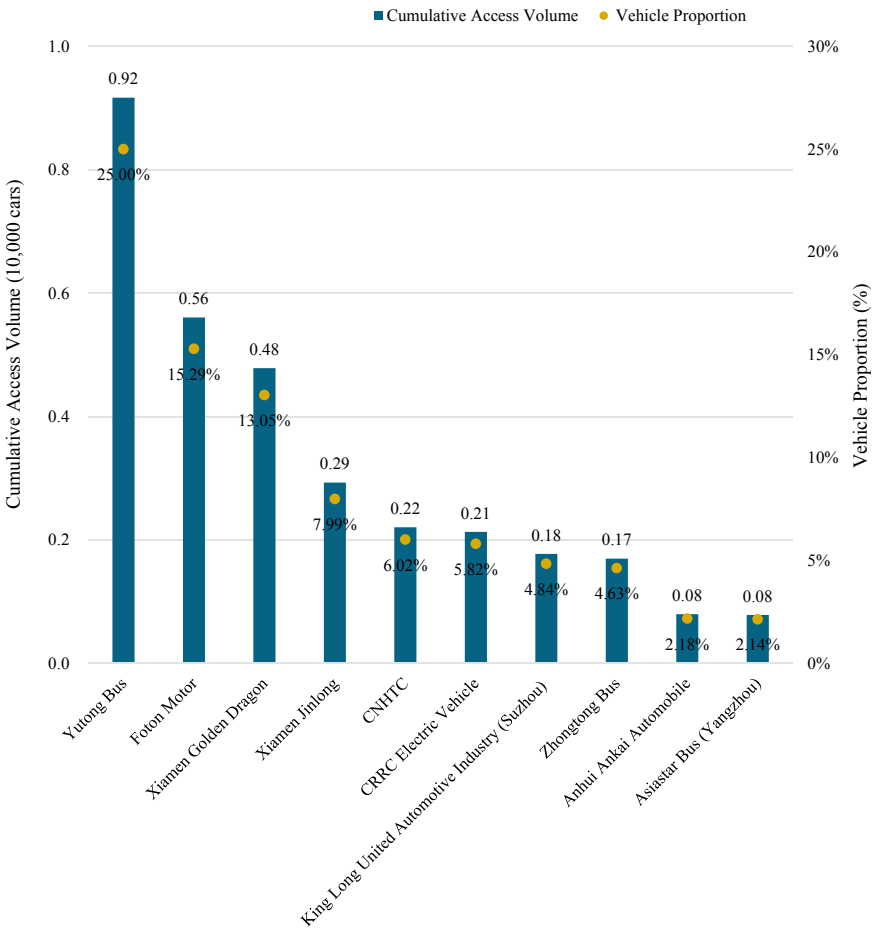

Fig. 8.9 Cumulative access characteristics of PHEV buses from TOP10 manufacturers

4800. Among them, the access volume of Zhengzhou Yutong's PHEV buses ranked first, accounting for 25.00% nationwide.

2. **Vehicle access characteristics over the years**

From the perspective of the access volume of PHEVs over the years (Table 8.3), the access volume of PHEVs was maximum in 2021, reaching 480,800, with a year-on-year increase of 2.2 times. From the perspective of monthly access over the years, the monthly access volume of PHEVs in 2021 was generally high. In the fourth quarter of 2021, the access volume of PHEVs showed a significant carryover effect, totaling 188,000 (Fig. 8.10).

The market demand for PHEVs is gradually shifting to cities not subject to purchase restriction.

Table 8.3 Access volume of PHEVs over the year

Year	2019	2020	2021
Access volume of PHEVs over the years (10,000 vehicles)	23.35	14.99	48.08

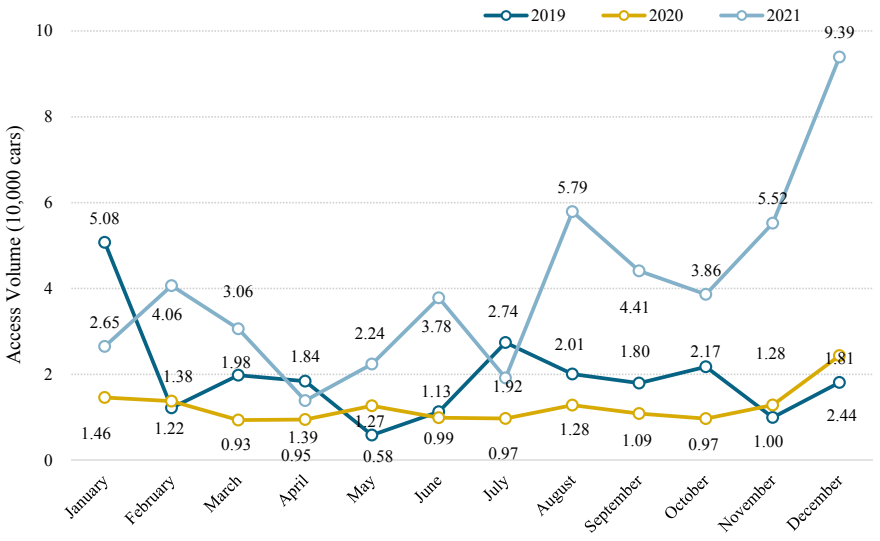

Fig. 8.10 Monthly access volume of PHEVs over the years

From the perspective of the access characteristics of PHEVs over the years, the market demand for PHEVs is gradually shifting to cities not subject to purchase restriction Fig. 8.11 shows that in the past three years, the market share of PHEVs in cities not subject to purchase restriction has proliferated, and the market share has significantly increased. In 2019, the market share of PHEVs in cities not subject to purchase restriction was 37.8%. By 2021, the market share of PHEVs reached 53.6%, with an increase of 15.8 percentage points compared with 2019. The market share of PHEVs in cities not subject to purchase restriction is rapidly expanding.

The share of PHEVs in first-tier cities has decreased, and market demand is gradually releasing to lower-tier cities.

