Chapter 3
Technical Progress of New Energy Vehicles

This chapter, based on the NEV access characteristics on the National Monitoring and Management Platform and also the data in the national announcements related to NEVs, makes an in-depth analysis of range, battery, vehicle lightweight characteristics, vehicle energy consumption change, and REESS rated voltage change as focuses, and summarizes the technical progress of new energy vehicles, providing a significant reference for promoting the technological innovation of NEVs and the development of the related industry.

3.1 Technical Progress in Range

The range of NEVs is increasing year by year.

According to the technical parameters of the NEVs' range in China (Fig. 3.1), the average range of NEVs of different types is increasing year by year. In the past three years, the average range of new energy passenger cars has increased from 215 to 300.3 km, that of new energy buses has increased from 258.6 to 400.6 km, and that of new energy logistics vehicles has increased from 243.3 to 287.6 km.

For BEVs of different types (Fig. 3.2), the average ranges of BEV passenger cars, BEV buses and BEV logistics vehicles in 2020 were 394 km, 457 km and 277 km, increasing by 34.9%, 46.5% and 8.2% respectively compared with 2018. As these data show, the increase in the range of BEV logistics vehicles is slow in these three years.

For FCEVs of different types (Fig. 3.3), the average all-electric range of FCEV passenger cars has basically maintained below 70 km with little change; the average all-electric range of FCEV buses increased by 63.0–112.3 km compared with 2018.

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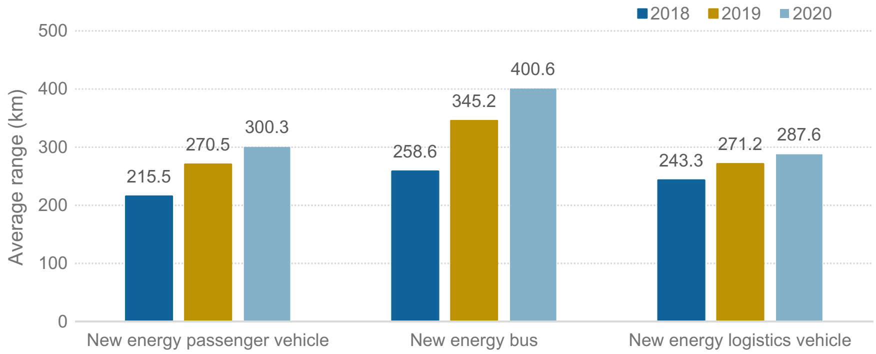

