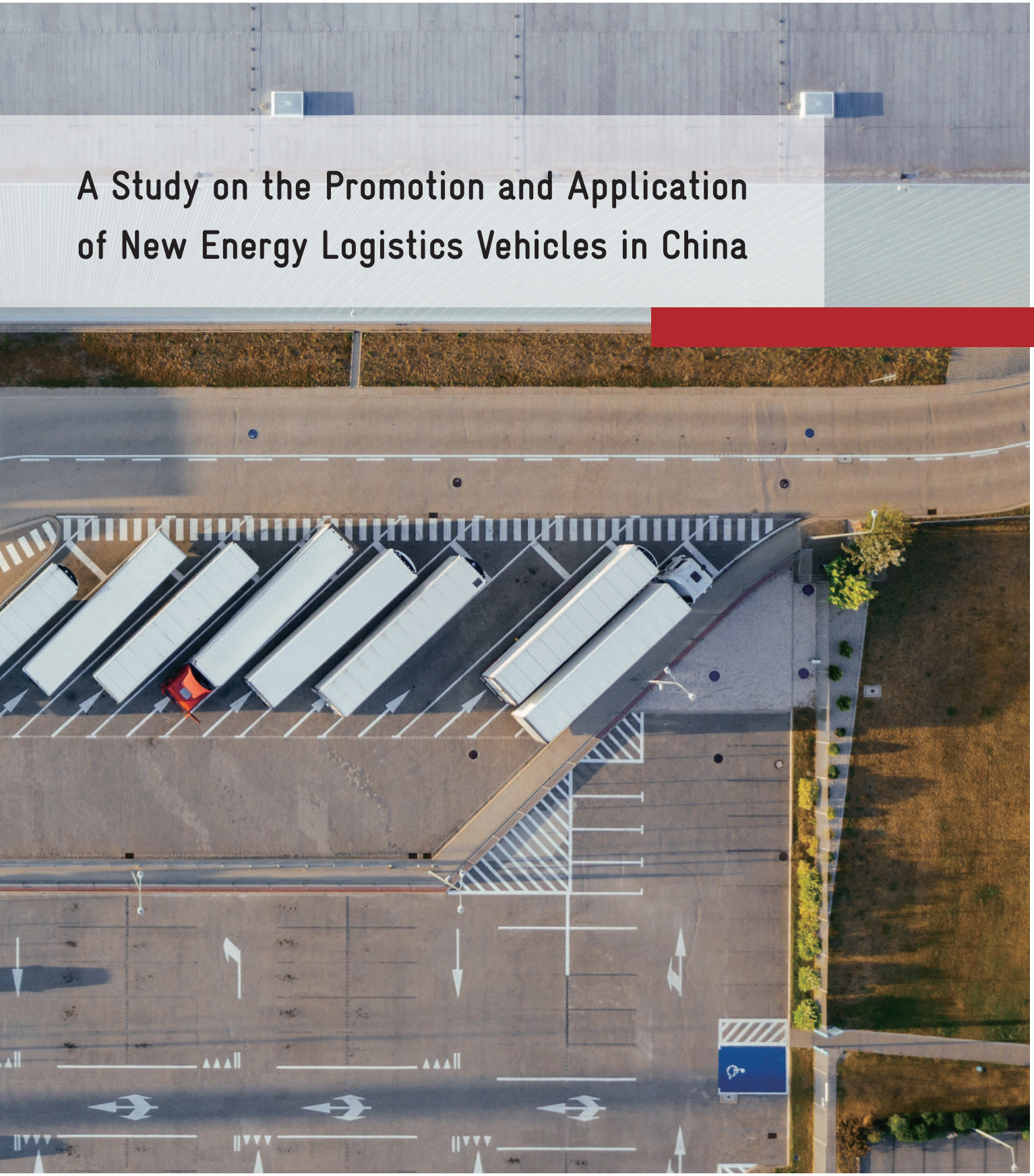
A Study on the Promotion and Application of New Energy Logistics Vehicles in China



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Abbreviation

BEV	Battery Electric Vehicle
BELV	Battery Electric Logistics Vehicle
CAAM	China Association of Automobile Manufacturers
CFLP	China Federation of Logistics and Purchasing
CRTA	China Road Transport Association
EVCIPA	China Electric Vehicle Charging Infrastructure Promotion Alliance
FCEV	Fuel Cell Electric Vehicle
FYP	Five-Year Plan
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
MoF	Ministry of Finance
MIIT	Ministry of Industry and Information Technology
MofCom	Ministry of Commerce
MoST	Ministry of Science and Technology
MoT	Ministry of Transport
MPS	Ministry of Public Security
NDRC	National Development and Reform Commission
NEA	National Energy Administration
NELV	New Energy Logistics Vehicle
NEV	New Energy Vehicle
NEVC	New Energy Vehicle Credit
NGO	Non-Governmental Organisation
SGCC	State Grid Corporation of China

1 Executive Summary

New Energy Vehicles (NEVs)[1] present a viable solution for carbon emission mitigation in China's growing logistics industry. Increasing their numbers and optimising the operation of NEVs can contribute significantly to low carbon sustainable development in the urban delivery sector, especially in the "last-mile delivery" context. Under the Green Urban Freight Pilot Programme launched by the Ministry of Transport (MoT) in 2017, 46 pilot cities were selected to promote new energy logistics vehicles (NELVs) in the urban delivery sector in China. The application of NELVs has been achieved with promising results, with over 412,000 NELVs on the road by 2019 and the number of these vehicles continues to rise. Nevertheless, the programme has also encountered various restrictions and obstacles, such as insufficient right of way privileges for NELVs, an inadequate provision of supporting facilities (e.g. charging points and infrastructure), and low levels of cost-effectiveness.

This study on the Promotion and Application of NELVs in China has been conducted within the framework of the Sino-German Cooperation on Low Carbon Transport (CLCT) project, which is funded by the International Climate Initiative (IKI) and implemented by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. The study aims to foster a constructive discussion on the future of sustainable and low carbon freight transport and logistics in China.

The study identifies the key challenges of NELV adoption in China, provides a detailed analysis of future trends and application scenarios, and outlines a set of comprehensive policy recommendations for promoting NELVs in the development of a low-carbon urban delivery sector. In order to produce these outputs, the study has examined China's current NELV development status, conducted a stakeholder analysis, carried out local investigations in five pilot cities of the Green Urban Freight Pilot Programme and interviewed stakeholders from the city of Zhangjiakou.

The development status analysis of this study concluded that although China has become the world's largest country in NELV production and sales, overall NELV sales have been declining for two consecutive years from 2018 due to the phasing out of purchase subsidies, and the market for new NELVs has entered a stabilisation phase. However, the NELV industry is still growing at a high speed, mainly driven by the continuous improvement of supporting services and infrastructures, maturing technologies, and sufficient scalability.

The development of NELV applications for the urban delivery setting depends on the support of three categories of stakeholders who are capable of shaping market structures and driving NELV demand, namely: 1. governmental authorities, 2. market players, and 3. other stakeholders. Relevant governmental authorities include ministries, departments, and commissions at national and local levels. Relevant market players are companies along the supply chain of the NELV industry, from production to operation and maintenance. Other relevant stakeholders include research institutions and universities active in the research and development (R&D) of related fields. Among these stakeholder groups, national-level governmental departments, production and sales enterprises, and research institutions have shown a stronger willingness to participate in promoting NELVs (see Table 3- 3).

[1] New Energy Vehicles (NEVs) are vehicles powered by unconventional fuels. These consist of four main power types of vehicles, Hybrid Electric Vehicles (HEVs), Battery Electric Vehicles (BEVs), Fuel Cell Electric Vehicle (FCEVs) and other new energy vehicles (e.g., super capacitor vehicles).

During field investigations in the pilot cities of Yinchuan, Zhengzhou, Chengdu, Shenzhen, and Foshan, and online interviews and surveys with representatives from the city of Zhangjiakou, numerous comments and practical suggestions from municipal transport and other relevant departments and enterprises were collected, and a detailed analysis of the current status quo, challenges, and experiences of NEV application in urban delivery was carried out. Findings from these detailed case studies are provided in Chapter 6, with the common features and individual characteristics of NELV promotion and application in these cities summarised in Table 4-2 and Table 4-3 in section 4.7.

The study identified the following obstacles and challenges for the development of NELVs in China:

- **Insignificant road access privileges**, i.e. no prioritised right of way is given to most NELVs compared with conventional fuel logistics vehicles in terms of the issuance of traffic permits for entering urban areas;

- **Low cost-effectiveness**, i.e. the purchase price of vehicles and key parts, such as battery packs, etc. are much higher than those of conventional fuel logistics vehicles. Currently, only the NELV renting model could be comparable to the total cost of ownership (TCO) of conventional fuel vehicles (see Table 5-1);

- **Insufficient charging facilities**, i.e. the current deployment of public charging facilities, both in regards to their quantity and geographic distribution, still cannot meet the present or near-future development requirements of NELVs;

- **Incomplete standardisation of NELV production and operation** has led to a lack of appropriate business management and maintenance practices, as well as obstacles to the effective implementation of policy incentives, including the allocation of subsidies;

- **Inadequate after-sales services** has led to inconvenient drawn-out maintenance processes and high costs for NELVs in their after-sales stage. The number of after-sales service centres still fails to meet levels of demand, and there is a lack of well-trained specialists, and of standardised quality assurance practices, as well as of policies for spare part replacement.

Encouraged by the announcement of China's 2030 carbon peaking and 2060 carbon neutrality goals, the investment in R&D on NEVs, especially on BEVs and FCEVs, is expected to accelerate. Nevertheless, the study shows that for most NELV application scenarios, battery-electric logistics vehicles (BELVs) can already meet the requirements of urban transportation and delivery. An exception to this is cold-chain (refrigerated) delivery, as current BELVs cannot meet its high-power consumption requirements for temperature control during goods transportation. Considering cold-chain deliveries usually serve high value goods, relatively high-cost FCEVs may still be used more cost-effectively for high value cold-chain delivery.

The study concludes with the following set of policy recommendations for supporting the promotion of NELVs for a green and low carbon urban delivery sector in China:

National level:

1. **Develop holistic measures** to realise substantial reductions in the total cost of NELVs, through supportive fiscal policies. These steps should include subsidies for the replacement of high emission vehicles with logistics vehicles of the China VI emission standard and NELVs, preferential tax policies for scrapping and replacing old vehicles, as well charging subsidies, and operation subsidies for NELVs based on travel mileage. Furthermore, the development of a New Energy Vehicle Credits (NEVC) mandate for commercial vehicles should be accelerated with the consideration of the phasing out of progresses of subsidy policies.

2. **Complete standards and norms for NELVs.** The standardisation of NELV batteries, core components and charging ports should be developed. A comprehensive standardized agenda for managing the whole life cycle of NELVs should be established. This agenda should include the processes of R&D, production, operation management, after-sale maintenance, and the scrapping and recycling of related parts.

3. **Complete NELV after-sale service systems.** After-sale services and networks should be standardised and improved, and the management of after-sale service quality should be strengthened. Training of highly skilled specialists in after-sale technical services and management should be developed to meet maintenance demands.

Local level:

4. **Continuously implement NELV road privileges.** New admittance permits to access urban areas should exclusively be granted to NELVs, and further road privileges such as preferential parking, a set road share of bus lanes and dedicated areas for NELVs should be adopted. Restrictions on conventional fuel logistics vehicles in central areas and on illegally retrofitted passenger vans should be strengthened and effectively implemented. To better implement these measures, new technologies such as parking sensors and GPS/Beidou units together with artificial intelligence should be employed.

5. **Accelerate the construction of new energy infrastructure.** Layout plans for charging stations should better reflect vehicle demand and operational areas, prioritising places such as logistics parks and arterial roads. Subsidy policies on the construction and operation of battery charging and swapping infrastructure should be formulated, and financial support should also be proportionally given to the construction of charging piles.

6. **Foster innovative NELV application business models.** The feasibility of battery-swapping should be further explored for Battery-as-a-Service (BaaS) business models, based on buying a vehicle, but renting a battery. New models of cooperation between freight operators and financial institutions should be supported in which the government should play a coordinating role by connecting operators and financing institutions. Optimised transportation organisations' operations, the strong management of urban logistics vehicle fleets and improved efficiency of transportation organisations can be achieved by implementing smart platforms that accumulate data from model selection and customisation processes, as well as productions and operations services of NELVs using big data, IoT and related technologies.

1 Background

Together with China's economic development since the beginning of Reform and Opening Up processes in 1978, the country's transportation industry has undergone a rapid transformation. This shift has been particularly notable in the movement of goods, which has grown in line with China's manufacturing capacity and consumer demand. China's freight volume and demand have been growing at an accelerated rate especially in the last decade. In 2019, the total freight volume of China reached 46.424 billion tons, with road freight traffic accounting for 74.3%[1]. The express delivery industry alone is experiencing rocket growth, with the overall business volume surging from 2.3 billion parcels in 2010 to 63.5 billion parcels in 2019, and an average of more than 100 million parcels being handled daily[2].

In 2019, China's transportation industry accounted for 10% (1.1 Gt) of the roughly 11.0 Gt of total CO_2 emissions in China[3]. Vehicle exhaust emissions are also one of the major contributors to atmospheric pollution. Diesel vehicles are the main fleet component of road freight transport in China. Although they only accounted for 11.1% of total vehicle ownership, they have contributed approximately 78% of the total NOx emissions and 89.9% of particulate matter emissions in the transport sector in 2019[4].