Based on the access characteristics of PHEVs in cities of different tiers over the years (Fig. 8.12), the proportion of access volume of PHEVs in first-tier cities has shown a decreasing trend yearly. In 2019, the proportion of PHEVs in first-tier cities was 64%, and by 2021, the annual proportion of PHEVs was 50.3%, with a decrease of 13.7%; The market share of PHEVs in cities of other tiers has increased, and the market demand is gradually releasing to lower-tier cities. With the continuous expansion of domestic brands in the PHEV market, and the trend of gradually narrowing the "green channel" of PHEVs in China, domestic brands have seized the window period of favorable policies on the one hand, and on the

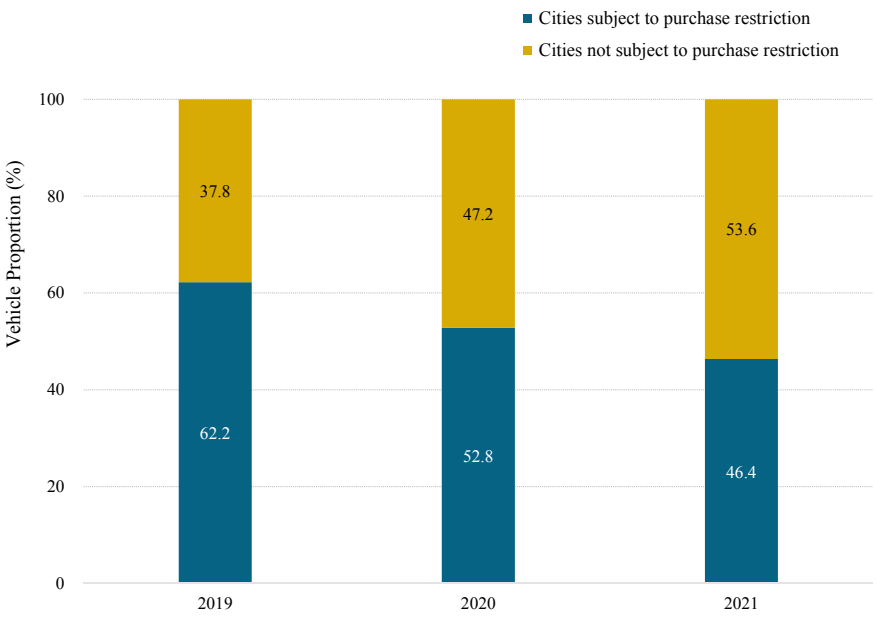

Fig. 8.11 Changes in the proportion of access volume of PHEVs in cities subject to and not subject to purchase restriction over the years

other hand, dispersing sales area distribution and getting rid of policy restrictions are conducive to sustained and stable growth in the medium to long term.

East China and South China are the main promotion regions. In 2021, the market share of PHEVs in Northeast, East, Central, and Northwest China increased.

Based on the access characteristics of PHEVs by region over the years (Fig. 8.13), East China and South China are the main promotion regions for PHEVs due to the great demand for PHEVs in Shanghai and Guangdong. From the change in PHEV access in the past three years, the proportion of PHEVs in Northeast China, East China, Central China, and Northwest China has shown an upward trend.

Individuals are the absolute main purchasing force, with a significant increase in private share.

Based on the access characteristics of PHEVs by type over the years (Fig. 8.14), individuals are the absolute main purchasing group, and the private share of PHEVs is gradually expanding rapidly. The proportion of PHEV private cars has shown a rapid growth trend, increasing from 85.1% in 2019 to 93.2% in 2021, an increase of 8.1%. The degree of marketization of PHEVs has significantly improved.

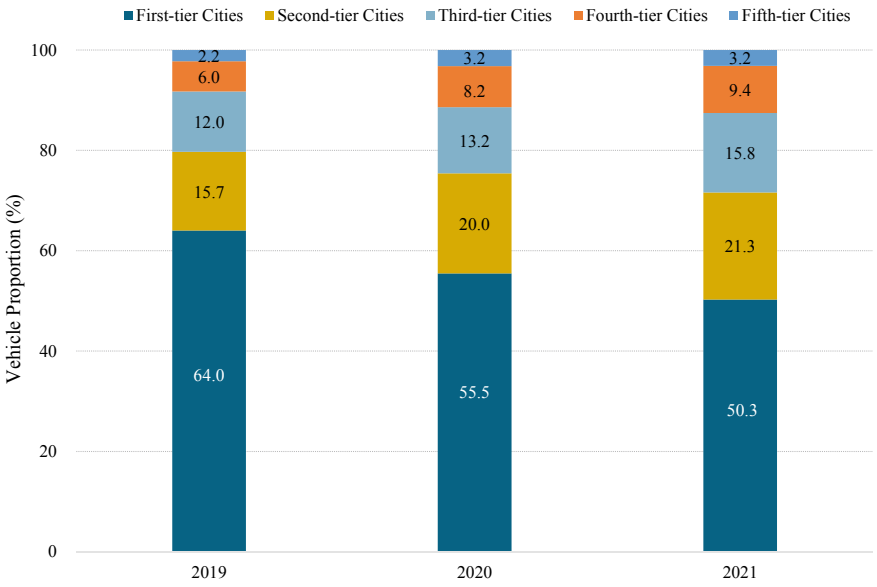

Fig. 8.12 Changes in the proportion of access volume of PHEVs in cities over the years—by city tier

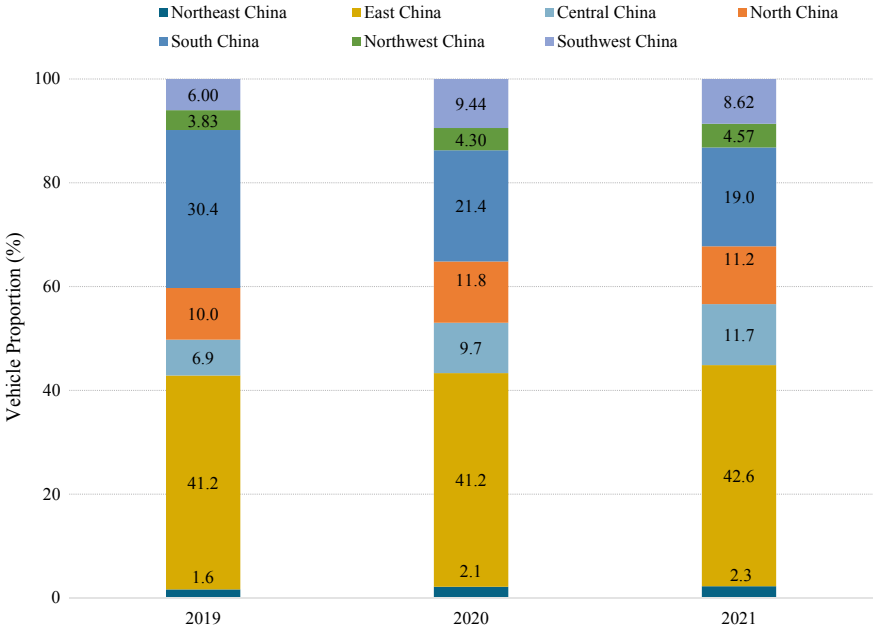

Fig. 8.13 Changes in the proportion of access volume of PHEVs in different regions over the years