Fig. 3.1 Changes in average range of NEVs of different types over the years

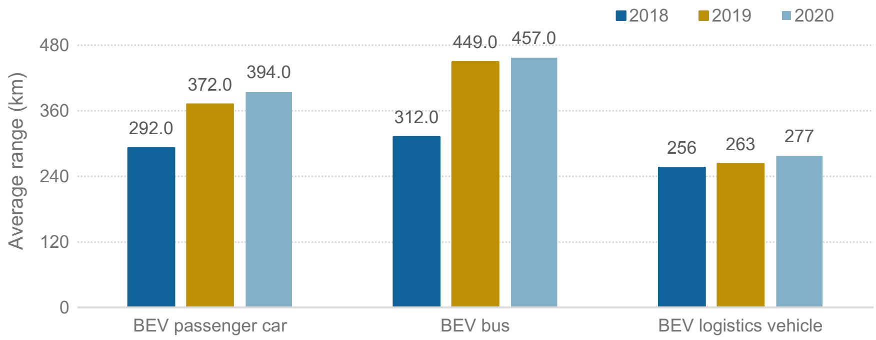

Fig. 3.2 Changes in average range of BEVs of different types over the years

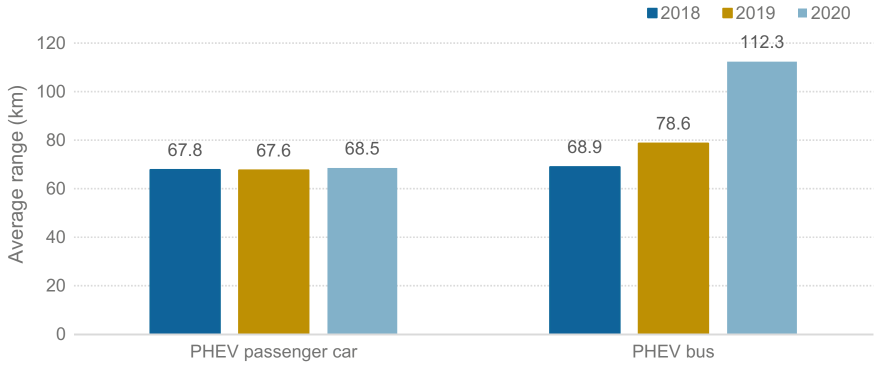

Fig. 3.3 Changes in average range of FCEVs of different types over the years

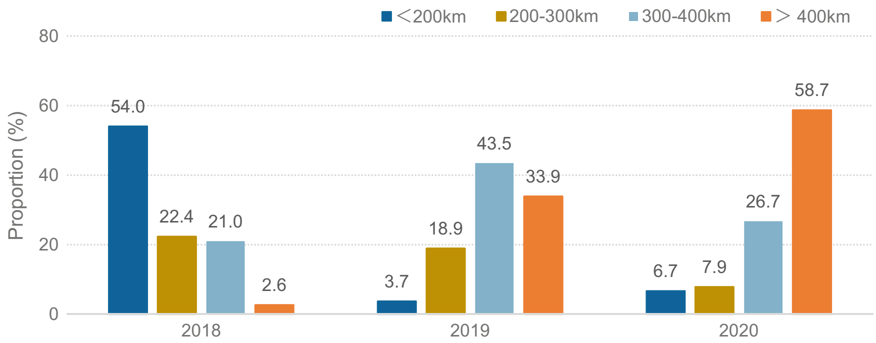

Fig. 3.4 Distribution of BEV passenger vehicles in different range sections. *Note* The sum of the proportion of vehicles in different range sections of each year is equal to 100%, which is the same below

The range of BEV passenger cars is increasing rapidly, so does the proportion of vehicles with a range of more than 400 km.

According to the change in the average range of BEV passenger cars (Fig. 3.4), the proportion of vehicles in the high range section increased rapidly, with the proportion of vehicles with a range of 400 km increased from 2.6% in 2018 to 58.7% in 2020; the proportion of BEV passenger cars with a range of less than 200 km increased faster than last year, which is mainly due to the rapid growth in the number of small BEV passenger cars.

The range of BEV passenger cars of different classes has increased rapidly, especially the cars of Class B and above.

According to the average range of BEV passenger cars of different classes (Fig. 3.5), their range is increasing rapidly year by year. In 2020, the average range of Class A0 + A00 cars, Class A cars, cars of Class B and above and SUVs were 284.2 km, 366.3 km, 443.1 km and 389.1 km, increasing by 54.9%, 34.5%, 55.8% and 29.7% respectively compared with 2018.

The proportion of BEV buses with a range of more than 300 km has increased significantly.

The proportion of BEV buses in different range sections changes greatly. According to the changes over the years (Fig. 3.6), the proportion of BEV buses with a range of more than 300 km is increasing year by year, i.e., from 44.7% in 2018 to 77.7% in 2020. The proportion of BEV buses with a range of 300–400 km increased from 15.3% in 2018 to 28.4% in 2020, and the proportion of BEV buses with a range of more than 400 km increased from 29.4% in 2018 to 49.3% in 2020. But, the proportion of BEV buses with a range of 200–300 km declined from 47.4% in 2018 to 13.0% in 2020.

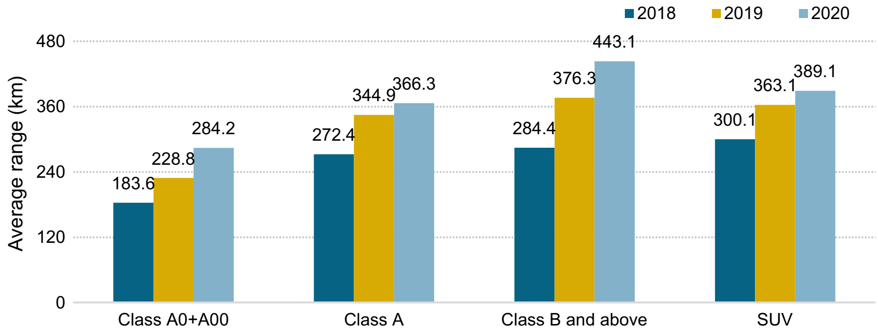

Fig. 3.5 Distribution of average range of BEV passenger cars of different classes

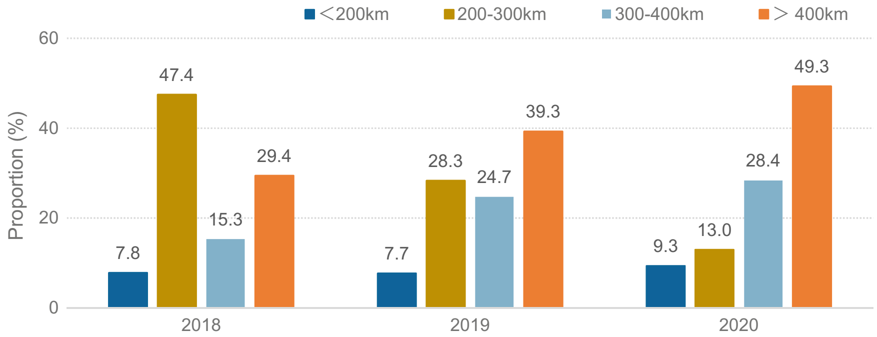

Fig. 3.6 Distribution of BEV buses in different range sections

The range of BEV logistics vehicles is mainly 200–300 km.