Given the continuous development potential of China's logistics industry and the increasing market demand for improving the efficiency of "last-mile delivery," services and following the trend of energy conservation and emission reduction in the transportation sector in China, new energy vehicles (NEVs) have emerged as one of most viable solutions for 'greener' urban delivery practices. Compared with conventional fuel logistics vehicles, NEVs have advantages in terms of energy conservation, emission reduction, and operation costs. Particularly light duty NEVs (below 4.5 tons) could better meet the demand of urban delivery in smaller quantities at a higher frequency.

To further drive the development of NEVs in urban delivery, China's Ministry of Transport (MoT), Ministry of Public Security (MPS), and Ministry of Commerce (MofCom) jointly launched the Green Urban Freight Pilot Programme. A total of 46 cities[2] in two batches (22 cities in December 2017[5] and 24 cities in September 2019[6]) were selected for the programme.

Though the development of new energy logistics vehicles (NELVs) can be considered a promising way to tackle the challenges brought by further growth of the urban freight industry, there are still obstacles to their expanded use, such as a lack in right of way provisions, low cost-effectiveness, and insufficient supporting facilities.

In this context, the Study on the Promotion and Application of NELVs in China has been included within the framework of the Sino-German Cooperation on Low Carbon Transport (CLCT). The CLCT project aims to promote exchange between China and Germany on the future of sustainable and low carbon freight transport and logistics and support technical cooperation and capacity building of Chinese partners in related effective decision-making and pilot implementation processes.

This study focuses on NELVs in the urban delivery sector, mainly referring to vehicles with a capacity below 4.5 tons, including mini vans with a capacity below 1.5 tons. Three-wheeled electric vehicles are not included in this study.

[2] The first batch of 22 cities includes Tianjin, Shijiazhuang, Handan, Hengshui, Ordos, Suzhou, Xiamen, Qingdao, Xuchang, Anyang, Xiangyang, Shiyan, Changsha, Guangzhou, Shenzhen, Chengdu, Luzhou, Tongren, Lanzhou, Yinchuan, Taiyuan, and Datong. The second batch of 24 cities includes Tangshan, Qinhuangdao, Nanjing, Wuxi, Xuzhou, Nantong, Wenzhou, Taizhou, Wuhu, Linyi, Zhengzhou, Jiyuan, Huangshi, Xianning, Yueyang, Huaihua, Zhuhai, Foshan, Dazhou, Xi'an, Baoji, Ankang, Urumqi, and Shihezi.

2 Application of NEVs in the Urban Delivery Sector

2.1 Development Status of NEVs in China

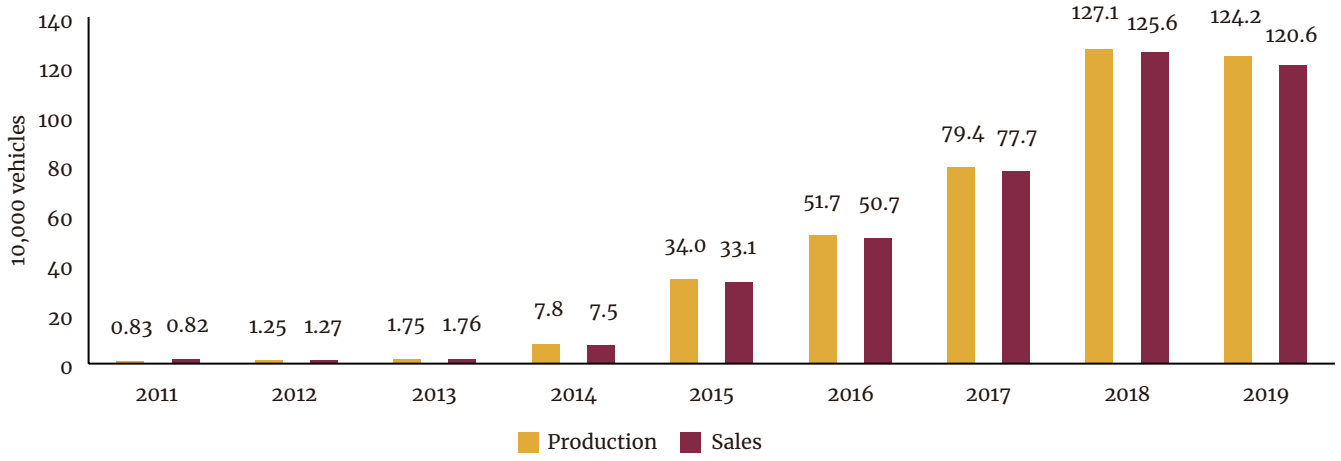
2.1.1 Development of NEVs and their Production and Sales

As one of the key components of NEVs, the development of NELV mainly follows the overall progress path of NEVs. The timeline for NEV development in China is mainly divided into four periods: 1. The uptake phase (2009-2012); 2. The market development phase (2013-2014); 3. The mass adoption phase (2015-2019), which coincides with the rapid growth of the NEV industry under the 13th Five-Year-Plan (FYP, 2016-2020), and; 4. The stabilisation phase (2020 onward).

During the uptake and market development phases of NEV development, China introduced financial incentives for NEV purchases, including subsidies, purchase tax exemptions, government procurement, and incentives for the construction of charging facilities, which have boosted the rapid development of production and sales of NEVs in the mass adoption phase. According to data published by the China Association of Automobile Manufacturers (CAAM)[3], the production and sales of NEVs in China increased year by year between 2011 and 2019 (see Figure 2-1).

In 2018, China started to gradually phase out its NEV purchase subsidy policy, beginning with the setting of higher thresholds for receiving subsidies, and continuing reductions through to 2019, when national subsidies for NEVs were reduced by about 50%[7]. Due to these subsidy reductions, macro-economic downward pressure, and upgrades in emission standards, the production and sales of NEVs in China decreased for the first time, ending at 1.242 million and 1.206 million vehicles in 2019, and with a year-on-year decline of 2.3% and 4.0%, respectively[8]. However, the number of NEVs in operation and their sales in China still account for half of the global total, making the country rank first worldwide in the production and sales of NEVs for five consecutive years.

■ **Fig. 2-1 Production and Sales of NEVs in China 2011-2019**



(Data sources: MIIT and CAAM)

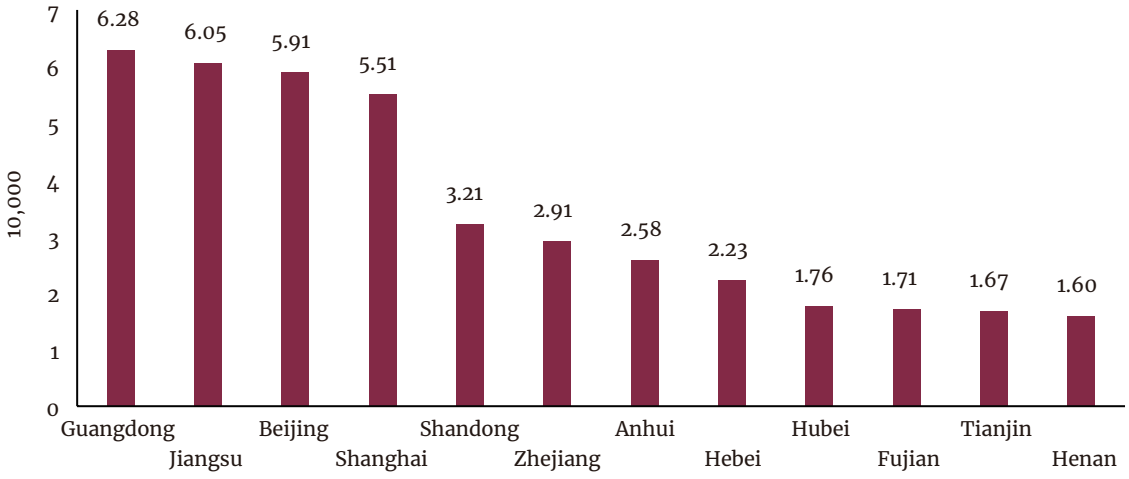
[3] Monthly data published by CAAM (China Association of Automobile Manufacturers).

2.1.2 Charging Infrastructure and Capacity Development

In 2019, charging infrastructure construction was primarily concentrated in Guangdong, Jiangsu, Shaanxi and Sichuan provinces, and Beijing, where the infrastructure layout was mainly designed to serve public buses and passenger cars, rather than logistics vehicles and other special purpose vehicles. In terms of charging infrastructure development, Guangdong, Jiangsu, Beijing, Shanghai, and Shandong rank top in the number of public charging piles in China (see Figure 2-2). Public charging facilities are mainly deployed in the Jing-Jin-Ji (Beijing-Tianjin-Hebei) area, the Yangtze River Delta, and the Pearl River Delta regions, with less distribution of these structures in northeast, northwest and southwest regions. The charging speed and utilisation rate of charging piles and the supporting environment for the NEV industry have been continuously optimised across these areas.

According to statistical data from the China Electric Vehicle Charging Infrastructure Promotion Alliance (EVCIPA), 807,000 units of charging piles were constructed in China by the end of 2020, including 498,000 AC charging piles, 309,000 DC charging piles, and 481 AC/DC[4] integrated charging piles (Figure 2-2)[9] . According to the Guidelines for the Development of Electric Vehicle Charging Infrastructure (2015-2020) issued by the National Development and Reform Commission (NDRC) and its "New Infrastructure"[5] plan, China set out to build 500,000 DC charging piles and 4.3 million AC charging piles by 2020. More than 36,000 charging/battery-swapping stations will be built by 2025, bringing the vehicle-pile ratio up to 1:1. There is still a large gap between the planning targets and the current number of charging piles.

■ **Fig. 2-2 Number of Public Charging Piles in Provinces and Cities of China in 2019[9]**



[4] DC stands for direct current and AC stands for alternating current. The main difference between DC and AC is the charging times, with DC charging faster than AD.

[5] New Infrastructure construction is focused on seven areas: 5G base stations, Ultra High Voltage (UHV), intercity high-speed railway and urban rail transit, NEV charging piles, big data centres, AI, and industrial Internet. It is an infrastructure system that is guided by new development concepts, driven by technological innovation, and based on information networks, providing services such as digital transformation, intelligent upgrading, and integrated innovation to meet the needs of high-quality development.

2.2 Development of NELVs

2.2.1 Development Status of Urban Delivery in China

There is a growing need for diversified and personalised, yet timely and convenient delivery services in China. In 2019, the country introduced a series of favourable policies for the urban delivery sector, and the demand of urban residents for urban delivery services continues to rise. As a result, the urban delivery market has grown exponentially, with total retail sales of consumer goods reaching totals of over EUR 5.26 trillion (RMB 41 trillion), of which urban retail sales exceeded EUR 4.48 trillion (RMB 35 trillion), accounting for 85.3%[10]. In 2019, the overall business volume of the express delivery industry reached 63.52 billion parcels, and its accumulative revenue was EUR 96.12 billion (RMB 749.78 billion) [10].

Urban delivery is a localized professional logistics distribution service, different from those professional logistics companies which provide networks at the national level. Urban delivery distances are relatively short, being mainly concentrated within a city or city cluster. This trait applies to the entire delivery process of urban deliveries – from warehousing, unloading, sorting, order generation, and final delivery of goods. Urban delivery services are highly market-oriented, with numerous participants and fierce competition, and have the following key characteristics:

Greater market demand and an increase in purchasing power have led to expanding demand for urban delivery in recent years. According to the "Report on competitiveness analysis and development prospect of China's urban delivery industry (2021-2025)" by the Zero Power Intelligence Company, China's urban delivery market exceeded EUR 128.2 billion (RMB 1.5 trillion) in 2019, and the market size may increase to about EUR 256.41 billion (RMB 3.6 trillion) by 2025[11].

Scattered delivery areas. The ongoing integration process of urban and rural areas and the continuous expansion of urban spaces have led to an expansion of urban delivery areas, a scattered distribution of deliveries (rather than being concentrated in one specific area of a city), and an increase in delivery demand.

Diversified service demands. Most urban delivery services are for end consumers. With increasingly personalised and diversified demands, customers seek and are willing to pay more for the timeliness, flexibility, and convenience of urban delivery services. This consumption upgrade further drives the need for a parallel logistics upgrade.

High environmental-friendly requirements. Since 2018, a series of national policies have required the proportion of NEVs as newly added or replacements for existing logistics vehicles, especially for key regions[6], to be no less than 80%[12]. Urban delivery is a key sector for promoting NEVs in China. In September 2021, the Central Committee of the Communist Party of China (CPC) and the State Council issued The Opinions on Complete and Accurate Implementation of the New Development Concept for Carbon Peaking and Carbon Neutral Work[13] (hereinafter referred to as the Opinions). In October 2021, the State Council issued The Action Plan for Carbon Peaking by 2030[14] (hereinafter referred to as the Plan), which is a systematic proposal and overall plan of the Party Central Committee for carbon peaking and carbon neutral work. The Plan clearly stated that in 2030, the proportion of new energy and clean energy transport tools would reach about a 40% share. Additionally, the Opinions play an overarching role in the policy system of carbon neutrality.

[6] The air pollution prevention and control areas include the Beijing-Tianjin-Hebei region, Yangtze River Delta region, Pearl River Delta regions, and Shandong City Clusters, Wuhan and its surrounding City Clusters, Changsha-Zhuzhou-Xiangtan City Clusters and Chengdu-Chongqing City Clusters.