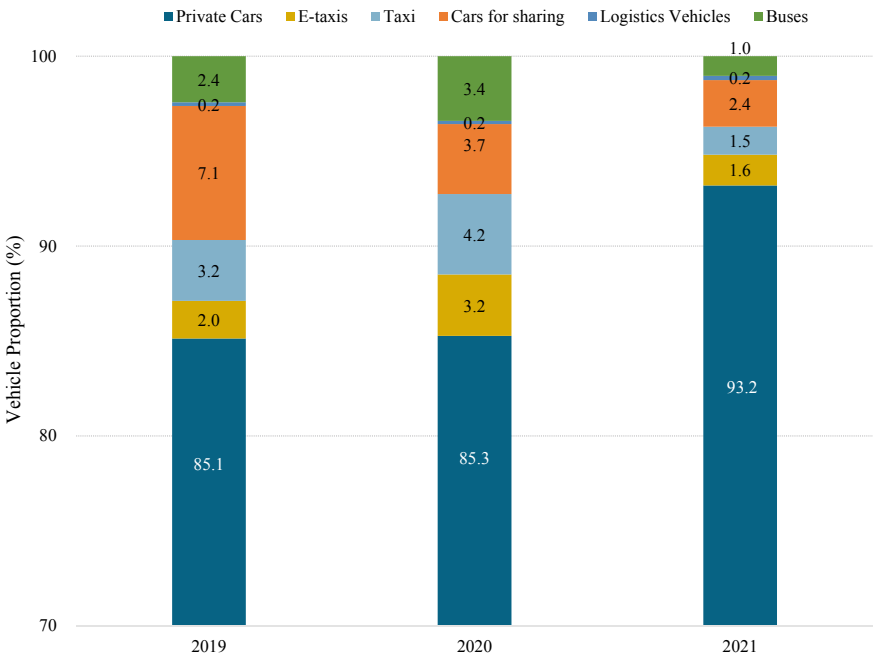

Fig. 8.14 Changes in the proportion of access volume of PHEVs in different application scenarios over the years

8.3 Operation Characteristics of PHEVs

8.3.1 Online Rate of PHEVs

The online rate of PHEVs remains at a high level, and the usage rate of PHEVs is relatively high.

From the perspective of the online rate of PHEVs in various regions (Fig. 8.15), in 2021, the average online rate of PHEVs in all regions of China was over 90%, indicating a high usage rate of PHEVs. From the historical changes in the online rate of PHEVs in various regions, the overall online rate in East China, Central China, North China, and Southwest China has shown an upward trend in recent three years.

From the perspective of the online rate of PHEVs in cities of different tiers (Fig. 8.16), the online rate of PHEVs in cities of different tiers remains above 90%. There are slight differences in vehicle online rates in cities of different tiers. The online rate in first-tier cities is the highest, and the online rate has been relatively stable in the past three years; The online rate in second and third-tier cities shows an upward trend.

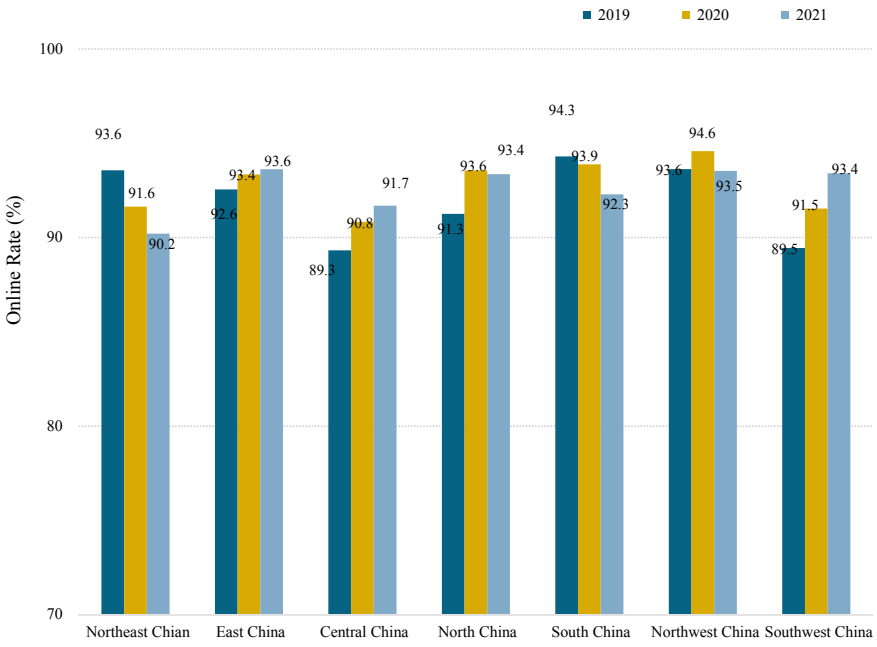

Fig. 8.15 Monthly average online rate of PHEVs in various regions of China

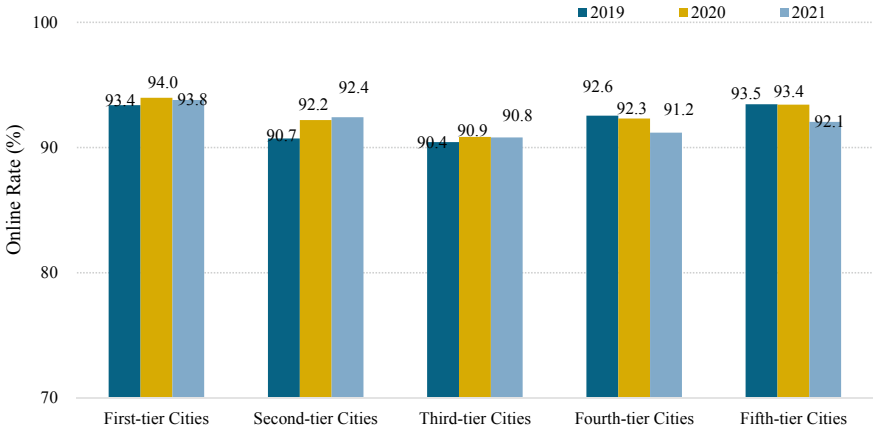

Fig. 8.16 Monthly average online rate of PHEVs in cities of different tier

From the perspective of the online rate of PHEVs by type (Fig. 8.17), the online rate of private cars, e-taxis, and taxis is generally at a high level, and the online rate of logistics vehicles is lower than that of other types of vehicles.