Since 2018, the proportion of BEV logistics vehicles with a range of 200–300 km has remained above 58% (Fig. 3.7), and in 2020, it increased to 78.2%, which is nearly 20% higher than that in 2019.

3.2 Progress in Lightweight Technology

In the past three years, the curb weight of new energy passenger cars has increased slightly.

According to the data over the years in China (Table 3.1), in 2020, the average curb weight of new energy passenger cars increased slightly to 1486.3 kg compared with 2019, which is mainly due to the increase in the curb weight of BEV SUVs, FCEV cars of Class B and above and FCEV SUVs.

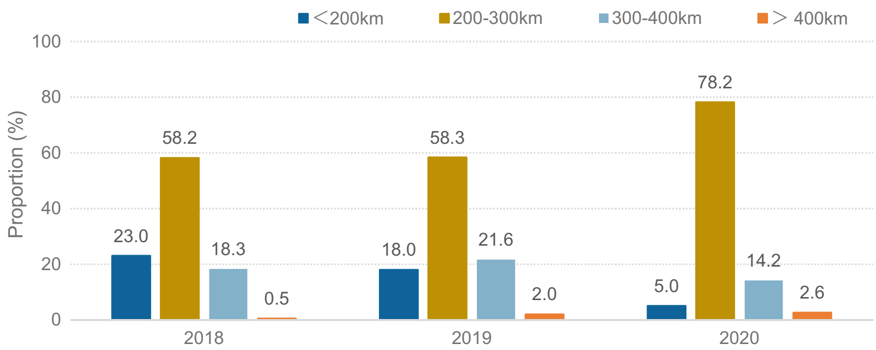

Fig. 3.7 Distribution of BEV logistics vehicles in different range sections

Table 3.1 Changes in average curb weight of new energy passenger cars over the years

Year	2018	2019	2020
New energy passenger vehicle Average curb weight (kg)	1317.4	1477.0	1486.3

Table 3.2 Changes in average curb weight of bev passenger cars over the years

Year	2018	2019	2020
BEV passenger car Average curb weight (kg)	1273.4	1457.2	1441.0

The lightweight technology of BEV passenger cars has achieved significant progress, especially the small BEV passenger cars.

According to the changes over the years (Table 3.2), the average curb weight of BEV passenger cars in 2020 was 1441.0 kg, which is higher than that in 2018 but 1.1% lower than that in 2019.

For BEV passenger cars of different classes (Fig. 3.8), the lightweight technology of BEV passenger cars has achieved significant progress, with the curb weight of Class A00 + A0 cars and Class A cars decreasing obviously; the average curb weight of cars of Class B and above cars in 2020 was basically the same as that of the previous year, showing a slow decrease trend; and the average curb weight of SUVs in 2020 was increased compared with 2019, suggesting that more intensive research on lightweight technology is required. On the whole, BEV passenger cars have higher requirements for lightweight, and have become a good carrier for the industrialization of aluminum alloy and carbon fiber composite materials. With the gradual decline in the cost of lightweight materials, this segment will provide a rich experience for the wide application of lightweight technology in the traditional automobile industry.

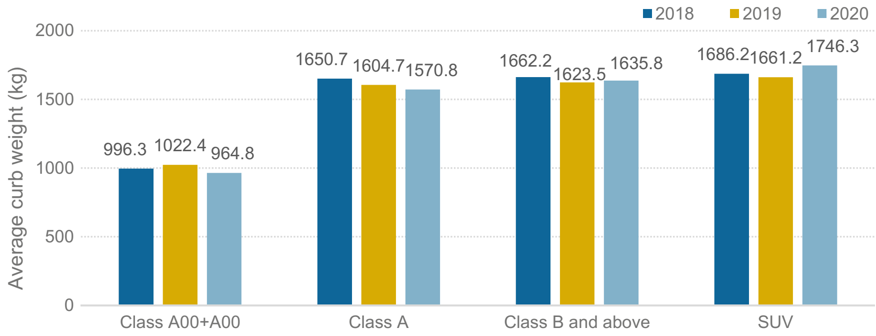

Fig. 3.8 Changes in average curb weight of BEV passenger cars of different classes over the years

Table 3.3 Changes in curb weight of FCEV passenger cars over the years

Year	2018	2019	2020
Average curb weight of FCEV passenger cars (kg)	1647.7	1661.7	1891.5

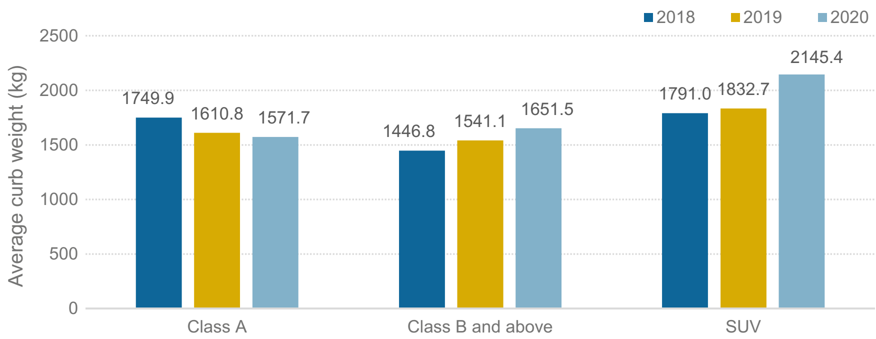

Fig. 3.9 Changes in average curb weight of FCEV passenger cars of different classes over the years

The curb weight of FCEV passenger cars is on the rise.