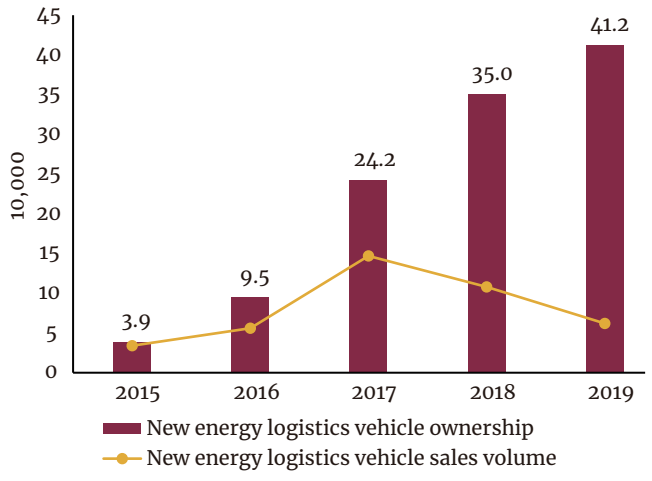
2.2.2 Development Status of NELVs

Several structural and economic priorities were outlined in the China Governmental Work Report 2020[15]. These included strengthening the construction of new types of infrastructure (i.e., the New Infrastructure), developing next-generation information networks, expanding 5G applications, building more battery charging facilities, promoting a wider use of NEVs, stimulating new consumer demand, and promoting industrial upgrading.

In the context of New Infrastructure, driven by different national and local incentive policies, the promotion and application of NELVs in China have seen the following overarching developments:

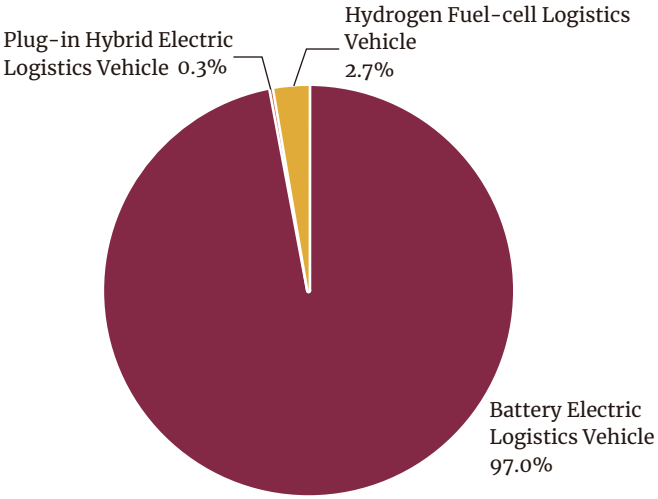
The market of NELVs has entered an adjustment period. China has already become the world's largest country in the production and sales of NELVs. However, due to the phasing out of purchase subsidies, the sales of NELVs have been in decline for two consecutive years from 2018. In 2019, NELV sales in China were at 62,000, with a year-on-year decrease of 43.7%[16]. The market has entered an adjustment period, with accumulative stocks of about 410,000 NELVs, accounting for 10.8% of total NEV ownership[17](Fig. 2-3). However, the growth of China's NELV industry is still ongoing, with a continuous improvement being seen in infrastructure, a gradual development and rise in the effectiveness of industrial supporting facilities, the presence of increasingly mature technologies, and a growing economy of scale, leaving significant potential for further growth.

■ **Fig. 2-3 Car Ownership and Sales of NELVs 2015-2019[17]**



Diversified technical approaches to powering NELVs have emerged, with electric batteries remaining mainstream, but increasing attention being given to the development of fuel-cell electric vehicles (FCEVs). NELVs in China are dominated by electric technology. In 2019, fuel cell and plug-in hybrid electric logistics vehicles gradually entered the market. Although the market for electric logistics vehicles has been in decline since 2018, the production of FCEVs has risen to 1,668 vehicles, accounting for 2.7% of all NELV productions[17] (See Figure 2-4). Due to their better suitability for carrying large payloads and their longer travel ranges, hydrogen logistics vehicles have gained a wide range of national and local policy support for their development.

■ **Fig. 2-4 NELVs by Fuel Type in 2019[16]**



At the national level, the "Opinions on the Department Assignments in Implementation of the Key Tasks of the "Report on the Work of the Government[18]", issued by the State Council in April 2019, called for the continued implementation of preferential policies for NEV purchases and a promotion of the construction of related facilities, including hydrogen refuelling stations. The NDRC issued the Catalogue for the Guidance of Industrial Structure Adjustment (draft for comments) in May 2019 to encourage highly efficient hydrogen production, transportation, and high-density hydrogen storage-related technological developments and applications. The building of hydrogen refuelling stations was also encouraged, being listed into Item V (New Energy) of Category I (Encouraged Category) of the Catalogue. The Blue Book on Infrastructure Development of China's Hydrogen Industry (2016 Edition) co-authored by the Chinese Institute of Standardisation and the National Hydrogen

Standardisation Technical Committee expressly specified that by 2030, more than 1,000 hydrogen refuelling stations were to be built in China, and the number of hydrogen fuel cell vehicles was set to reach 2 million[19].

The tide of digital transformation in logistics is pushing high-quality service development. To ensure the safety of NEVs throughout their whole supply chain and life cycle, the MIIT issued the Notice on Further Improving the Safety Supervision in the Promotion and Application of NEVs in November 2016, requiring the establishment of NEV platforms which monitor the safe development and use of NEVs from enterprises to local and national levels.

According to policy requirements, automobile enterprises shall establish a product operation safety monitoring platform for NEVs to monitor all sold vehicles' operating status and connect it to the national NEV monitoring platform. Information on the operation safety status, mileage, and charging capacity of NEVs in public services, as well as the failures of key systems, including the vehicle, battery, and electric motor, can also be obtained from the national platform.

In 2017, entrusted by the MIIT, the Beijing Institute of Technology established the world's first national NEV monitoring and management platform (Figure 2-5). This service is run as a third-party national information platform for NEVs with over 6 Million vehicles (as the end of 2021) connected in China. It effectively supports the national supervision of information safety and NEV quality by gathering, monitoring and integrating NEV data, and provides verified evidence for national financial subsidies through real-time supervision over information on vehicle operations. The platform marks an important step in NEV information supervision and provides data support for NEV technological and scientific research, industry policy making, dynamic safety management, industrial layout, and financial subsidies.

■ **Fig. 2-5 National NEV Monitoring and Management Platform**

(Source: https://www.evsmc.cn/)

3 Overview of NEV Application in the Urban Delivery Sector

3.1 Application of NEVs in the Urban Delivery Sector

With the rapid development of express delivery and logistics sectors in China, the demand for short-distance urban freight services has increased significantly. Urban delivery has become an important part of modern logistics, and the industry is in urgent need of more logistics vehicles. By 2020, NEVs and "China VI" emission standard vehicles accounted for more than 50% of newly added vehicles, replacing light-duty logistics vehicles in urban built-up areas, with 80% of these unites being operated in key regions, according to the Three-year Action Plan for Promoting Transport Restructuring 2018-2020 issued by the State Council[12]. This has brought great development opportunities for NELVs.

3.1.1 Mainstream NELV Models

The NELVs market currently consists of vehicle types with limited functions, which are only used for ordinary transport purposes. There are only a few models of NELVs available with refrigeration and insulation functions. The dominant vehicle type of NELVs are cargo vans, accounting for more than 60% of current units, and box truck types account for only 30%. Conversely, box trucks comprise more than 70% of conventional fuel logistics vehicles, while cargo vans only account for 25%[20].

Urban traffic conditions are relatively complex, requiring a high flexibility in the type of vehicles that need to be used for specific terrains, including those which are able to access narrow roads. Most urban delivery services run over short distances of within 100km. In addition, many cities have formulated regulations for time restrictions for large vehicles to access certain areas, and strict standards on environmental protection and exhaust emissions. NELVs used in the urban delivery sector are therefore mainly mini and medium vans, and mini and light-duty trucks (see Figure 3-1).

■ **Fig. 3-1 Examples of Mini and Medium Vans and Mini and Light-Duty Trucks**

(Source: Youjia + hyperlink)

3.1.2 Application Scenarios

In the urban delivery sector, battery-electric logistics vehicles (BELVs) are mainly utilised in three scenarios: 1. express deliveries, 2. retailer supply, and 3. e-commerce sales, with leading e-commerce enterprises largely operating their own fleet of logistics vehicles. However, the application of NELVs for personal delivery services is rare due to many practical obstacles such as a lack of urban road accessibility, inefficient cost-effectiveness, and a lack of convenient charging options.

Urban express delivery: Considering the current technical limitations on travel ranges (how far vehicles can go on one charge), recharging times and a lack of related infrastructure, and challenges with vehicle attendance rates and reliability, BELVs are mainly used for point-to-point express delivery within cities, but rarely used for customised delivery services for individual end-users.

Urban retail supply: With the rise of new retail modes, urban convenience stores, such as Suning and T-mall, began to expand on a large scale. Since urban convenience stores, franchising bakeries, and other urban retailers have fixed delivery times, product types, and routes, urban retail delivery for these expanding services will continue to be an important role that can be filled by BELVs.

E-commerce enterprise self-built logistics transportation: With the changes in the consumption patterns of urban residents, the characteristics of logistics demands have

been turning to deliveries covering diverse ranges, small volumes of products, multiple batches of units being sent over different times, and short cycles of delivery traffic. As e-commerce enterprises attach great importance to time efficiency, under current urban traffic restrictions, it is difficult for conventional fuel logistics vehicles to meet the growing logistical demands of e-commerce. Under the background of emerging energy-saving and emission reduction policies, as well as enhanced promotions on NEVs, large scale e-commerce enterprises such as Alibaba and JD have put BELVs into use in their urban delivery sectors. By January 2018, JD fulfilled its promise to replace 100% of its own conventional fuel logistics vehicles in Beijing with electric vehicles[21][22].

3.1.3 Operation Modes

NELVs are operated in two main modes in urban delivery. First, urban freight operators rent logistics vehicles from NELV operation platforms (NELV leasing companies), which is the dominant NEV operation mode. Second, urban freight operators, mainly large logistics companies, purchase NELVs. More than 90% of electric logistics vehicles in operation are rented[20] , allowing the operators to avoid risks affiliated with purchasing vehicles and to save costs.

There are two main renting practices for NELVs: 1. Leasing and 2. Sharing. For leasing, the end customers (logistics companies) rent vehicles from an NELV operation platform. Some types of leasing platforms may not involve actual logistics operations, and only provide vehicles and related maintenance services, whereas other types may directly provide drivers and vehicles, ultimately outsourcing overall actual logistics operations. Logistics companies and leasing platforms tend to establish long-term and stable cooperative business relationships for their leasing practices.

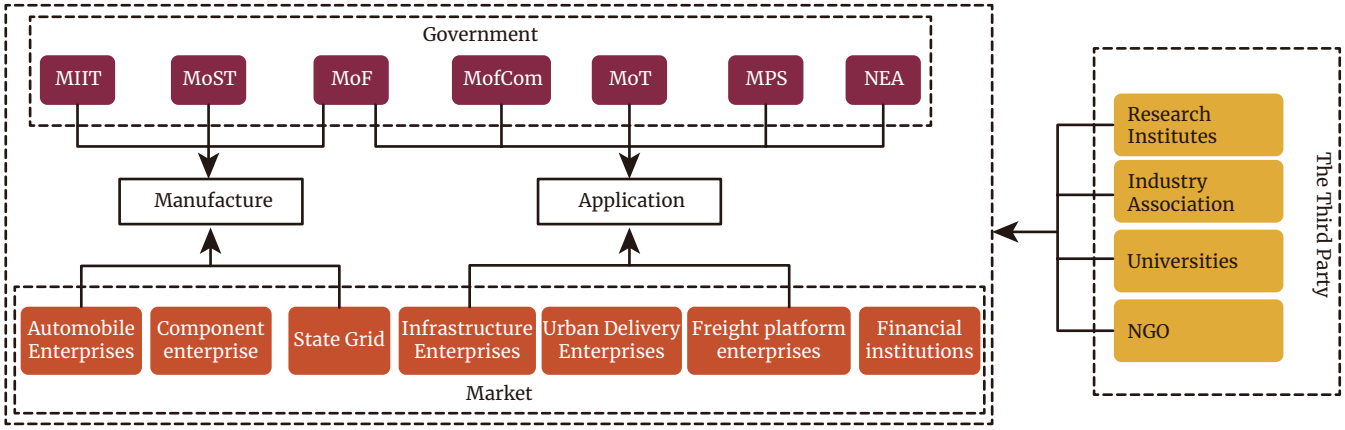
NELV sharing opportunities create new business models for the urban delivery sector, which follow the model for car-sharing in the passenger transport. Platforms for sharing logistics vehicles, such as the Shenzhen Xinwo Transport Power Automobile Co. LTD[23], provide multiple service functions for this type of service, such as timeshare rentals, vehicle maintenance and management, and payment options. Utilising web-based solutions, sharing practices help solve logistics demand problems by quickly matching vehicles and cargos to find solutions which match customers' flexible and diversified transportation service demands.

3.2 Stakeholder Analysis

3.2.1 Overview of Stakeholders

The development of NELV applications for urban delivery services is driven by key stakeholders who have played important roles in shaping market structures and stimulating market demand. These stakeholders, further analysed in this section, are divided into three groups: 1. Governmental authorities, 2. Market players, and 3. Other stakeholders. Governmental authorities include national ministries and commissions, and local industrial authorities, whereas market players refer to all kinds of enterprises within the industrial supply chain, and the other stakeholders are scientific research institutions and industry associations. The stakeholder relationship diagram is shown in Figure 3-2.