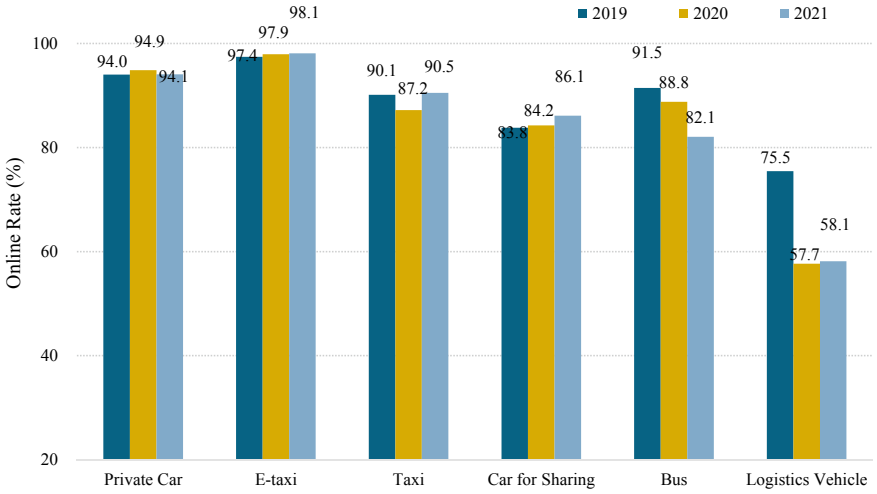

Fig. 8.17 Calendar year average monthly uptime rates by segment for PHEVs nationally

8.3.2 Vehicle Operation Characteristics

The operating modes of PHEVs are divided into electric driving mode, hybrid driving mode, and fuel-powered driving mode. From the proportion of mileage of PHEV passenger cars in different driving modes by type (Fig. 8.18), the electric mileage of private cars and e-taxis is relatively high, and the average daily mileage of private cars and e-taxis in the electric driving mode accounts for 45.0% and 45.6% of the total average daily mileage respectively; Taxis take second place, with an average daily mileage in the electric driving mode accounting for 40.6%; The average daily mileage of cars for sharing in the electric driving mode accounts for 37.6%, and the utilization rate of the electric driving mode is relatively low. Regardless of the type, the proportion of fuel-powered driving mode is less than 10%, indicating that in actual use, PHEV passenger cars are low-carbon and environmentally friendly among vehicles of the same class.

From the proportion distribution of different types of vehicles with different mileages in the electric driving mode (Fig. 8.19), it can be seen that the proportion distribution of private cars with different mileages in the electric driving mode is relatively uniform; e-taxis, taxis, and cars for sharing with the mileages in the electric driving mode accounting for 40–60% of the total mileage in the electric driving mode are dominated.

From the distribution of PHEV passenger cars with different average single-trip travel duration in the electric driving mode in cities of different tiers (Fig. 8.20), it can be seen that vehicles with average single-trip travel duration in the electric driving mode ranging from 0.5 to 1 h in first-tier cities account for a large proportion, i.e.,

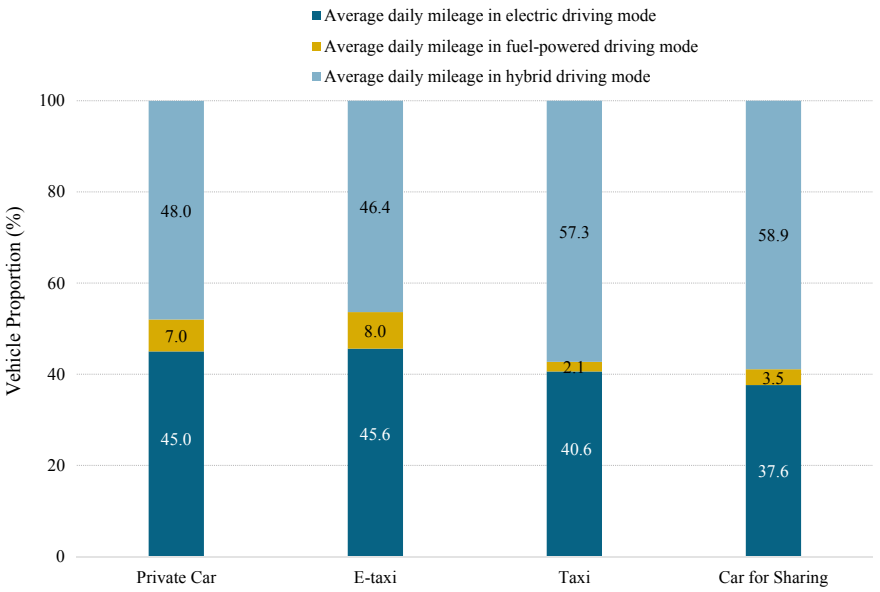

Fig. 8.18 Proportion of average daily mileage of PHEV passenger cars in different driving modes in 2021

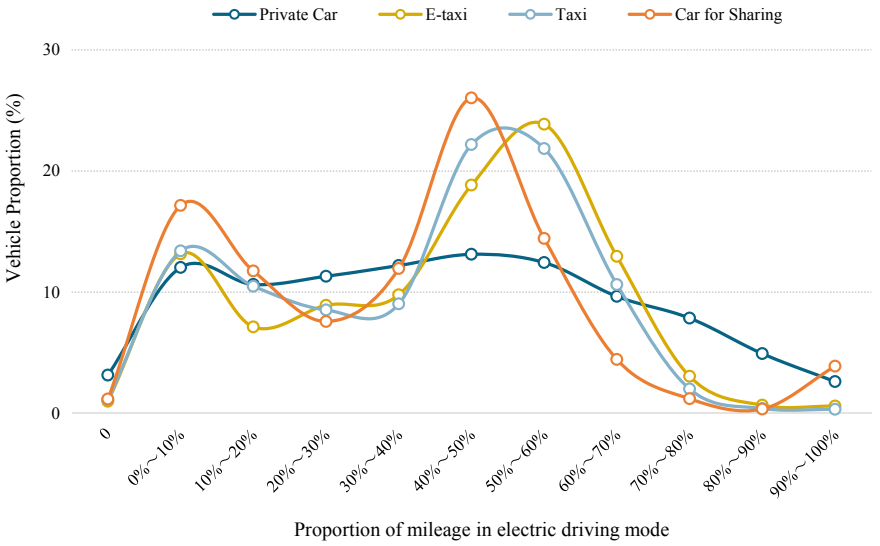

Fig. 8.19 Distribution of PHEV passenger cars with different mileages in the electric driving mode in different scenarios in 2021