According to the changes over the years (Table 3.3), the average curb weight of FCEV passenger cars in 2020 was 1891.5 kg, increasing greatly compared with 2018 and 2019. According to the distribution of the average curb weight of FCEV passenger cars of different classes (Fig. 3.9), the Class A car has achieved an obvious lightweight effect, with the average curb weight decreasing year by year; the average curb weight of cars of Class B and above and SUVs has increased rapidly over the years.

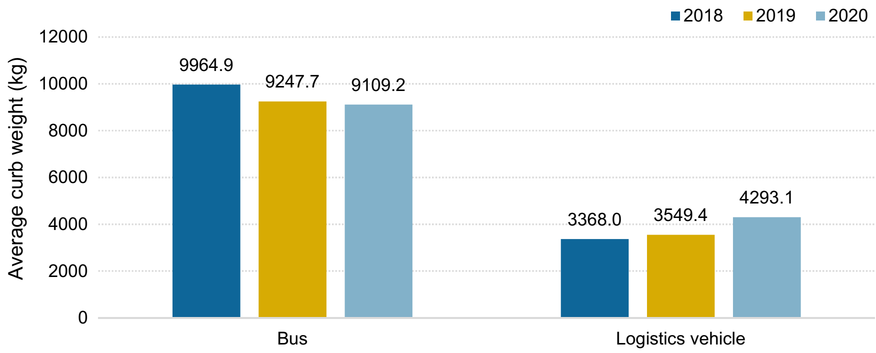

Fig. 3.10 Changes in average curb weight of new energy commercial vehicles of different types over the years

The average curb weight of new energy buses is decreasing year by year, while that of logistics vehicles is increasing year by year.

The average curb weight of new energy buses is decreasing year by year (Fig. 3.10), and compared with 2018, it was slightly reduced to 9109.2 kg in 2020.
The average curb weight of new energy logistics vehicles is increasing year by year, and compared with 2018, it was significantly increased to 4293.1 kg in 2020, which is due to, on the one hand, the significantly higher proportion of logistics vehicles with a range of more than 200 km, and on the other hand, the diversity of NEV logistics vehicle models and the rapidly-increased proportion of new energy medium-duty logistics vehicles with higher curb weight (specifically, the proportion of logistics vehicles with a curb weight above 4.5 ton accessed to the National Monitoring and Management Platform in 2020 increased by 1.1% compared with 2019).

3.3 Changes in Energy Consumption Over the Years

This section, according to the data of the actual operation condition of NEVs on the National Monitoring and Management Platform, summarizes the electricity consumption of BEV passenger cars, buses and logistics vehicles per 100 km, and analyzes the electricity consumption characteristics of vehicles of different types under different road conditions, providing a significant reference for promoting the technical progress of new energy vehicles in China.
Electricity consumption per 100 km refers to the average electricity consumption of BEVs every 100 km in the actual operating environment, which is expressed in kWh/100 km. The calculation formula is as follows:

$$E_{bev} = \frac{Q}{L} \times 100$$

where, E_{bev} is the electricity consumption per 100 km (kWh/100 km) of an electric vehicle in the actual operating environment, Q is the electricity consumption (kWh) of the electric vehicle, and L is the driving mileage (km).

(1) The energy consumption of BEV passenger cars of different classes shows a downward trend

In the past three years, the energy consumption per 100 km of BEV passenger cars of different classes has decreased. As shown in Fig. 3.11, in 2020, the electricity consumption of Class A00 + A0 cars was 12.4 kWh/100 km, decreasing by 3.1% compared with 2019 and by 5.3% compared with 2018; the electricity consumption of Class A cars was 14.1 kWh/100 km, decreasing by 2.1% compared with 2019 and by 7.8% compared with 2018; according to the distribution of average electricity consumption over the years, the average electricity consumption of BEV cars of Class B and above was 16.9 kWh/100 km, decreasing by 13.8% compared with 2019 and by 17.6% compared with 2018; and the average electricity consumption of BEV SUVs in 2020 was 18.1 kWh/100 km, decreasing by 2.2% compared with 2019 and by 9.5% compared with 2018.