■ **Fig. 3-2 Stakeholder Relationship Diagram**



(Source: TPRI)

3.2.2 Analysis of Governmental Authorities

The Chinese government has played an important role in encouraging and guiding NEV promotion in the urban delivery sector. In terms of responsibility, the application of NEVs in this sector mainly involves the MIIT, Ministry of Commerce (MofCom), Ministry of Finance (MoF), MoT, MPS, Ministry of Science and Technology (MoST), and the National Energy Administration (NEA) on the national level and their corresponding bureaus on local administration levels. Local Bureaus develop corresponding measures to follow their respective ministries and ground the national policies. Table 3-1 lists the specific responsibilities of national authorities in the promotion of NELVs.

The development of NEVs in China is both a strategic development direction of the country's automobile industry and, together with the increase of renewable energy capacities, a strategic measure for achieving China's targets to peak carbon dioxide emissions before 2030 and carbon neutrality before 2060. Therefore, relevant governmental authorities at all levels actively promote NEVs and have introduced various policies and measures for their use. See Chapter 3.3 for details on these relevant policies.

All related ministries and commissions remain highly engaged within their relevant responsibilities in the promotion of the application of NEVs in the urban delivery sector, as do local authorities, such as by issuing preferential polies and measures. However, local financial subsidies differ depending on local economic development, taxation levels, and varying contexts of capacities. In formulating policies on the right of way of NELVs, local public security bureaus need to consider various local environmental factors, such as levels of traffic congestion and air pollution control, which may lead to different traffic accessibility patterns. Varying local contexts means differences in the level of participation and support available from local public security bureaus, which need to be reflected in planning.

■ **Table 3-1 Responsibilities of National Level Government Authorities in the Promotion of NELVs**

National authorities	Specific responsibilities
MIIT	Manage the manufacturing of NELVs, formulate related policies and standards, and implement incentive policies with other ministries and commissions, etc.
MoF	Formulate financial subsidy policies to encourage the promotion of NELVs
MoT	Manage the intercity and urban freight industries in terms of the application of new energy urban logistics vehicles; organise pilot programmes and demonstrations, and release incentive policies with other ministries and commissions, etc.
MofCom	Manage the logistics industry related to the application of new energy urban logistics vehicles, and release incentive policies with other ministries and commissions, etc.
MPS	Design and implement policies on right of way of new energy urban logistics vehicles, and release incentive policies with other ministries and commissions, etc.
NEA	Provide guidance on the construction of charging (swapping) infrastructure, regulate electricity consumption and rate, etc.
MoST	Organise research and development of technologies related to NEVs, and jointly release incentive policies to promote the technological progress of NEVs.

3.2.3 Analysis of Market Players

Enterprises along the NELV industrial supply chain play a key role in promoting the application of NELVs in the urban delivery sector. These enterprises fall into three major categories (see Table 3-2): 1. Production and sales enterprises, including vehicle manufacturers and sales enterprises, and spare parts production and sales enterprises; 2. Application enterprises, including urban delivery and NELV operation platform enterprises; and 3. Supporting infrastructure enterprises, including the State Grid, entities engaged in the construction and operation of charging (including battery-swapping) infrastructure, and financial institutions.

NELV manufacturers and others involved in the production and sales of the vehicles, supported by the encouragement of favourable national policies and financial subsidies at all administrative levels, and the pressure on the automobile industry itself to switch to a use of clean energy, are actively working to promote different ways that NELVs can be applied. Industrial growth is being driven via two main technological pathways – namely battery electric vehicles (BEVs) and FCEVs.

Conversely, enterprises involved in the actual use of NELVs, including urban delivery enterprises are still not sure of how much an impact the vehicles might make to their operations. This is due to the fact that, as primary vehicle users, urban delivery enterprises still regard current models of NELVs as unable to meet urban delivery needs due to their technical standards, limited battery life, and related limitations in use, and their initial purchase cost is considered to be too high. Existing promotional support for NELVs mainly depend on local subsidy policies and measures that promote the right of way for these vehicles, which may not be yet attractive enough to development enterprises.

Vehicle leasing enterprises, as they do not have the same business models and the pressure of low-price competition faced by delivery enterprises, are more engaged and interested in the promotion of NELVs. Leasing enterprises can also obtain operating subsidies in some places through innovative business models, if they support NELVs. This is an additional incentive for their support of the vehicles.

■ **Table 3-2 Responsibilities of Market Players in the Application of NELVs**

Market players		Specific responsibilities
Production & sales	Vehicle manufacturers and sales enterprises	Carry out R&D related to new energy urban logistics vehicles, develop related technology roadmaps, and manufacture different types of vehicles, sell NELVs and provide after-sales services
	Spare parts production and sales enterprises	Manufacture spares parts of NELVs, sell and provide after-sales services
Application	Urban delivery enterprises	Provide urban freight, logistics, and express delivery services with NELVs
	NELV operation platform enterprises	Provide vehicle cargo matching, new energy vehicle rental services, vehicle maintenance, order settlement, operation optimisation and other services
Supporting infrastructure	Financial institutions	Provide financial services for production and sales enterprises, urban delivery enterprises, NELV operation platform enterprises, infrastructure construction and operation enterprises
	State grid	Take the lead in the construction and operation of public charging (battery-swapping) infrastructure
	Other enterprises for constructing and operating charging (battery-swapping) infrastructure	Carry out construction and operation of the charging (battery-swapping) infrastructure for self-use or public use

3.2.4 Analysis of Other Stakeholders

Other stakeholders have played active roles in promoting the application of NEVs in the urban delivery sector. These groups mainly include research institutions (universities, research institutes, think tanks, and non-governmental organisations, or NGOs) and industry associations, including all kinds of industrial organisations, such as CAAM, the China Road Transport Association (CRTA), the China Federation of Logistics & Purchasing (CFLP), China EV100, and the New Energy Vehicle Promotion Centre. Through their engagement with relevant policies, standards, and regulations, these stakeholders track the technological progress of NEVs, conduct analysis and research reports on their development and use, and objectively summarise and evaluate the status quo of the promotion of NEVs in the urban delivery sector.

Offering their perspective as a third party, these stakeholders have provided references for government departments and market players in decision-making processes relating to NEVs. Due to current trends for the promotion of NEVs in the urban delivery sector and a growing body of research, exchanges, and discussions on the strong demand for the industry's development, the above-mentioned stakeholders are highly engaged and interested in seeing the inclusion of NELVs in the sector succeed. The degree of support and willingness of participation among various stakeholders in the promotion and application of NEVs in the urban delivery sector is shown in Table 3-3.

As indicated in Table 3-3, the responsibilities and willingness of different stakeholders to participate in NELV promotion vary from each other. In regard to governmental departments, each ministry and commission at both the national and local levels is responsible for policy making and implementation processes, and they all have a strong willingness to promote NELVs. Market players, encouraged by policy incentives, will be the most important force in the actual marketing and industrial development of NELVs and have a varied level of willingness to promote the vehicles. For example, in comparison to enterprises in the fields of production and sales, and vehicle leasing and supporting infrastructure, urban delivery enterprises are less motivated to promote the application of NELVs, mainly due to high purchase costs of the actual vehicles and insufficient right of way policies that would help their delivery services. In regard to other stakeholders, such as research institutions and industry associations, these groups will continue to actively participate in studies of relevant policies, standards, and regulations relating to NELVs, and provide advice on decision-making processes that could help the promotion of the vehicles.

■ **Table 3- 3 Willingness of Participation Analysis of Stakeholders**

Stakeholders		Willingness of Participation
Government departments	National ministries	☺☺☺
	Local government	☺☺
Market players	Production and sales enterprises	☺☺☺
	Urban delivery enterprises	☺
	NELV operation platform enterprises	☺☺
	Enterprises of supporting infrastructure	☺☺☺
Other stakeholders	Research institutions	☺☺☺
	Industry associations	☺☺

3.3 Policy Overview on the Promotion of NEVs in the Urban Delivery Sector

Policy support has been an important driving force for the development of the NEV industry in China. Policies related to this promotion at both national and local levels are summarised in this section.

3.3.1 Review of National Policies

(1) Promotion and application of NEVs

Since China started the promotion of NEVs in 2009, the national government has issued various supporting incentive policies for the industry. These policies focus on the promotion of overall industrial development, the promotion of the construction of charging infrastructure, and the setting of preferential right-of-way measures for NEVs. These measures have been designed to not only promote the use of NEVs, but also their inclusion on policy making decisions of local governments. Sixteen important national and local policies pertaining to NEVs are listed in Annex I and Annex II, for more detailed reference. Among them, two guiding documents, namely the "Energy-Saving and NEV Industry Development Plan (2012-2020)"[24] and the "NEV Industry Development Plan (2021-2035)"[25], have already determined the general development direction and technical pathways of the NEV industry, with the latter being used as a reference for the creation of other supporting policies. Financial policies, as the main incentive mechanisms for the use of NEVs, have been constantly adjusted and improved and then restricted when required. For example, although a national vehicle purchase subsidy initiative for NEVs was extended to the end of 2022[26] , though there has been a gradual phasing down of NEV purchase subsidies since 2018[27], the national strategy demonstrated a shift from having incentives being policy driven to being better suited to changes in the market. To ensure that NEVs are being rolled out in a safe and sustainable way, the MIIT has put forward a standard system that regulates their use and related charging infrastructure, as part of its regular work.

(2) Promotion and application of NELVs

In the uptake phase (2009-2012) for the promotion and application of NEVs, policies were initially developed in favour of the whole NEV industry and all NEV vehicle types. Gradually, numerous favourable policies for NELVs, including those relating to overall industry goals, the construction of charging facilities, and a plan for the preferential right-of-way of NELVs have been introduced (See Annex I) during the 13th FYP period (2016-2020), especially after the release of the Three-year Action Plan on Air Pollution Control in 2018. In general, China has been proactive in the promotion and application of NEVs in the urban delivery sector, with the policies mainly being characterised as promoting the following things:

a. Emphasis on cooperation amongst governmental departments

The promotion and application of NELVs involves the responsibilities and authorities of many departments at national and local levels, who are in charge of Transport, Development and Reform, Finance, Public Security, Environment, and related sectors. Cooperation between these departments is essential for the successful promotion of NELVs. For example, in 2017, the MoT, MPS, and MofCom jointly organised the Green Urban Freight Pilot Programme and identified 46 pilot cities (in 2 batches)[28], demonstrating how ministries can work together to make programs both effective and sustainable.

b. Identification of the direction of promotions and application objectives for NEVs

Directions for the promotion of NEVs were outlined in two NEV industry development plans. From 2012 to 2020, the main strategic direction of NEV development and the related transformation of the automobile industry was to shift towards vehicle electrification and energy saving technologies [24]. From 2021-2035, the development vision of NEVs shifted to support for the R&D of core technology for the vehicles and infrastructure, with the aim of having China's core technology on NEVs be at the highest global level[25]. Additionally, several policies have specified objectives relating to the actual application of NELVs. In 2018, the State Council advocated that in key regions, the proportion of NEV and China VI emission standard vehicles operating as new and replaced light duty logistics vehicles should exceed 50% and 80% respective, by 2020[12].

c. Various supporting policies

Current national incentive policies have involved providing financial support for the promotion NELVs through such initiatives as the provision of purchase subsidies and vehicle purchase tax exemptions, support

for the construction of related infrastructure, and the setting of preferential right-of-way policies for these vehicles. These financial-based supporting initiatives encouraged users to purchase and operate NELVs. For example, in 2020, to mitigate the impacts of the Covid-19 pandemic on the NEV industry, the MoF, MIIT, MoST, and NDRC extended the NEV purchase subsidy policy to the end of 2022[29]. Financial subsidies have also supported the construction of charging infrastructure together with other preferential infrastructure-supporting policies. Furthermore, the right of way policy is essential to guarantee a preferential driving environment for NELV operators. Especially after the phasing out of NEV purchase subsidies, the operation subsidy and right of way policy will be the key driving forces to support the use of NELVs in the current vehicle market.

Despite the achievements of the above policies, there is still room for their improvement and the introduction of new policy initiatives. Firstly, New Energy Vehicle Credits (NEVCs) are important non-fiscal incentive policy for manufactures, and these are currently not available for commercial NEV manufacturers. Secondly, post-2022, the future of policies of subsidies for purchasing and operating NELVs, as well as for the construction and operation of charging (battery-swapping) infrastructure, remains unclear. Thirdly, the current preferential right of way policies for NELVs are insufficient, and the way they are regulated and implemented varies amongst local governments.

3.3.2 Review of Relevant Local Policies

(1) Promotion and application of NEVs

The role of local governments in the promotion and application of NEVs is to implement policies, to formulate relative measures based on local conditions, and to supervise policy development and measure their implementation. For example, the right of way policy is an advocacy target of national level plans, but the concrete regulation, formulation and implementation of these policies are the responsibility of local governments. Some local governments have formulated NEV development plans and objectives for their promotion, as well as subsidy policies, and have subsequently set corresponding goals for the proportion of NEVs they aim to have as newly added vehicles. The reach, scope and contents of these policies vary amongst local governments due to their different contexts (see Chapter 4 for further details).