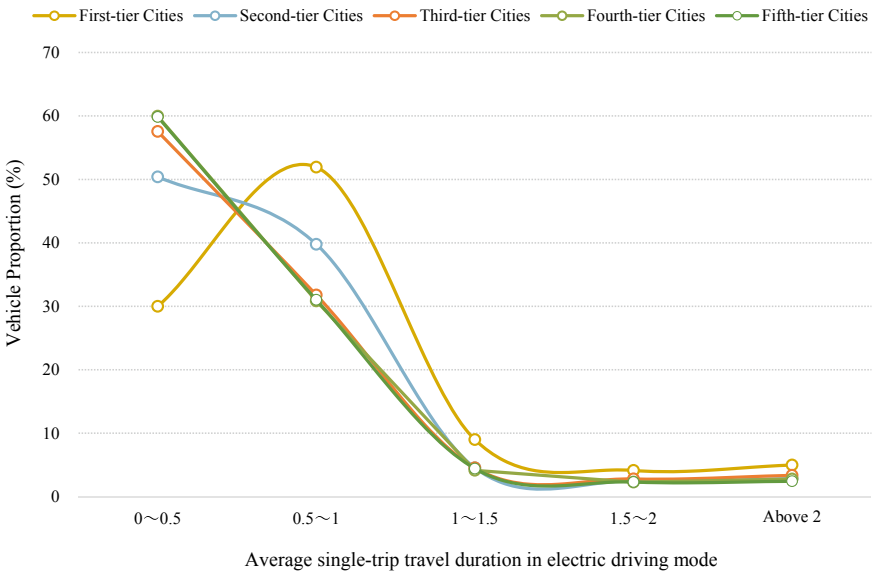

Fig. 8.20 Distribution of PHEV passenger cars with average single-trip travel duration in cities of different tiers in 2021

51.92%, which is affected by urban area and traffic conditions; The average single-trip travel duration in the electric driving mode in other tiers of cities is 0.5 h, and the PHEVs with such average single- trip travel duration in the electric driving mode account for over 50%.

8.4 PHEV Charging Characteristics

In the field of passenger cars, in the Chapter—Vehicle Charging, a detailed comparative analysis of the charging characteristics of PHEV private cars and EV private cars has been made. This Chapter will compare the charging characteristics of private cars, e-taxis, taxis, and cars for sharing based on different application scenarios of passenger cars.

8.4.1 Average Single-Time Charging Characteristics

The average single-time charging duration of PHEV passenger cars has been about 3.0 h over the years.

The average single-time charging duration of PHEV passenger cars has remained stable over the years, and in the past three years, the average single-time charging

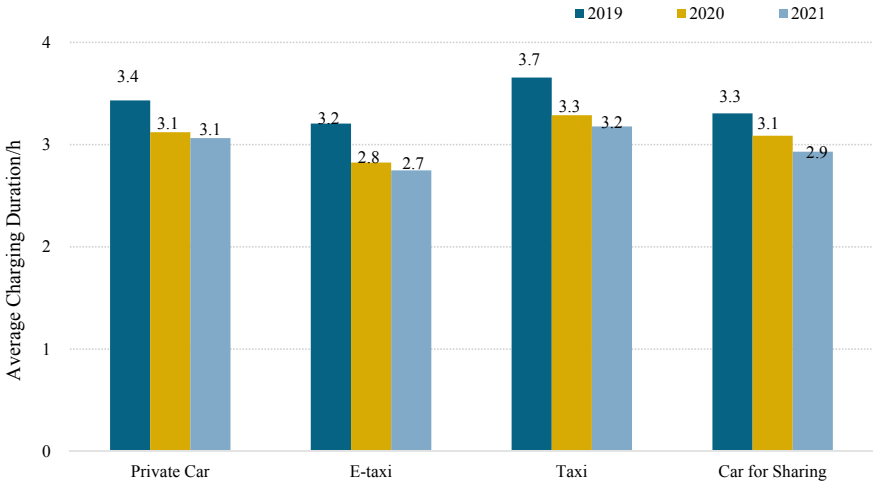

Fig. 8.21 Average single-time charging duration of classified PHEV passenger cars over the years

time has been about 3.0 h. As seen from the average single-time charging duration of different types of PHEVs over the years (Fig. 8.21), the average single-time charging duration of each type of vehicle has shown an overall downward trend in the past two years. From the average single-time charging duration of all types of PHEVs in 2021, the average charging duration of private cars is mostly 3.1 h, the same as that of the previous year. The average single-time charging durations of e-taxis and cars for sharing are relatively short, 2.7 h and 2.9 h, respectively.

From the perspective of vehicle charging methods (Fig. 8.22), the fast charging duration of each type of PHEV is mostly less than 0.5 h, and the slow charging duration is about 3.0 h; From the perspective of the fast charging duration of all types of PHEVs, the fast charging duration of cars for sharing is slightly lower than that of other types of vehicles, and the slow charging duration of e-taxis is relatively low.

As seen from the proportion of PHEVs with different average charging durations (Fig. 8.23), compared with other types of PHEVs, e-taxis with an average single-time driving duration of 2–3 h have the highest proportion, reaching 36.79%, and the average single-time charging duration of PHEVs shows obvious aggregation; The proportion of cars for sharing with different average single-time charging durations is relatively flat.

In 2021, the average single-time initial SOC of PHEV passenger cars was 29.8% at the beginning of charging, and the average initial SOC was 85.5% at the end. Compared to other types of vehicles, the average initial SOC at the beginning and end of charging private cars was higher than that of other vehicles (Fig. 8.24).

From the distribution of initial SOC of charging in different segments (Fig. 8.25), e-taxis, taxis, and cars for sharing account for 10–20% and 20–30% of the PHEVs in charging initial SOC segments, all of which exceed 30%; The proportion of private

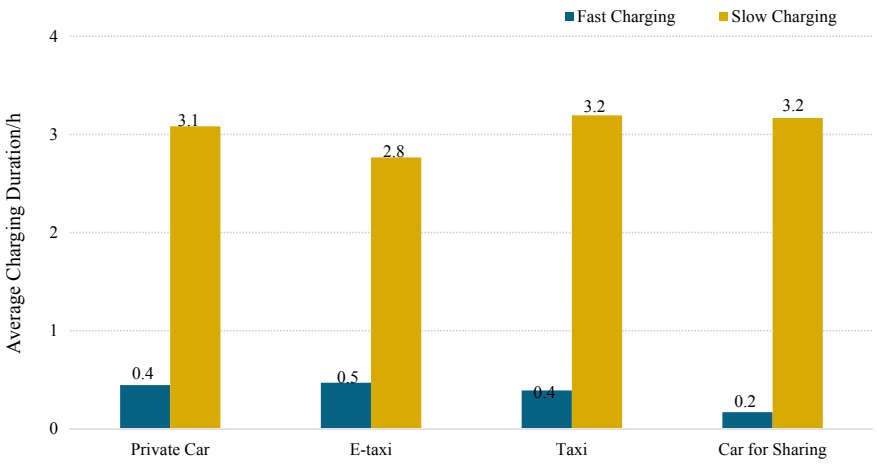

Fig. 8.22 Average single-time charging duration of PHEV passenger cars in different charging modes in 2021