(2) The energy consumption of BEV commercial vehicles increased in 2020 compared with last year

As for buses, 35 enterprises with an annual sales of more than 1000 were selected for analysis, and the calculation shows that the average electricity consumption of BEV buses in 2020 was 73.6 kWh/100 km, increasing by 2.3% (Table 3.4) compared with 2019; as for logistics vehicles, the average electricity consumption of BEV logistics vehicles in 2020 was 33.8 kWh/100 km, increasing by 1.5% (Table 3.5) compared with last year.

Fig. 3.11 Electricity consumption of BEV passenger cars of different classes per 100 km

Table 3.4 Electricity consumption of buses over the years-average

Year	2018	2019	2020
Average electricity consumption of buses (kWh/100 km)	66.9	71.9	73.6

Table 3.5 Electricity consumption of logistics vehicles over the years-average

Year	2018	2019	2020
Average electricity consumption of logistics vehicles (kWh/100 km)	33.6	33.3	33.8

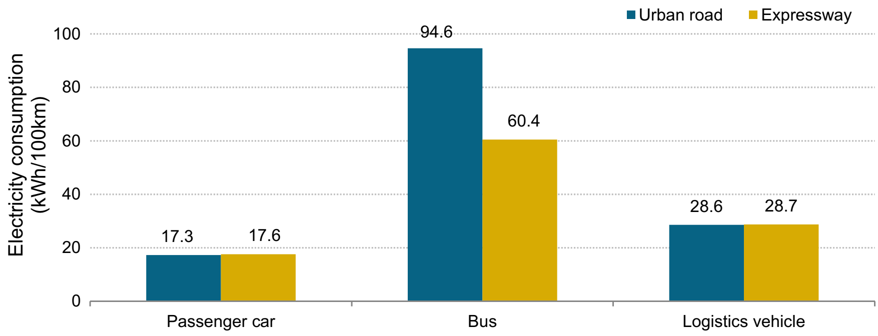

Fig. 3.12 Electricity consumption of vehicles of different types under different road conditions

(3) Energy consumption of vehicles under different road conditions

BEV passenger cars and logistics vehicles are more suitable for driving on urban roads than conventional fuel vehicles.

According to the electricity consumption of vehicles of different types under different road conditions, the electricity consumption of BEV passenger cars and logistics vehicles on urban roads and expressways is basically the same (Fig. 3.12); but the fuel consumption of conventional fuel vehicles on urban roads is far higher than that on expressways, indicating that their economy on urban roads is worse. In a word, BEV passenger cars and logistics vehicles are more suitable for driving on urban roads than conventional fuel vehicles.

The electricity consumption of buses on urban roads is significantly higher than that on expressways because, on urban roads, the frequent start and stop and low-speed running of buses increase their combined electricity consumption.

3.4 Change in Battery Type

Ternary batteries dominate the NEV market, but in 2020, the types of vehicles equipped with lithium iron phosphate batteries increased.

Considering the types of battery installed on the vehicle (Fig. 3.13), ternary batteries dominate the NEV market, with the proportion of vehicles equipped with such batteries higher than 70% in the past three years. According to the changes over the years, in 2020, the proportion of vehicles equipped with ternary batteries in 2020

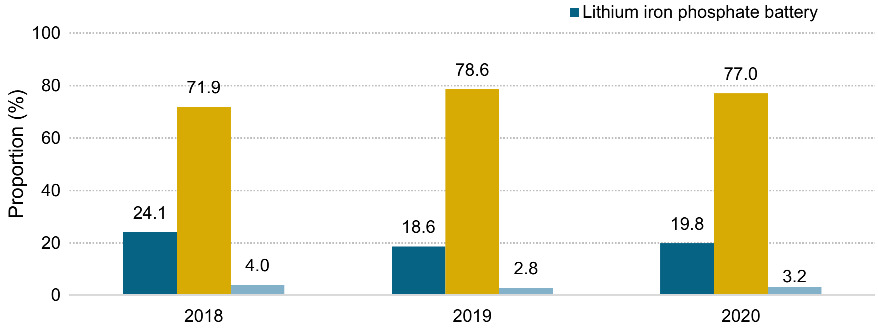

Fig. 3.13 Proportion of NEVs equipped with batteries of different types

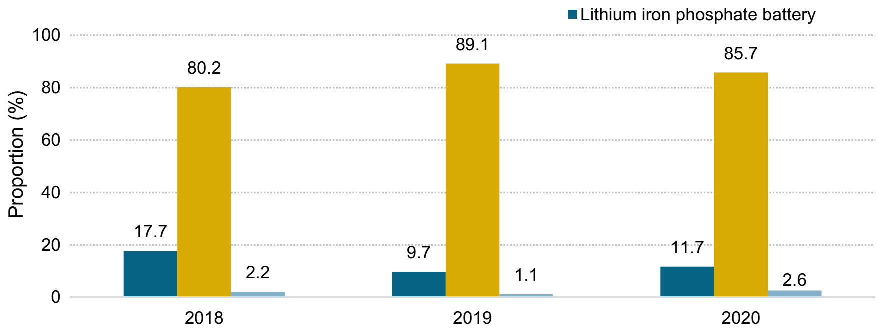

Fig. 3.14 Proportion of BEV passenger cars equipped with batteries of different types. *Note* The sum of the proportion of vehicles equipped with batteries of different types in each year is equal to 100%, which is the same below

was 77.0%, which is lower than that of last year, and the proportion of vehicles equipped with lithium phosphate batteries increased by 1.2–19.8% compared with last year.