(2) Promotion and application of NELVs

Supplementing the implementing policies of the central government, local governments have also developed their own support policies for NELVs, which mainly include financial subsidy policies and right of way policies. Their formulation and implementation are based on the characteristics of different regions and cities. Cities, which not only have well-implemented, favourable local policies for NELVs, but also issue purchase and road access restriction policies and measures for conventional fuel vehicles, such as Shenzhen, Chengdu, Guangzhou, Shanghai, Beijing, Tianjin, Wuhan, and Qingdao, enjoy the most active NELV markets. Concrete and effective measures for supporting NELVs mainly include no restrictions bet set on their new number plates (thus there is no need for a new number plate lottery),[7] special plates for right of way NELV privileges, no traffic restrictions related to NELV number plates, and priority in processing number plate applications for NELVs (see Annex II for more policy details of some provinces and cities).

With the gradual phasing out of purchase subsidies at the national level, responsibilities for further promoting NEVs have shifted to local governments, who can take two main steps to keep supporting NEVs with their policies. Firstly, local policies should provide more support for the construction and operation of charging (battery swapping) infrastructure. Secondly, it is necessary to further lift road access restrictions and provide more dedicated parking spaces for NELVs based on local conditions. An overview of preferential policies for NELVs in major cities is available in Annex II.

[7] With the purpose to ease traffic congestion and air pollution in big cities, total vehicle ownership is controlled by the application of new number plate lottery schemes in several cities in China. The new vehicle quotation is determined for the year, and citizens who would like to own a new vehicle have to register for the lottery to be eligible for new vehicle registration.

3.4 Trend Analysis on the Application of NEVs in the Urban Delivery Sector

3.4.1 Cost decline in NELV production

The cost of the core components and parts of NELVs is steadily declining. The cost of NELVs is greatly affected by the cost of their key electrical components. Taking a 4.5 ton logistics vehicle (with a driving range exceeding 250km) as an example, the current market cost of the vehicle is approximately EUR 25,641 (RMB 200,000)[17]. To examine more closely the cost of the key electrical components of the vehicle, together the cost of the battery, motor, electronic control unit, high-voltage wiring harness, and the vehicle control unit is approximately EUR 12,820 (RMB 100,000), of which the battery alone is worth EUR 8,970 (RMB 70,000) [17]. In the future, there is still a significant opportunity for a reduction in the cost of batteries and motor systems, and by 2025, it is expected that the installation cost of the three electrical components of batteries, motors and electrical controls will be reduced by 40-50%[17].

It is also expected that the main challenges of primary purchase and operational costs for NEVs will also be reduced. This decline in costs will be driven by an improvement in the performance and quality of key vehicle key components, as well as battery management systems. A decrease in safety hazards associated with the vehicles, including their operational failure and fire incidents rates, will also lead to a reduction in any costs associated with these risks. Overall, it is therefore expected that the competitiveness of NELVs from a cost perspective, will be significantly improved.

3.4.2 Emerging business models

Battery-swapping and leasing options are maturing as new business models to support the application of NEVs.

(1) Battery-swapping

Since the uptake phase (2009-2012) of NEVs in China, two competing technical approaches to recharging NEVs have emerged: conventional charging mode and battery-swapping mode. Due to the need for heavy operational assets, and incomplete industrial chains, the development of battery-swapping mode was paused in 2009, but with industrial developments, by the second half of 2019, battery-swapping, had moved back into focus within the NEV industry.

NELVs have the advantages of producing zero emissions, low noise levels, and they offer a comfortable driving experience in their application phase, but they also have disadvantages compared to conventional vehicles. Drawbacks to NELV operation include higher purchase prices, short travel ranges (as they're limited by how far they can travel on one charge), long wait times when using charging stations, and inconvenient after-sales maintenance support. However, many of these disadvantages can be lessened through using battery-swapping models. A major feature of battery-swapping services is the separation of vehicles and batteries, which could bring several advantages to the adoption of NEVs:

1) Selling batteries separate from vehicles can greatly reduce vehicle purchasing costs. In general, the battery capacity of a 4.5-ton battery powered truck is about 70kwh. With an approximate unit price of EUR 0.13/Wh (RMB 1 per Wh), the whole battery costs about EUR 8,974 (RMB 70,000). This accounts for approximately 40% of the total cost of the vehicle. Therefore, the use of battery-swapping practices could save around 40% of vehicle purchase costs[30].
2) The shorter time it takes to swap a battery rather than charge a battery can increase the operational convenience of NEVs.
3) Battery operation companies centrally monitor, maintain, and manage the batteries, which can extend the life cycle and improve the safety of the batteries.
4) Reduced charging costs, with charging available at preferential rates during off-peak hours, can potentially lead to lower energy costs for customers.
5) Centralised charging of batteries can solve issues with strict requirements on the voltage load of charging piles.
6) When renting batteries, consumers can consider the capacity that they need according to their daily mileage, therefore saving both energy and costs (depending on the costs of specific energy/power plans).
7) Battery-swapping schemes can give rise to new business models and new service forms, such as the delivery of batteries to customers by Battery-as-a-Service (BaaS) companies.

However, battery-swapping modes also face several shortcomings:

1) Battery-swapping relies on the availability of NEV battery plugs, and current systems are not able to accommodate the plugging in of battery packs, and are not suited to be used with the frequency that swapping systems demand.
2) Varying vehicle battery designs, structures, and weight standards are difficult to harmonise, and different batteries can be incompatible with different vehicle models.
3) The layouts of battery-swapping stations are not yet finalized in design, and there are only a few battery-swapping stations currently in operation – the construction of the number of stations that would be needed is not yet completed.
4) Battery-swapping stations require higher intensive electricity demands and more expensive hardware (for example, the batteries themselves,) than the charging piles of a regular charging station. Battery-swapping stations require more investment and energy resources than traditional hubs, and the battery sizes and the required number of batteries that each station would house is also difficult to determine.
5) The daily maintenance of batteries that are to be swapped is very demanding, and the management of these resources requires clear guidelines on who is responsible for each defined role in their maintenance, and an effective safety plan for the batteries and supporting systems.

As listed above, there are several advantages and obstacles relating to the promotion and use of the battery-swapping model. To its credit, the current rechargeable BELV has been able to meet the needs of urban freight distribution, as with an average of 1-1.5 hours of charging time per day, it can meet the needs of less than 200 kilometres of travel distance. However, although the battery-swapping mode can save substantial vehicle purchasing costs over conventional fuled vehicles, according to the current business model, the battery leasing fee needs to be paid, for as long as the vehicle can be in operation on the road. This means that with the extension of the battery leasing time, the total cost of the TCO for a conventional fuledvehicle may or may not still be even higher than the TCO of rechargeable BELVs.

Current battery-swapping commercial vehicle manufacturers are mainly producing heavy-duty trucks, as the related technology and support for the swapping methods advance. In October of 2021, the MIIT issued the Notice on the Organisation of Pilot Work for the Application of Battery-swapping New Energy Vehicles, and then selected 11 pilot cities for the initiative[8], with the goal of promoting the use of more than 100,000 battery-swapping vehicles and building more than 1,000 new battery-swapping stations. At present, the best scenario for the battery-swapping mode is promoting its use for high-frequency, short-distance, heavy-duty carrier transport routes, and not for new energy logistics vehicles.

(2) Battery leasing

Previously discussed in Section 3.1.3, battery leasing systems can offer advantages including:
1) Sharing high operation, maintenance, and production costs.
2) Attracting more dedicated NELV manufacturers for better products.
3) Providing a professional after-sales service system.

Battery leasing modes can effectively reduce the purchase and operational costs of NELVs. It can also help in solving the difficulties of battery recycling, the low residual value of used vehicles, insufficient supporting facilities for NELVs, and poor after-sales service for these vehicles. Therefore, as battery leasing mode is considered to be more mature than other battery services, it could be used as an add-on argument in favour of the promotion of NELVs.

3.4.3 Standardisation and safety acceleration

The focus of China's NEV standardisation work has been expanded from the focusing on elements of vehicle's power packs (batteries, cooling systems, etc.) during the uptake phase (2009-2012), to looking at how the entire vehicle and its components can be supported during the mass adoption phase (2015-2019).

According to the MIIT's Key points of standardisation of new energy vehicles in 2020[31], the preparation of the "14th FYP standard system for NEVs" will be completed, and the third edition of the "China Electric Vehicle Standardisation Roadmap" (in process) will be prepared and released. In the future, there will be more standardisation work focusing on BEV safety and

[8] The pilot cities are Beijing, Nanjing Wuhan, Sanya, Chongqing, Changchun, Hefei, Jinan, Yibin, Tangshan and Baotou.

related testing guidelines, and on energy efficiency. Regarding FCEVs, standardisation work is expected to be carried out on hydrogen refuelling facilities, post-crash safety conditions, vehicle performance, and key vehicle components. For batteries, battery safety test standards, recycling, and related echelon utilisation standards are to be established and improved. Further work will also be conducted on compatibility between charging units and battery-swapping related electromagnetic needs, safety requirements for conductive charging, standards for charging connection devices, and the safety of battery-swapping systems and other related services.

In addition to supporting planned improvements in related technology, the government has issued numerous documents to strengthen the safety control of NEVs. These plans were aimed at setting up safety supervision mechanisms for manufacturers via the MIIT, requiring enterprises to set up internal safety control protocols for NEVs, and setting up relevant national safety standards [32][33][34]. The documents put forward detailed technical guidelines for different actions to be taken, such as the testing battery thermal management systems. It is expected that the standardisation and safety improvement of NEVs will continue to develop, including the setting of testing guidelines, BEV energy efficiency standards, standards for hydrogen refuelling facilities, FCEV post-crash safety conditions, standards on FCEV performance and key components, battery safety test standards, recycling plans, related echelon utilisation standards, safety requirements for conductive charging, standards for charging connection devices, and safety standards for battery-swapping stations.

3.4.3 Development trend of NELVs

The application of NEVs in the urban delivery sector is driven by improvements in both related policies and technology. A study by China EV100 on the subject has predicted three scenarios for NELV development in China[17]:

Scenario 1:

Assumption: NEV related technologies improve rapidly, and vehicle costs drop by more than 50%; supportive national and local policies continue to be issued and well implemented, and; New Energy Vehicle Credits (NEVCs) for new energy commercial vehicles can be implemented before the phasing out of purchase subsidies.

Result: By 2025, the share of NELV sales will reach more than 20%. With the forecasted 4.19 million total logistics vehicle sales, the sales of NELV will reach about 838,000 units by 2025.

Scenario 2:

Assumption: NEV-related technology development only leads to a moderate reduction (about 40%-50%) in vehicle costs; national and local policies are not well implemented, and; NEVCs for new energy commercial vehicles fail to be implemented before subsidies are completely phased out.

Result: By 2025, the share of NELVs sales will be approximately 10%. With the expected 2025 total sales as outlined in Scenario 1, the sales of NELV will be 419,000 units.

Scenario 3:

Assumption: The reduction of NEV cost reaches less than 40%; there is a lack of strong policy target guidance at the national and local levels, and; no NEVCs for new energy commercial vehicles will be introduced.

Result: By 2025, the share of NELVs sales will only be at 6%-7%[17]. With the expected 2025 total sales as outlined in Scenario 1, the sales of NELV will be around 293,300 units.

According to the "Study on the Implementation Path of Carbon Neutrality in the Transport Sector" (a consultancy project undertaken by TPRI), the share of NELV ownership under the baseline (under current policy trends), low carbon (peaking by 2035) and enhanced low carbon (peaking by 2030) scenarios are 4%, 14% and 20% respectively. Meanwhile, the 14th Five-Year Plan for Green Transport clearly states that the proportion of new energy vehicles in urban logistics vehicle fleets should reach 20% by 2025.

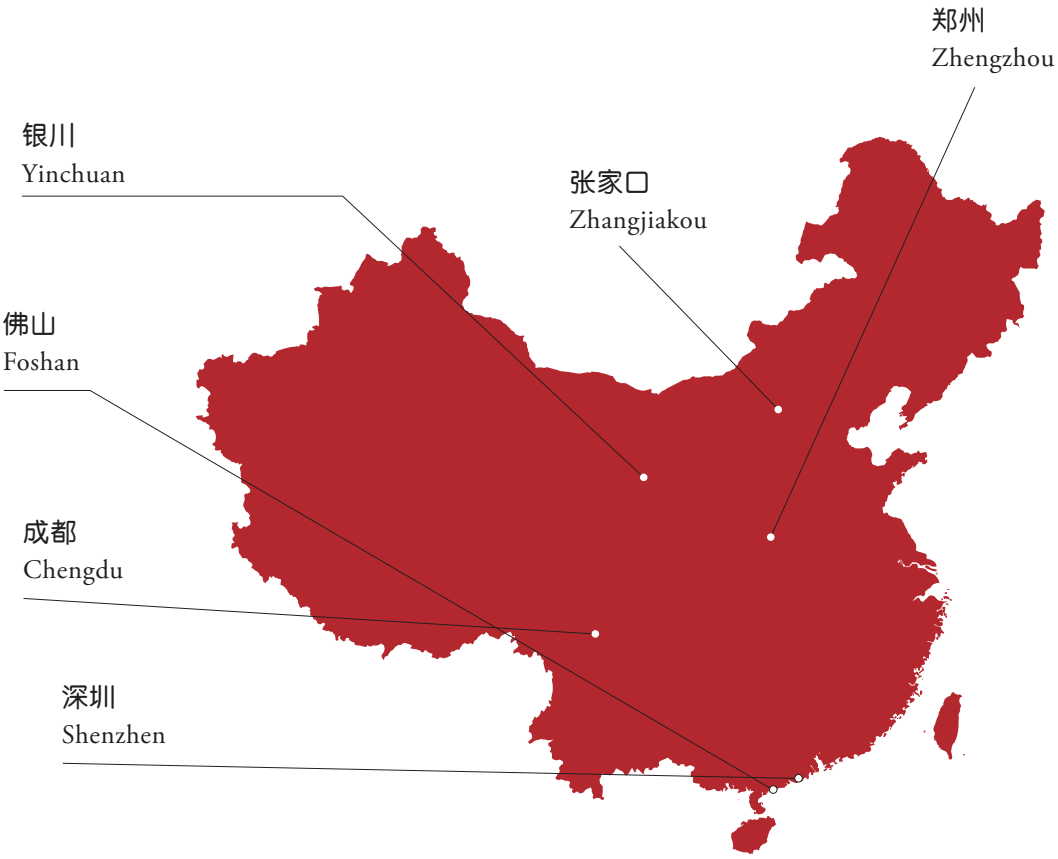
Boosted by China's 2030 carbon dioxide emission peaking and 2060 carbon neutrality goals, demand on NEVs to decarbonise the transport sector is also rising, therefore the investment on R&D for NEVs, especially on BEVs and FCEVs, is expected to accelerate. The studies by China EV100 and TPRI predicts that by 2025, the proportion of NEVs in newly added urban delivery vehicles would reach 40%-50%, and the share of NEVs in the urban delivery sector would reach 20%.