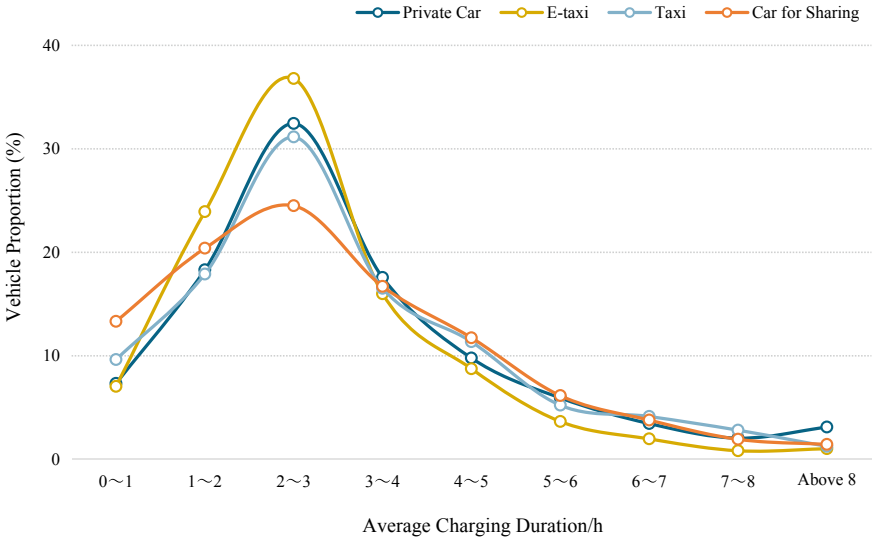

Fig. 8.23 Proportion of PHEV passenger cars with different average single-time charging durations in 2021—by type

cars in the PHEVs in two average single-time charging initial SOC segments is significantly lower than that of other types of vehicles, while the proportion of PHEVs in the charging initial SOC segments of 30–40%, 40–50%, and 50–60% was significantly higher than that of other types of vehicles. The phenomenon of private cars charging on demand is more obvious.

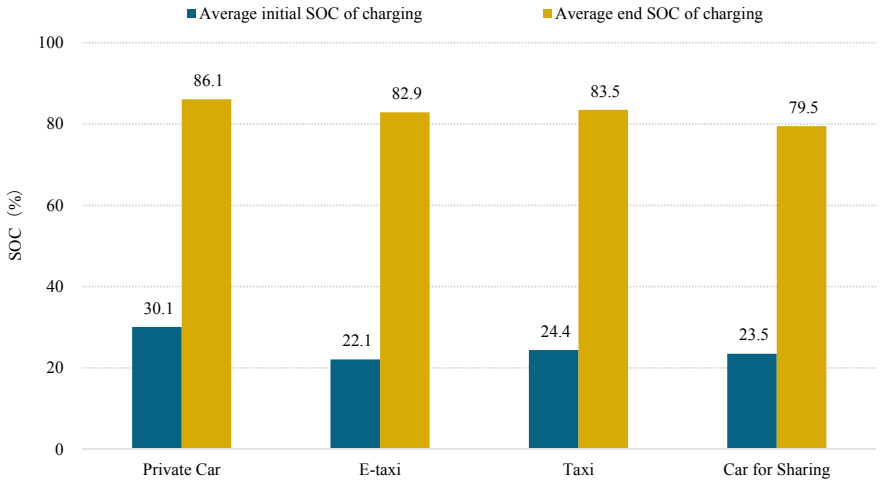

Fig. 8.24 Distribution of PHEV passenger cars with average single-time charging SOC in 2021—by type

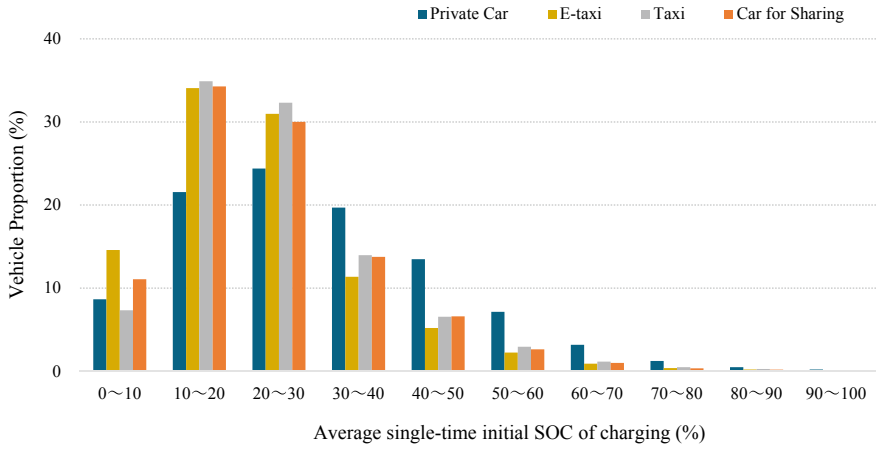

Fig. 8.25 Distribution of PHEV passenger cars with average single-time initial SOC of charging in 2021—by type

The distribution of PHEVs in different charging end SOC segments (Fig. 8.26) shows that the distribution of private cars in the 90–100% charging end SOC segment was significantly higher than that of other types of vehicles, accounting for 63.4%.

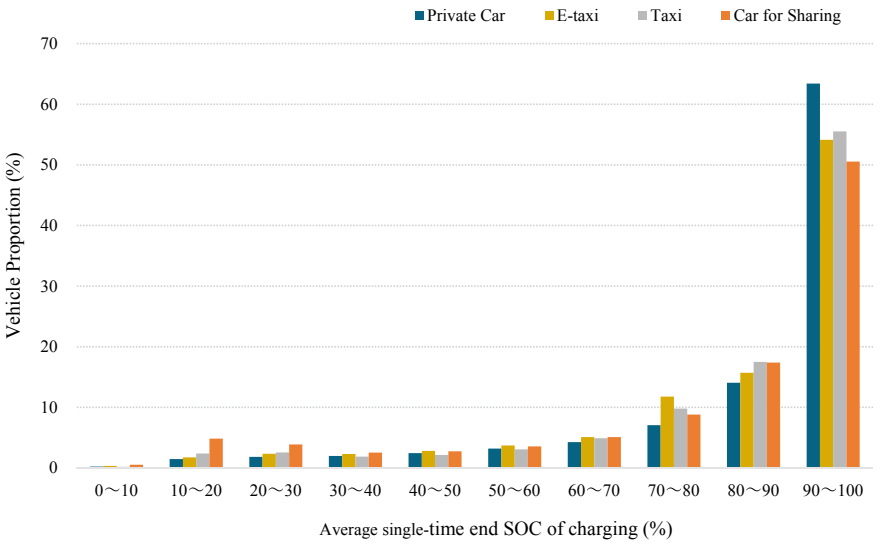

Fig. 8.26 Distribution of PHEV passenger cars with average single-time end SOC of charging in 2021—by type

8.4.2 Monthly Average Charging Characteristics

The average monthly charging frequency of PHEV passenger cars in 2021 was slightly higher than that in 2020.