The batteries on BEV passenger cars are mainly ternary batteries, but in 2020, the proportion of BEV passenger cars equipped with lithium iron phosphate batteries increased.

The batteries on BEV passenger cars are mainly ternary batteries, with the proportion of BEV passenger cars equipped with such batteries higher than 80% in the past three years. According to the annual change of batteries of different types (Fig. 3.14), the proportion of vehicles with lithium iron phosphate batteries, compared with 2019, increased by 2–11.7% in 2020, showing an upward trend.

The batteries on FCEV passenger cars are mainly ternary batteries.

In the past three years, a battery construction based on ternary batteries has been gradually formed for the FCEV passenger cars (Fig. 3.15). In 2020, the proportion

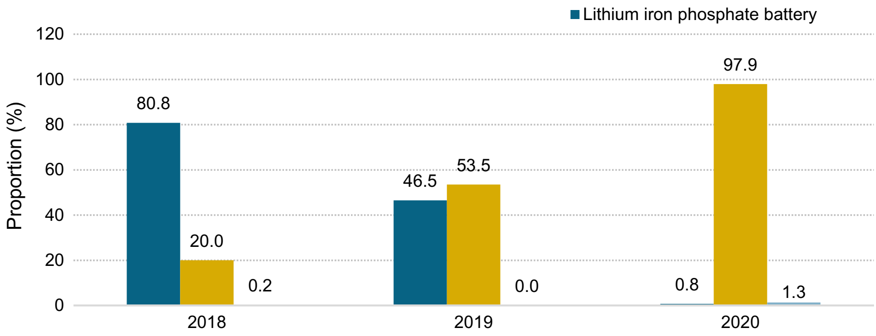

Fig. 3.15 Proportion of FCEV passenger cars equipped with batteries of different types

of FCEV passenger cars equipped with ternary batteries was 97.9%, increasing by 44.4% compared with 2019.

As for the BEV passenger cars, the market share of batteries in high and low energy density sections is rising, and that of batteries in the middle energy density section is declining.

As for the BEV passenger cars, the market share of batteries in high and low energy density sections is rising, and that of batteries in the middle energy density section is declining. Compared with 2019, the market share of batteries with an energy density lower than 125 Wh/kg and higher than 160 Wh/kg increased by more than 35%, while that of batteries with an energy density of 125–160 Wh/kg decreased; As for FCEV passenger cars, the installation of batteries with an energy density of 140–160 Wh/kg increased rapidly (Fig. 3.16).

The batteries on BEV buses are mainly lithium iron phosphate batteries, and only a small number of them are installed with other types of batteries.

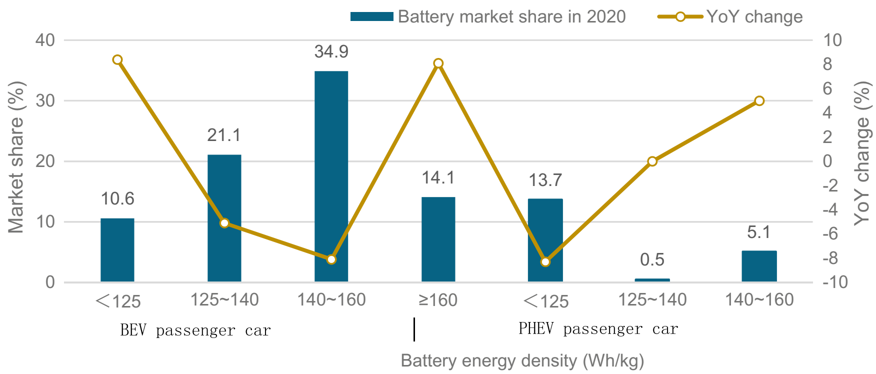

Fig. 3.16 Market share of batteries in different energy density sections

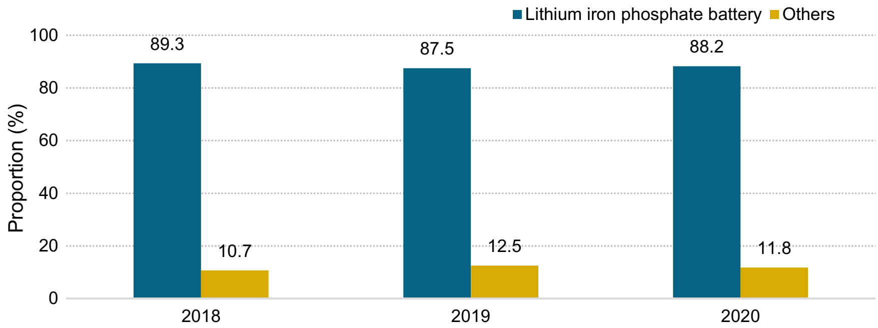

Fig. 3.17 Proportion of BEV buses equipped with batteries of different types

Most (namely 88.2%) BEV buses are installed with lithium iron phosphate batteries, and only a small number of BEV buses are installed with lithium titanate batteries, lithium manganate batteries and batteries of other types (Fig. 3.17).