4 Investigation of "Green Urban Freight Pilot Programme" Pilot Cities

To gather first-hand data on the overall implementation progress in the pilot cities of the Green Urban Freight Pilot Programme of the MoT, field investigations were carried out in five pilot cities (Yinchuan, Zhengzhou, Chengdu, Shenzhen, and Foshan), and an interview and questionnaire survey was conducted in Zhangjiakou City – the joint host city of Beijing Winter Olympic Games 2022 (see Figure 4-1). The case cities were selected for their particular characteristics, such as notable achievements on NELV application in the transport sector (such as Chengdu and Shenzhen), the climate and economic status of different region (such as Chengdu in the West, Yinchuan in the Northwest, Zhengzhou in the central East, Shenzhen and Foshan in the South), and differences in available new energy types, related policies, and implementation of systems that support NELVs (such as Foshan and Zhangjiakou).

Out of the six pilot cities, four locations focus on BELV promotion, while the remaining two, Zhangjiakou and Foshan, focus on the promotion of both BELVs and FCEVs. Zhangjiakou is promoting FCEVs, as its hydrogen resources are generated by green electricity from surrounding wind farms. In addition, the city has geographical advantages for green hydrogen, and the city also promoted hydrogen for green transportation options at the 2022 Winter Olympic Games. Foshan has been promoting itself as a hydrogen capital in China since 2010, therefore the city's promotion of NEVs was focused on BELVs and FCEVs. Through field investigations with local transport bureaus, other relevant departments, and enterprises in the field, this study has reviewed the overall context of applying NEVs in the urban delivery sector in the investigated cities during November 2020 and identified related problems and experiences. The study includes data collected until the end of 2020.

■ **Fig. 4-1 Investigation Map**



(Source: TPRI)

4.1 Yinchuan

4.1.1 Progress to Date

By the end of 2019, Yinchuan had introduced approximately 3,000 light-duty NELVs (< 4.5t) into operation (see Figures 4-2 and 4-3). A total of 484 charging piles were also constructed and put into use between 2018 and 2020.

4.1.2 Management Mechanism

A Leading Group for the Green Urban Freight Pilot Programme has been set up with the Deputy Mayor as the group leader. Further members include the heads of the Bureaus of Commerce, Agriculture and Livestock, Market Regulation, Public Security, Transport, Industry and Information Technology, as well as the local Development and Reform Commission, and the Municipal Postal Administration. The group's office is located at the Yinchuan Municipal Bureau of Commerce. The Bureau is in charge of coordinating planning for the promotion of green urban freight delivery in Yinchuan and the application of NELVs.

■ **Fig. 4-2 Unloading of a New Energy Truck of Xinbai Logistics in Yinchuan**

(Source: TPRI)

4.1.3 Supporting Policies

A series of policies have been successively introduced in Yinchuan to create a favourable environment for the modern logistics industry, from overall planning guidelines to specific measures. These measures include digitalisation measures for urban and rural distribution routes, and plans for reducing costs and increasing benefits for NELVs[35][36][37][38].

Some traffic policies in the city prioritize NELV access. For example, in the Xinhua business area (city centre), there are entrance time restrictions for conventional fuel vehicles but no such traffic restrictions are applied to NELVs with city admittance permits. Both types of vehicles do, however, have to receive an admittance permit to operate in the city.

In 2019, the Yinchuan Municipal Bureau of Commerce introduced the Modern Logistics Industry Development Project[39], focusing on supporting node network construction and the application of NELVs. Through financial support provided by the project, commercial delivery enterprises have been encouraged to purchase NELVs for freight and cold-chain delivery services, as well as to construct public charging stations. A maximum reward of 30% of the enterprise investment amount (subject to audited results) is provided, with the highest reward available to be given to one single enterprise is capped at no more than EUR 128,205 (RMB 1 million)[39].

■ **Fig. 4-3 Charging Piles for New Energy Trucks of Xinbai Logistics Park in Yinchuan**

(Source: TPRI)

4.1.4 Problems and Obstacles

(1) Insufficient travel range

Generally, BELVs can travel 200km-300km per charge, but it may be difficult for the vehicles to reach even 200km with a full load, limiting their application to urban delivery or short distance intercity delivery routes. This travel range is less desirable for logistics enterprises which prefer high frequency services and long overall delivery distances in a day. In addition, Yinchuan is cold in winter (on average between -3.4℃ and -16℃, but temperatures can go as low as -20℃), and the working temperature range for BEVs is 0-40℃[40] with an optimal temperature of around 25℃[41]. Low temperatures (when the temperature is below 0℃) can reduce a BELV's travel distance per charge by up to 50%, meaning that in winter, they could only travel about 100 km.

(2) High purchase costs

With the gradual phasing out of purchase subsidies since 2018, the purchase costs of NELVs are rising, which gradually reduces their price advantages over conventional fuel vehicles and increases the total cost of ownership for the operators. The current purchase cost of a conventional fuelled light duty truck (below 4.5 tons) in Yinchuan is approximately EUR 12,820 (RMB 100,000), while a new energy truck of the same size is at least EUR 25,641 (RMB 200,000). Without local financial subsidies or other operational subsidies, under the current traffic policy of Yinchuan (providing minimal advantages to NEVs), the high purchase costs of NELVs render them unable to compete with conventional vehicles.

(3) Insignificant right of way privileges

At present, NELVs are still categorised in the same group as conventional fuel trucks when it comes to the city admittance permit policy in Yinchuan. They must apply for admittance permits to operate in the city, which objectively restricts the promotion and application of NELVs.

(4) Incomplete after-sales support

During the field investigation, most NELV operators mentioned maintenance issues as a challenge. The structural and power-train systems of NELVs are completely different from conventional fuel logistics vehicles, and an after-sales maintenance system for NELVs needs to be re-established. The unique structure of NELVs leads to fewer after-sales stocks available, and longer maintenance times for adjustments than those of conventional fuelled trucks. Additionally, there are not enough sufficient technical staff and maintenance shops currently available. Therefore, for urban logistics enterprises, the maintenance of NELVs takes longer and costs more, which seriously affects their business operation potential, and consequently, logistics enterprises are less willing to purchase NEVs.

4.2 Zhengzhou

4.2.1 Progress to Date

By the end of 2019, there were 224,500 logistics vehicles in Zhengzhou, including a total of 162,500 urban logistics vehicles, of which 14,600 were fully electric and 200 were hybrid vehicles (see Figure 4-4). BELVs thereby account for approximately 9% of the urban logistics vehicles in the city. There were more than 20,000 charging piles by the end of 2019, over 4,000 of which were allocated to NELVs.

■ Fig. 4-4 NELV fleet of local logistics company in Zhengzhou

(Source: TPRI)

4.2.2 Management Mechanism

In Zhengzhou, a Leading Group for the Green Urban Freight Pilot Programme has been set up, with the Deputy Mayor as the group leader. Its members include local Bureaus of Transport, Finance, Ecology & Environment, Urban and Rural Construction, City Administration, Commerce, Market Regulation Administration, Logistics and Port, Big Data, Industry and Information Technology (automobile), Natural Resources and Planning, as well as the local Development and Reform Commission, the Municipal Postal Administration, the traffic police, and the Zhengzhou Power Supply Company of the State Grid. The office of the Leading Group is located at the Bureau of Transport. The Leading Group is responsible for coordinating all tasks of the Green Urban Freight Pilot Programme.

4.2.3 Supporting Policies

(1) Introduction of a series of supporting policies for the promotion of NEVs

In 2019, the Zhengzhou Municipal People's Government introduced a comprehensive set of policies supporting the automobile industry in Zhengzhou. These policies include plans for accelerating the promotion and application of NEVs, the development of new energy and intelligent connected vehicles, and implementation plans for new energy taxies in Zhengzhou[42][43][44].

Zhengzhou's bureaus of the ecological environment, transport, public security, city administration, and urban and rural construction jointly issued policies and measures pertaining to the systems of road traffic, urban delivery, and vehicles in general. The bureaus formulated policies that specify, for example, the provision of purchase and operation subsidies, discount parking fees, right of way plans, and preferential charging rates for NEVs.

To accelerate the plan to scrap existing conventional fuel light-duty trucks and replace them with NELVs in the logistics market, traditional vehicles. have been gradually banned from entering built-up areas since 2020. The city also plans to have NELVs used as all new or replaced sanitation vehicles [45].

Differentiated traffic management measures have been implemented for NEVs with special green number plates, and a classified management system for their right of way has been improved to provide convenient access to eligible NELVs on the road. Including and within the Third Ring Road, NEVs are only subject to traffic restrictions during morning and evening peaks. However, both new energy and conventional fuel trucks of any size were not allowed to travel on elevated roads (such as portions of ring roads and some highways) before 2021. Mini conventional fuel trucks and new energy trucks of all types will be allowed to travel on elevated roads under a new policy, which is yet to be issued.

(2) Fiscal policies

For the vehicles listed in the National Key Project on Energy Saving and NEVs, the Zhengzhou Municipal Finance Bureau provides a subsidy at the ratio of 1:1, as per the national subsidy standard and conducts progress assessments of the project together with relevant departments.

Rewards (1.2 times the reward value for replacing conventional fuel logistics vehicles within their service age) are granted for NELVs which are sold in Zhengzhou and registered in the Vehicle Management Department of Zhengzhou Municipal Public Security Bureau. In 2019, reimbursements were EUR 3,846/vehicle (RMB 30,000/vehicle) and in 2020, reimbursements were EUR 2,564/vehicle (RMB 20,000/vehicle).

(3) Supporting policies for the construction of charging piles

Specialised planning measures are being planned to optimise the distribution layout for charging and battery-swapping stations, to increase their utilisation rate, and ensure the orderly accessing and use of these stations in the city[46].

Based on the local conditions for implementation, the 2019 layout plan includes the construction of 7,098 charging piles in areas located under Fourth Ring Road flyovers (elevated sections of highways), maintenance areas of national and provincial trunk highways, logistics parks, wholesale markets, important transportation hubs, public parking lots, and in the operation areas of charging pile enterprises (see Table 4-1).

New residential compounds equipped with parking spaces are to provide charging facilities or reserve installation conditions for chargers, and new residential projects are to

■ **Table 4-1 Construction Layout Planning of Charging Piles**

S/N	Type	Qty.
1	Areas under the Fourth Ring Road flyover (under construction)	400
2	Maintenance areas of national and provincial trunk highways, as well as roads	146
3	Logistics parks and wholesale markets	3,516
4	Important transportation hubs	934
5	Public parking lots	820
6	Operation areas of charging pile enterprises	1,282
Total		7,098

ensure at least 10% of the parking slots are equipped with charging piles before opening to the public.

Similarly, the parking lots of new shopping malls, hotels, hospitals, office buildings, and other large public buildings with an area of more than 20,000 m^2, as well as public parking lots, are to be provided with charging facilities, with at least 10% of parking slots with charging facilities being installed before the structures and properties are opened to the public.

The construction of charging facilities in existing residential areas should be introduced as soon as possible to promote their development in an orderly way. Centralised office areas of the Municipal Bureaus, as well as enterprises and schools under the purview of municipal administration should be equipped with charging piles covering no less than 15% of the surface parking slots. Existing parking spaces of private enterprises, shopping malls, hotels, and public parking lots are encouraged to also provide charging piles. Additionally, the construction of hydrogen refuelling stations is encouraged. The Zhengzhou Municipal Finance Bureau has granted subsidies of 50% for needed investments in equipment for hydrogen refuelling stations installed between 2019 and 2020.

4.2.4 Problems and Obstacles

(1) Unfair competition caused by improper use of passenger vehicles for freight purposes

There is a growing phenomenon of passenger vehicles being illegally modified for logistics purposes in Zhengzhou. Such vehicles are allowed to move without restrictions in urban areas and on roads that are elevated, including portions of some ring roads resulting in unfair competition with other transport vehicles. Using passenger vehicles in this way also weakens the importance of the right of way privileges for urban areas and elevated sections of roads that may be provided to NELVs.