The average monthly charging frequency of PHEV passenger cars in 2021 was 7.5, with an increase of 4.9% compared with 2020. Due to the gradual regularity of vehicle operation after the normalization of epidemic prevention and control, the charging frequency shows an upward trend (Table 8.4).

Figure 8.27 shows that the average monthly charging frequency of e-taxis is significantly higher than that of other types of vehicles. In 2021, the average monthly charging frequency of e-taxis reached 15.1; the average monthly charging frequency of private cars was relatively low, mostly about 6.

The slow charging method is often suitable for PHEV passenger cars.

In 2021, PHEV passenger cars' average monthly fast and slow charging frequencies were 1.6 and 6.0, respectively. More PHEV passenger cars are slowly charged. Judging from the charging methods of different types of PHEV passenger cars (Fig. 8.28), the charging frequency of e-taxis was higher, and the average monthly fast and slow charging frequencies were 4.7 and 10.4 respectively. e-taxis has a slightly

Table 8.4 Monthly average charging frequency of PHEV passenger cars

Year	2019	2020	2021
Monthly average charging frequency of PHEV passenger cars (times)	6.2	7.2	7.5

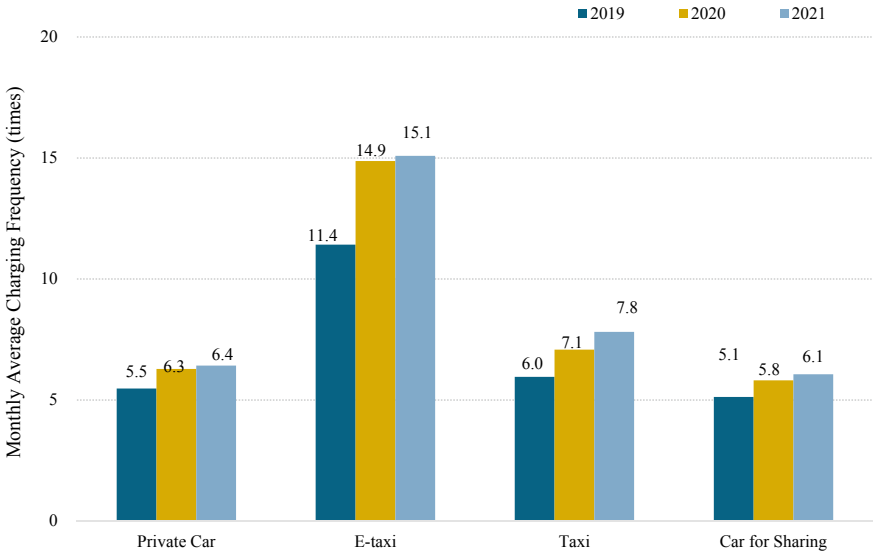

Fig. 8.27 Monthly average charging frequency of PHEV passenger cars over the years—by type

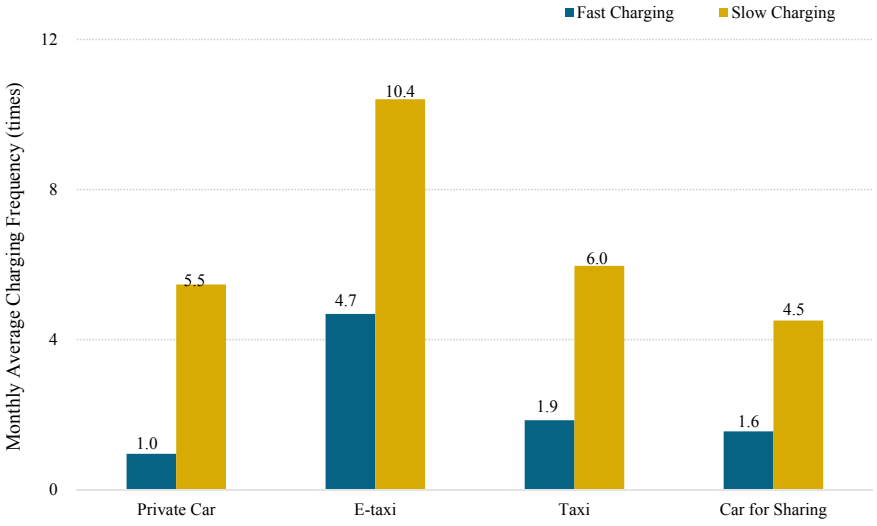

Fig. 8.28 Average monthly charging frequency of PHEV passenger cars in different charging modes in 2021

higher average monthly charging frequency than other types of vehicles due to the temporary power supply demand.

As seen from the distribution of vehicles in different monthly average charging frequency segments (Fig. 8.29), the average monthly charging frequency of private

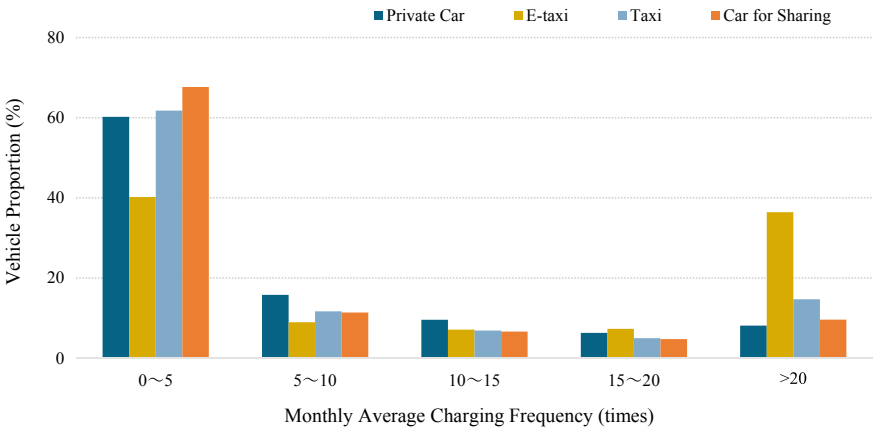

Fig. 8.29 Proportion of PHEV passenger cars with different average monthly charging frequencies in 2021—by type

cars was less than 5 times, and private cars, taxis, and cars for sharing with an average monthly charging frequency of less than 5 times accounted for over 60%; The average monthly charging frequency of e-taxis was maximum, and the vehicles with an average monthly charging frequency of more than 20 times accounted for 36.4%, significantly higher than other types of vehicles.

As seen from the distribution of monthly charging frequencies of PHEV passenger cars in different cities (Fig. 8.30), the charging frequencies in December, January, and February in Beijing were significantly lower than those in other months because the temperature in winter is low, the battery performance is reduced, and the mileage in the electric driving mode is reduced. To alleviate mileage anxiety, users use the electric drive mode less often. Since the temperature difference in Guangzhou is relatively small throughout the year, the battery performance is less affected by temperature, and the monthly average driving power consumption is relatively stable, the charging frequency is relatively stable.