For BEV logistics vehicles, a vehicle construction based on lithium iron phosphate battery is gradually into shape.

In the past three years, the structure of battery types of BEV logistics vehicles has changed greatly. Specifically, in 2018, the batteries used on BEV logistics vehicles were mainly ternary batteries, with a proportion of 67.4%, but in 2020, the proportion of BEV logistics vehicles with lithium iron phosphate batteries increased up to 80.3% (Fig. 3.18).

The assembly of batteries is concentrated in several battery manufacturers, especially CATL.

According to the production of NEVs and the assembly of batteries for those NEVs, the assembly of batteries has been gradually concentrated in some battery manufacturers (Fig. 3.19). The TOP3 battery manufacturers in 2020 were CATL, BYD

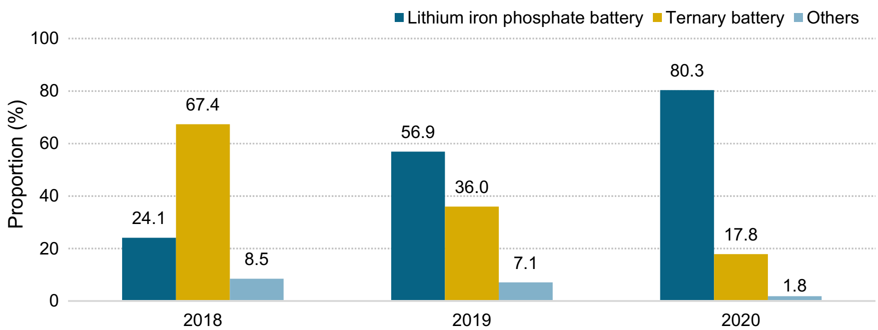

Fig. 3.18 Proportion of BEV logistics vehicles equipped with batteries of different types

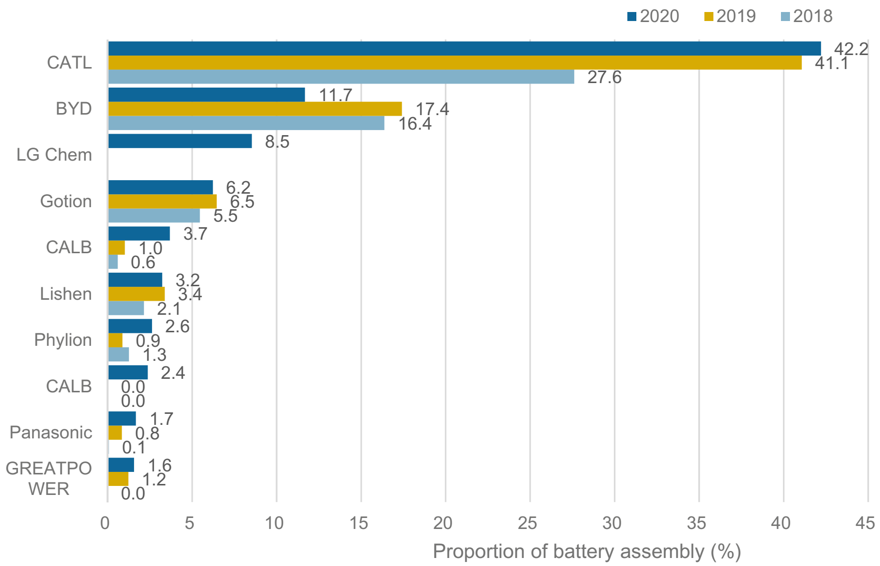

Fig. 3.19 Battery assembly of battery manufacturers. *Note* The proportion of battery assembly of different battery manufacturers in each year is equal to 100%

and LG Chem. Those three manufacturers occupy 62.4% of the total assembly of batteries, and among them, CATL performed best, with the proportion of battery assembly up to 42.2% and the market share gradually increased in 2020.

3.5 Change in Voltage of Onboard Energy Storage System

The NEVs' energy storage system has become higher and higher, and especially, the energy storage system of passenger cars has progressed fast.

According to the changes in the voltage technology trend of onboard energy storage systems for vehicles of different types (Fig. 3.20), the voltage of energy storage systems for passenger cars and buses is increasing, especially the passenger cars, whose energy storage system in 2020 had a voltage 15.1% higher than that in 2019, i.e., 335.2 V. But in 2020, the voltage of the energy storage system of the new energy logistics vehicles decreased slightly compared with last year.