(2) Freight distribution problems caused by traffic restrictions during peak hours

Although NELVs enjoy a certain priority over other vehicles in Zhengzhou by having right of way privileges to access different roads at different times, they are not allowed to travel within the Third Ring Road in the morning and evening peak hours, which is a restriction that is the same as for conventional fuel logistics vehicles. This limitation has a substantial negative impact on green urban freight distribution, particularly since the morning peak hours of 7am to 9am coincide with the busiest hours for urban freight distribution services.

(3) High purchase cost

Under the trend of phasing out national and local purchase subsidies for NEVs, the focus of fiscal support for these vehicles has shifted to NEV operation and charging infrastructure in recent years. As one example of the impact of the loss of these subsidies, a light-duty, battery-electric truck in Zhengzhou would have received a subsidy of EUR 192 (RMB 1,500) per kWh in 2017, but in 2020, the subsidy for the same vehicle was only EUR 40 (RMB 315) per kWh in 2020. Due to this subsidy decrease, the end sale prices of BELVs are now about 30%-60% higher than those of conventional fuel vehicles.

4.3 Chengdu

4.3.1 Progress to Date

Chengdu has established an urban joint-distribution monitoring platform to support the better administration of registered delivery vehicles under the Joint-Distribution Pilot Programme[9] of MofCom in 2015. By June 2020, the platform identified 2,973 standardised delivery vehicles, including 1,502 NELVs and 394 cold-chain conventional fuel vehicles, and marked 5,664 urban delivery service stations. As of August 2020, there were 30,431 battery electric and plug-in hybrid logistics vehicles working in urban delivery in Chengdu, and 23,500 charging piles[10].

4.3.2 Management Mechanism

In 2015, Chengdu set up a Leading Group for the pilot work of the Urban Joint-Distribution Programme with the Deputy Mayor in charge as the group leader. It established a multi-departmental coordination mechanism with the logistics administration department as the main body, and the Departments of Commerce, Public Security, Transport, and related bodies as collaborative parties. A particularly important contribution of this plan was the establishment of a collaborative mechanism between departments managing urban logistics vehicles (such as that of public security or transport) for policy research, development, and implementation of related programs.

In June 2018, Chengdu was approved as one of the first cities to join the Green Urban Freight Pilot Programme. Based on the Leading Group coordination mechanism, Chengdu further completed the green urban delivery coordination mechanism according to the new requirement set by the Green Urban Freight Pilot Programme. Relevant departments of the municipal government have increased efforts to support the purchase and operation of NELVs, the construction of distribution centres, the promotion of advanced NELV business modes, and the cultivation of support for the vehicles amongst the main market players.

4.3.3 Supporting Policies

In 2019, the municipal government issued a set of policies and measures to reduce costs and increase benefits for the development of the logistics sector, as well as to support the restructuring of transportation services overall in Chengdu[47][48][49]. These plans also include measures for improving the management of temporary roadside parking, such as by specifying the requirements for divided or staggered parking periods and providing a classification specifically for the roadside parking of urban logistics vehicles.

The policies also encourage postal, express service, and urban delivery enterprises to establish innovative freight delivery modes, including integrated and centralised distribution plans, and joint-delivery and night-delivery services, and encourages the use of NELVs and low emission vehicles for urban and rural delivery routes. These plans provide instructions for creating an environment conducive to the development of a green, low-carbon, and efficient logistics system. They also promote the development of the substantial economy in Chengdu, which further drives the development of green urban freight delivery in the city. Additionally, right of way privileges are fully given to NELVs to ensure the ability of these legally compliant standardised vehicles to enter into built-up areas at all times, for the efficient delivery of goods central to citizen's livelihoods, such as those that need to be sent via cold-chain delivery, fresh agricultural products, and general urban express deliveries.

In October 2019, five municipal departments, including the Bureau of Economic and Information Technology, jointly issued a notice on issuing policies that support the development and promotion of hydrogen energy and NEVs [50]. The notice specified that urban admittance permits will no longer be issued to conventional fuel logistics vehicles (except for those with irreplaceable applications) from 2020 onwards. NELVs in urban

[9] In order to implement the Opinions of the State Council on Deepening the Reform of the Circulation System and Accelerating the Development of the Circulation Industry (Guo Fa [2012] No. 39) and the Opinions of the General Office of the State Council on Policies and Measures to Promote the Healthy Development of the Logistics Industry (Guo Ban Fa [2011] No. 38), improve the efficiency of urban logistics and reduce the cost of logistics, the Ministry of Commerce and the Ministry of Finance launched the Joint-Distribution Pilot Programme in 22 cities, including Nanjing, Wuhan, Xiamen, and Chengdu.

[10] Data summarised by Chengdu Transport Bureau

delivery services are allowed to temporarily park and handle freight in dedicated parking areas on downtown roads, with the precondition of not blocking traffic and are exempt from parking fees for the first two hours per day.

4.3.4 Management innovations

(1) Standards and Regulations

The establishment and improvement of local standards for the urban freight distribution supply chain (e.g. warehousing, operation, and services) help to normalise the development of the urban delivery sector. In 2015, Chengdu formulated a local standard for urban logistics distribution vehicles[51]. The standard specifies the requirements for the main technical parameters and technological basis of these vehicles, as well as for energy saving programs and environmental protection plans. Based on the needs of the pilot program, local standards also provided the outline of basic requirements for vehicle identification and service management initiatives.

Chengdu also issued a local standard specifically for cold-chain deliveries in 2017[52], which outlined the basic requirements for the necessary facilities and equipment, as well as plans for temperature control, quality tracing, and information management relating to urban cold chain deliveries of major agricultural products. The standard has facilitated the setting of quality and safety standards for agricultural products and normalised urban cold chain activities. NELVs deployed during the Green Urban Freight Pilot Programme in Chengdu also strictly followed local vehicle standards and regulations, which promoted the development of green urban freight while supporting the standardisation of the industry (see Figure 4-5).

■ **Fig. 4-5 Standardised New Energy Delivery Vehicles**

(Source: TPRI)

(2) Other Measures

The urban joint-distribution monitoring platform has played an important role in the 2015 Urban Joint-Distribution Pilot Project by undertaking service monitoring, assessment, and evaluation tasks for green urban freight services. It has also provided a linkage to share information that was previously only available internally to individual shippers, carriers, and government agencies

By acquiring third-party services to establish and operate the platform, the Chengdu government applied new regulation patterns and management techniques in an innovative way. The platform allows for the integration of various service functions such as information queries, vehicle monitoring services, electronic fence services, the provision of index statistics, performance evaluation, and data analysis options.

The platform can generate monthly analysis reports on connected vehicles and has established a real-time big data analysis system to effectively meet government requirements for performance assessment and to provide information services for the pilot enterprises. It has also enabled the sharing and co-management, and co-governance of information resources in the urban freight system.

During the implementation of the Green Urban Freight Pilot Programme, enterprises which want to add new conventional fuel logistics vehicles into the monitoring platform must simultaneously also add corresponding NELVs into the platform in a ratio of 1:1 or 1:2. Since 2018, newly added NELVs also use the platform to receive free delivery information services (see Figure 4-6).

■ **Fig. 4-6 Joint-Delivery Monitoring Platform in Chengdu**

(Source: TPRI)

(2) Problems and Obstacles

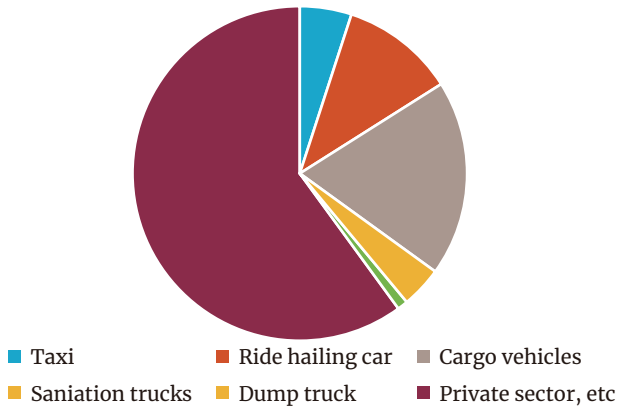
The promotion of NELVs in Chengdu is still facing difficulties. With the gradual phasing out of the national subsidy for NEVs and a lack of additional subsidies for NELVs being provided in Chengdu, the cost-efficiency of choosing NELVs over other vehicles is diminishing. Current NELV models, performance standards, and after-sales services cannot fully meet the urban delivery market's demand. In addition, charging facilities still cannot match even the short-term charging demands of NELVs. Management standards for new business models of NELVs, such as leasing/sharing and the "Internet +" model, are yet to be completed. Finally, the systems required for the responsible scrapping of NELVs and for power battery recycling still need to be improved.

4.4 Shenzhen

4.4.1 Progress to Date

By the end of 2019, Shenzhen had 3,549,200 vehicles in operation of which 443,000 were NEVs, accounting for 12.5% of the total number. Over 75% of these NEVs were passenger vehicles. The share of NELVs in Shenzhen is higher than anywhere else in China, with 85,900 NELVs in operation, accounting for 19% of the total number of NEVs (see Figure 4-7).About 65,000 NELVs are utilised as regular logistics vehicles, making Shenzhen the city with the most extensive NELV logistics stock. A total of 60,593 charging piles had been built in Shenzhen by the end of 2019.

Fig. 4-7 Overview of types of NEVs in Shenzhen[11]



In Shenzhen, approximately 95% of BELVs were rented to freight operators through 15 vehicle renting companies, who together owned over 1,000 vehicles. These BELVs account for 49.7% of the total number of NELVs, showing a high degree of use of this particular type of vehicle in the city.

4.4.2 Management Mechanism

The promotion of NELVs in Shenzhen is led by the Logistics and Supply Chain Development Department of the Municipal Transport Bureau and other participating departments in the city, including the Municipal Development and Reform Commission, the Ecological Environment Bureau, and the Public Security and Traffic Police Department.

The Shenzhen New Energy Vehicle Application and Promotion Centre is responsible for the implementation of systems relating to new energy vehicle application and promotion. In contrast, the city's municipal departments are mainly responsible for solving problems during operation and providing preferential policies to maintain a favourable market environment for NELV development.

4.4.3 Supporting Policies

(1) Continuously subsidising NELVs

A combination of subsidy policies have been implemented to provide financial incentives for the purchase and operation of eligible NELVs in the Implementation Rules of Fiscal Subsidy for Promoting the Application of NEVs. Furthermore, with the Management Measures for Special Funds for Modern Logistics Industry Development, support for the operation of NELVs is reinforced with several subsidies, for example, up to EUR 9,615 (RMB 75,000) can be given as a subsidy to be applied towards the purchase of eligible NELVs to be used by scaled freight operators[12],[53]. In 2019, 39 enterprises received subsidies amounting to EUR 9.9 million (RMB 77.25 million) in total, for 6,557 NELVs in their operation alone[54].

[11] Data from XIELI Innovation Centre (NEICV), Shenzhen

(2) Implementing a preferential policy for roadside parking of NELVs

In March 2015, the Shenzhen Municipal People's Government issued Policy Measures for Promoting the Application of NEVs allowing all NELVs to temporary park free-of-charge at curb side parking lots for one hour per day. In June 2020, this was extended to two hours to help enterprises cope with the pandemic and elevate the preferential efforts for the temporary parking of NELVs.

(3) Continue implementing road access priority for NELVs

To promote NELVs, the Traffic Police Department of Shenzhen Municipal Public Security Bureau has continuously issued several regulations which give NELVs road privileges over their conventional counterparts[55][56][57][58][59].

These traffic incentives include preferential road access policies for e-filed[13] NELVs with RFID and GPS installed and monitored by administrative authorities. These e-filed electric light-duty and mini-cargo vans/trucks can travel on all roads at all times except on Shennan Road, one of Shenzhen's artery roads, between 7:30 to 21:00, from Monday to Friday. Furthermore, e-filed electric medium and heavy trucks with body lengths of no more than 6 meters can pass in sections of the city and periods of the day when conventional counterparts are restricted.

(4) Setting up "Green Logistics Zones" to ban light-duty diesel trucks

To strengthen road traffic safety standards and improve overall traffic conditions, the Traffic Police Department of Shenzhen Municipal Public Security Bureau issued an announcement in 2018[60], which specified that one "Green Logistics Zone" (see Figure 4-8) was to be set up in each of the ten administrative districts in Shenzhen, with a ban on allowing light-duty diesel trucks to enter. Those trucks violating these legal provisions would be fined with a penalty of EUR 38 (RMB 300) and 3 points (of an annual 12 points quota) would be deducted off the offending driver's license.

■ **Fig. 4-8 Green Logistics Area in Shenzhen**

(Source: TPRI Left: 10 green logistics zones in Shenzhen. Right: Road sign banning light-duty diesel trucks)

[12] Scaled operator stands for owning more than 300 urban logistics vehicles, of which at least 100 are BELVs or at least 50 are electrically refrigerated or are container tow trucks. An "eligible NELV" is one that is driven at least 15,000 Km/year.

[13] NELVs which are e-registered in authority and installed with Radio Frequency Identification (RFID) unit for management purpose by the authority.

4.4.4 Management innovations

(1) Promote and support the construction of new energy infrastructure

To support the development of NELVs, Shenzhen has actively promoted the construction of new energy infrastructure and supporting charging facilities[61]. In 2020, the Shenzhen Development and Reform Commission formulated a policy giving subsidies to enterprises whose cumulative construction of charging facilities in Shenzhen reached a total power of 8,000kW. Subsidies could be given again to the same enterprise if it their facilities reached an additional 3,000kW after their first claim. The subsidy standards were outlined as: according to the installed power capacity, DC charging facilities will be given a construction subsidy of 400 yuan/kW; AC charging facilities of 40kW and above will receive a construction subsidy of 200 yuan/kW, and; AC charging facilities below 40kW will be paid by 100 yuan/kW.