From the distribution of monthly charging frequencies of PHEV SUVs in different cities (Fig. 8.31), PHEV SUVs' average monthly charging frequency in Beijing was 10.6, while the average monthly charging frequency in Guangzhou was 10.0. There is no significant difference in the average monthly charging frequency between Beijing and Guangzhou because the main promotion model in Beijing is the Li ONE with high battery capacity.

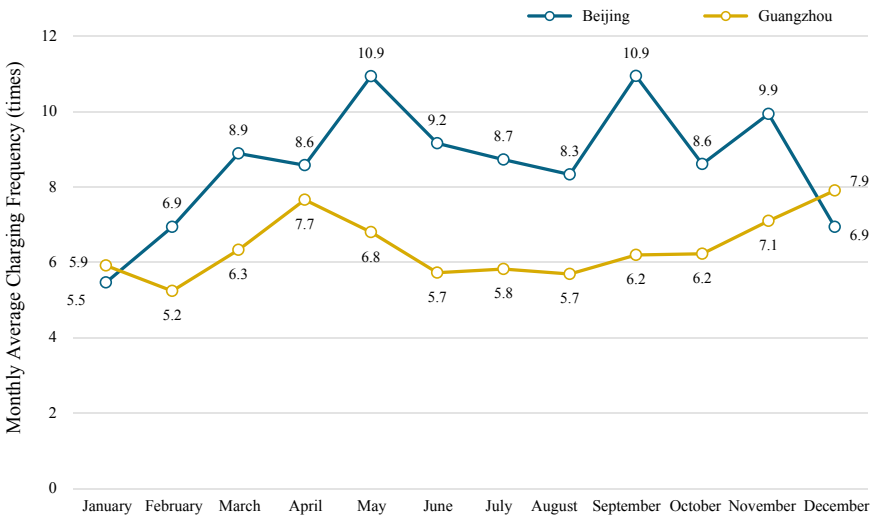

Fig. 8.30 Average monthly charging frequencies of PHEV passenger cars in 2021—cars

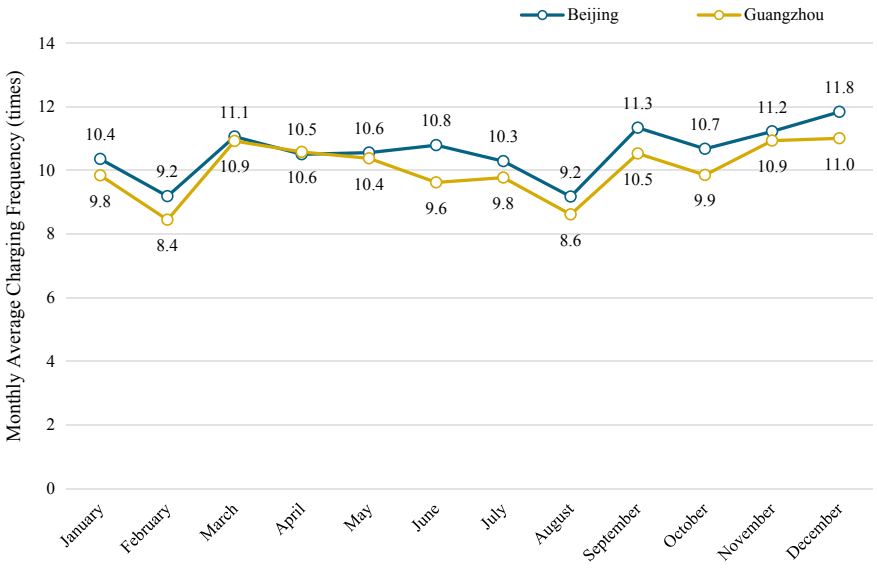

Fig. 8.31 Average monthly charging frequencies of PHEV passenger cars in 2021—SUVs

8.5 Summary

At present, new energy vehicles have become an important strategic path to accelerate China's automobile industry towards carbon peaking and carbon neutrality, and PHEVs play an important role in achieving rapid replacement of fuel models in the automotive industry in the short to medium term, and promoting energy conservation and carbon reduction in the automotive industry as soon as possible. Based on the access characteristics, vehicle operation characteristics, and vehicle charging characteristics of PHEVs on the National Monitoring and Management Platform, the market characteristics, vehicle operation laws, and charging laws of China's rapidly growing demand for PHEVs were summarized in this report. The main research results are described as follows:

PHEVs in China are gradually shifting from a supply-side drive to a supply-and-demand drive, and the domestic market maintained a high growth demand trend in 2021. PHEVs can meet the diverse application scenarios of consumers and have a certain market demand space. The supply of domestic brand models has diversified with the breakthrough of various technologies in the field of PHEVs by vehicle manufacturers. In 2021, the sales of PHEVs showed a rapid growth trend, reaching 603,000 throughout the year, with a year-on-year increase of 7.6 times, and the market demand has rapidly released.

The degree of marketization of PHEVs has significantly improved, with private purchases being the leading consumer force and demand gradually releasing in lower-tier cities. From the perspective of the access characteristics of PHEVs to the National Monitoring and Management Platform over the years, personal purchases have become the absolute mainstay. The proportion of PHEV private cars in the national PHEVs has increased from 85.1% in 2019 to 93.2% in 2021, with an increase of 8.1%, and the market share of private cars has rapidly increased; From the perspective of cities subject to purchase restriction/cities not subject to purchase restriction, the market demand for PHEVs is gradually shifting to cities not subject to purchase restriction. In 2021, the market share of PHEVs in cities not subject to purchase restriction was 53.6%, with an increase of 15.8% compared with 2019; From the perspective of cities of different tiers, the market share of PHEVs in the first-tier cities is gradually decreasing, and the market demand is gradually releasing to lower-tier cities.

The usage rate of PHEVs is relatively high, and the vehicle online rate remains high. The online rate of PHEVs remains at a high level, and the usage rate of PHEVs is relatively high over the years. From the perspective of the mileage in the electric driving mode, private cars and e-taxis have a relatively high proportion of average daily mileage in the electric driving mode in the total average daily mileage, and the utilization rate of the electric driving mode is high.

The charging duration of PHEVs is mostly stable, and their batteries are often slowly charged. The average charging duration of PHEV passenger cars has remained stable at around 3.0 h over the years, the slow charging method is often used, and the fast charging duration remains at around 0.5 h; With the normalization

of epidemic prevention and control, vehicle operation is gradually becoming more regular, and the charging frequency is showing an apparent upward trend; From the perspective of average monthly charging frequencies of all types of vehicles, the running mileage of e-taxis is longer, and the average monthly charging frequencies of e-taxis are significantly higher than those of other types of vehicles.