The voltage energy storage system of BEV passenger cars has increased greatly, especially the mini cars.

As for BEV passenger cars (Fig. 3.21), the average voltage of the battery pack of Class A00 + A0 cars increased from 182.2 V in 2018 to 253.1 V in 2020, showing an obvious high-voltage development trend; the energy storage systems for Class

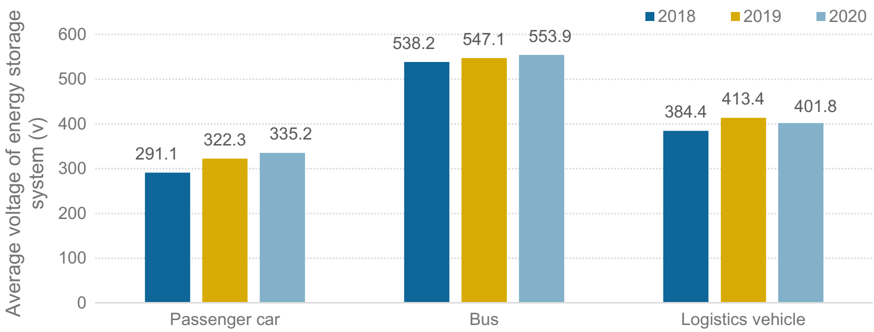

Fig. 3.20 Change in voltage of energy storage system of NEVs of different types

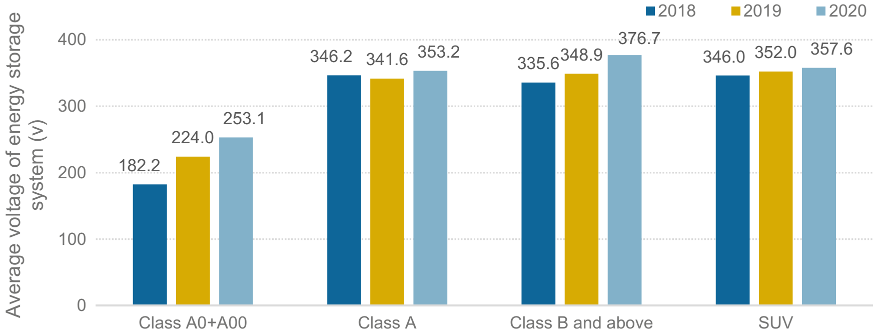

Fig. 3.21 Trend of change in battery pack voltage of cars of different classes

A cars, cars of Class B and above and SUVs realized high-voltage development in 2018, and since then, their voltage continued to increase gradually in the past two years.

3.6 Summary

For NEVs, significant progresses have been achieved in range, lightweight and other technical indicators. This chapter, through in-depth analysis of the technical parameters of NEVs, mainly draws the following conclusions:

The vehicle range has increased quickly, and meanwhile, the body's lightweight technology has also achieved significant achievements. The range of NEVs of different types is increasing year by year. From 2018 to 2020, the range of new energy passenger cars increased from 215 to 300.3 km, that of new energy buses increased from 258.6 to 400.6 km, and that of new energy logistics vehicles increased from 243.3 to 287.6 km, and among them, the range of BEVs increases faster. Specifically, the range of BEV passenger cars of Class B and above increases fastest; the proportion of BEV buses with a range of more than 300 km has increased rapidly; the proportion of BEV logistics vehicles with a range of 200–300 km has expanded quickly, and in 2020, it was increased by nearly 20–78.2% compared with last year. The body lightweight technology, with the industrial application of aluminum alloy and carbon fiber composite materials, has achieved significant progress. Compared with 2019, the average curb weight of NEVs decreased by 7.5% to 1910.0 kg in 2020, and the cars of Class A and above were obviously lighter than before.

As for the battery, the batteries on passenger cars are mainly ternary batteries, and in 2020, the lithium phosphate batteries returned to the market; the buses and logistics vehicles have gradually formed a vehicle construction based on lithium iron phosphate battery. Considering the types of batteries equipped on vehicles of different types, the batteries equipped on BEV passenger cars are mainly ternary batteries, with a proportion of more than 80%. The lithium iron phosphate battery gradually returns to the market, with the proportion of vehicles equipped with this battery increased by 2–11.7% compared with 2020; the batteries equipped on FCEV passenger cars are mainly ternary batteries. For BEV buses and logistics vehicles, a vehicle construction based on lithium iron phosphate battery is gradually into shape, and in the past three years, the main type of batteries on logistics vehicles has changed from ternary battery to lithium iron phosphate battery.

The NEVs' energy storage system has become higher and higher. The voltage of energy storage systems for new energy passenger cars and buses is increasing year by year. The voltage of energy storage systems for BEV cars of different classes has increased greatly, but the voltage of energy storage systems for SUVs has not increased a lot.