(2) Raise public awareness on the potential application of NELVs

Since 2016, the China (Shenzhen) New Energy Vehicle (Logistics Vehicle) Competition has been held annually to increase communication about the NEV industry, in order to accelerate the mass application of NELVs and help leverage the driving force of the delivery sector for the development of the overall NEV industry. The annual competition mainly invites NEV OEMs, logistics and transport enterprises, and industry authorities to participate, and has the purpose of selecting and showcasing high-quality NEVs, in order to allow prospective end customers to better understand and experience how NEVs can operate. The competition is also designed to motivate all stakeholders in NEVs to communicate and work together for the eventual integrated development of the industry. It is also hoped that the annual event will create a leading domestic platform for the in-depth experience of using these vehicles, the professional evaluation of their performance, and the authoritative release of information on, and comprehensive demonstration of, NEVs.

4.4.5 Problems and Obstacles

(1) Stronger vehicle safety regulations

There were eight fire incidents with NELVs in Shenzhen in 2018. Four occurred during the charging process, three while vehicles were being driven, and one while a vehicle was parked. Some of these incidents were caused by car accidents, while others resulted from an overheating of the battery system or short circuits induced by water damage due to insufficient waterproofing.

The safety of NEVs is directly related to people's lives and property safety, and therefore of paramount importance for the industry's development prospects. A lack of safety considerations would lead to reckless development and an unsustainable future for the NEV industry. Therefore, the supervision of the safety of NEVs need to be further developed, big data supervision platforms to monitor the real-time operation status of vehicles should be established, and preventive measures in case of accidents should be put in place.

(2) The after-sales maintenance service system should be improved

The rapid growth of the NEV market has led to an increasing number of challenges in after-sales markets, with services such as maintenance lacking for the industry as a whole Several factors amplify these challenges, and some of these are outlined in this chapter section

The technical specifications of various batteries, electronics, and motors are different depending on the manufacturer of each NEV type, and they lack overall coordination and standardisation across models. Since broader after-sales support services for these vehicles have not yet been regulated, the original equipment manufacturers (OEMs) have had to develop their own after-sales service systems due to diversified technology roadmaps and maintenance criteria for different models. Most of the maintenance enterprises in the NEV market have weak capacities for comprehensive maintenance across vehicle types. Only 16 maintenance companies to date have been licensed to work with three or more brands, and these businesses cannot meet the demands of all NEV consumers.

Additionally, there is a lack of specialised maintenance personnel for NEVs and the current programs to train future employees, run by vocational schools, are insufficient for graduates to be ready to work in practical application scenarios. To complicate these challenges, due to the fast iteration of NEVs and the stop in manufacturing of outdated parts or technologies used in some vehicles, aftersales services are operating under increasing difficulties affiliated with finding spare parts for vehicle maintenance.

Moreover, the common manufacturing practice of early batch NELVs was to assemble buyer-ordered vehicle components and construct them into one vehicle instead of developing and producing the NELVs as a whole. As a result, there has never been a warranty available for full vehicles, as coverage was limited to individual parts or systems.

4.5 Foshan

4.5.1 Progress to Date

Foshan has been promoting itself as a hydrogen capital city in China for over a decade. Besides BEVs, Foshan's NEV promotion has also put great attention on FCEVs. By the end of October 2020, Foshan had accumulatively registered 25,623 NEVs (10,530 vehicles in the public domain and 15,093 vehicles in the non-public domain). Among these registered vehicles, 786 were BELVs, 1,377 were hydrogen vehicles (926 public buses, 448 logistics vehicles (see Figures 4-9 and 4-10) and 3 were coach buses.

By 2019, the construction of 27 hydrogen refuelling stations was initiated. Out of these 27 hubs, 16 stations have been finished (15 of which have been put into operation or trial operation), 8 stations are still under construction, and 3 stations are going through preliminary application and approval procedures. 40 new charging stations were also constructed, with 843 charging piles added in 2020. In total, Foshan now houses 197 charging stations and 6,109 charging piles.

■ **Fig. 4-9 Hydrogen Fuel Cell Logistics Box Truck in Foshan**

(Source: TPRI)

■ **Fig. 4-10 Hydrogen Tank of a Hydrogen Logistics Box Truck in Foshan**

(Source: TPRI)

4.5.2 Management Mechanism

In 2020, Foshan set up a Leading Group of green urban freight delivery work with the Mayor as group leader, which was responsible for decision-making, deployment, and overall promotion of green freight delivery services. The leading group members included the sub-governments of Chancheng District, Nanhai District, Shunde District, Gaoming District, and Sanshui District, along with various departments, such as the local Development and Reform Commission, and the Municipal Bureaus of Industry and Information Technology, Public Security, Justice, Finance, Natural Resources, Ecology and Environment, Housing and Urban-Rural Development, Transport, as well as other related actors. The daily work of the Leading Group is undertaken by the Municipal Transport Bureau, which is in charge of strengthening the dynamic supervision and coordination of various departments to jointly promote the work of urban green freight delivery services.

4.5.3 Supporting Policies

The Foshan municipal administration issued two guiding documents in 2018 to foster the development of the NEV and hydrogen energy industries.[62][63]. Furthermore, its administrative districts introduced relevant supporting measures for the industry's development in their respective regions.

Subsidy policies have been introduced to help promote the application of NEVs and NELVs. The subsidies allocate financial support to accelerate the integrated development of urban and rural logistics infrastructure, guide the development of pilot enterprises, reduce overall costs, and increase demand for further development of the urban delivery sector[64]. The same subsidy policies also include recommendations to employ new energy cargo vans/box trucks for urban delivery, with the specific goal of reducing the environmental impact of the transportation industry.

Further measures to support hydrogen FCEVs have been proposed to encourage freight, logistics, and city express enterprises to use hydrogen logistics vehicles. These measures include the planning and construction of supporting facilities, such as hydrogen refuelling stations[65]. The overall goal of these measures is to see hydrogen FCEVs, as well as BEVs, be considered as vehicle options for urban freight delivery services.

In regard to road access policies, the Foshan Traffic Management Bureau introduced relevant policies in August 2020. The policies noted that logistic vehicle restriction areas in Foshan and road access limits would not apply to NELVs with a weight of 5 tons or below, except during the morning peak time from 7:00 to 9:00 and the evening peak time from 17:00 to 19:00, and in city sections where government agencies and schools were located, as well as bridges which have stricter height and weight limits.

Policies noted that NELVs would be given an express path in applying for traffic permits, which would be gradually set to give them priority during application processes. Meanwhile, differentiated management measures would be taken to provide convenient and priority-driven access measures for NELVs within cities. These measures were to include expanding access for NELVs in a different city zone, lifting traffic restrictions, and gradually granting right of way at all times on urban roads for those NELVs involved in areas of business that affect people's livelihoods, including cold chain logistics services, fresh agricultural product deliveries, and express deliveries.

4.5.4 Management Innovations

(1) Innovative Approval Procedure

Making use of lessons learned from the management of natural gas refuelling stations on issues such as taking coordinated action based on findings from joint reviews, how to receive approval of multiple departments led by the government, and making sure that safety technology is overseen by specialists, Foshan has significantly simplified related review and approval processes, and eased difficulties in acquiring land for pilot projects. As a result, the administrative reviews and approvals of hydrogen refuelling station projects in the city were completed within only a few months.

(2) Improve Management Mechanisms

From 2018 to 2020, Foshan issued a series of supporting policies relating to hydrogen powered vehicles and related infrastructure[66][67][68]. These policies reinforced Foshan's ambitions of setting up a safety assessment expert database for hydrogen refuelling stations, which would serve as a technical support resource pool to guide districts in constructing and operating these bases.

(3) Scientific Supervision

Intelligent and digital measures were adopted to increase the operational safety of hydrogen refuelling stations through intelligent and comprehensive monitoring and management platforms, which allow for the remote monitoring of the status of hydrogen refuelling stations and drivers, vehicles, and equipment. The platform also was designed to provide functions such as data analysis, an early warning system in case of leakages, and emergency notifications and actions.

4.5.5 Problems and Obstacles

Various investors, including state-owned and private enterprises, were guided to participate in the construction and commercial operation of hydrogen refuelling stations in Foshan. Multiple actions were actively explored to support the industry, including building integrated natural gas and hydrogen refuelling stations, reconstructing or expanding existing natural gas stations with hydrogen refuelling functions, and utilising enterprise investment or joint investments by government and private enterprises to encourage its growth. Nevertheless, Foshan has still encountered various problems and obstacles on promoting hydrogen FCEVs and NELVs, which are outlined below:

(1) Inadequate supporting measures for hydrogen sourcing

The inadequacy of hydrogen refuelling stations causes inconvenience for hydrogen vehicle refuelling across the city. In Foshan, 16 hydrogen refuelling stations (15 of which have been put into operation) have been completed. However, these stations still cannot meet the hydrogen refuelling demands of existing vehicles. There is also the problem of insufficient hydrogen supplies. From July to November 2020, the hydrogen supply in the city was insufficient due to the rectification of hydrogen suppliers, whose available supplies of 2,400 kg/day covered only 1/5 of the actual demand of operating vehicles. In addition, Foshan does not have its own hydrogen source and the resource is mainly transported in from surrounding cities like Zhanjiang via road freight on expressways. However, hydrogen transport vehicles are not allowed to access expressways during major holidays or at rush periods, which causes significant supply shortages during times of high demand. Since demand exceeds supply in the hydrogen market, prices for the resource increased to the current level of EUR 10.25/kg (which exchanged to approximately RMB 80/kg in 2020). Assuming the energy consumption of light-duty hydrogen vehicles (<4.5 tons) was 3 kg per 100 km, the cost of running them would be roughly 0.30 EUR/km (2.4 RMB/km), which is more than double the cost of operating a conventional fuel vehicle[14]. This price discrepancy shows that as the cost of using hydrogen FCEVs is much higher than that of conventional fuel vehicles, unless there are significant policy and financial incentives awarded to the vehicles, freight logistics companies will lack any motivation to use costly FCEVs.

(2) Promotion methods for NELVs need to be further improved

At present, favourable policies for financial subsidies have been implemented in Foshan for NELVs. Nevertheless, support for ensuring preferentially right of way access of these vehicles is still insignificant. Currently, among different cities in the Guangdong Province, only Shenzhen has lifted traffic restrictions for light-duty electric vehicles and minivans, but medium to heavy duty new energy trucks are excluded from these beneficial policies. Consequently, steps to date to give priority in right of way for NELVs have not been sufficient.

4.6 Zhangjiakou

4.6.1 Progress to Date

By the end of 2020, Zhangjiakou had 304 hydrogen FCEVs in total under operation, covering distances totalling over 10 million km, which made the city rank as first in China for the amount of driving distances covered by FCEVs. In May 2021, plans for the application and promotion of the first logistics FCEV vehicle models were officially launched in Zhangjiakou, when five models of logistics FCEVs tailored for the express delivery industry were officially put into trial operation. These vehicles have a maximum travel range of more than 400 km per charge, and their range capacity is not affected by cold temperatures down to -25°C, which reduces the limitations often faced in the driving range of BEVs in winter.

Zhangjiakou has built 360 charging stations and more than 5,600 charging piles, basically achieving full coverage for the operation of these vehicles in five major areas: 1. The core area of the Winter Olympic Games 2022; 2. Transportation hubs and main roads; 3. Key tourist attractions; 4. Public parking lots, and; 5. Government and enterprise units. Before 2021, Zhangjiakou had built four hydrogen refuelling stations and the city planned to build another 16 hydrogen refuelling stations by the end of the same year.

■ Fig. 4-11 Weisan Lu Hydrogen refuelling station in Zhangjiakou

(Source: http://jingkaiqu.hebnews.cn/2020-12/10/content_8252755.htm)

[14] From the project field investigation result

4.6.2 Management Mechanism

The municipal government leads the promotion of NEVs in Zhangjiakou, arranging meetings with relevant departments such as the Municipal Transport Bureau, the Municipal Industry and the Information Technology Bureau to deploy work arrangements according to annual tasks relating to new energy vehicle promotion. Unlike other cities, the Transport Bureau in Zhangjiakou does not have a leading role or clear functions in the promotion of NEVs (especially for logistics applications), but only follows the relevant tasks illustrated in the Municipal Annual Working Plan.

4.6.3 Supporting Policies

(1) Guided by new energy development plans

Zhangjiakou is leading the development of the hydrogen energy industry through planning and preferential policies.

The city has formulated a series of policy documents, such as a Hydrogen Energy Construction Plan[69] to systematically promote the hydrogen energy industry's development. Further supporting strategies in Zhangjiakou include action plans on hydrogen energy, hydrogen refuelling development, spatial distribution, construction and management plans for refuelling stations, as well as other measures for improved investment processes and safety regulations in the hydrogen energy industry[70][71][72][73][74][75][76].

(2) Improve the layout of the whole industry chain

Zhangjiakou seeks to improve the hydrogen fuel industry chain's layout in four areas: 1. Production; 2. Storage and transportation; 3. Refuelling, and; 4. Application. It also constructs demonstration, R&D, and production centres for hydrogen energy to build a "first-class domestic hydrogen energy industry cluster and equipment manufacturing base".

Zhangjiakou implements preferential electricity prices of no more than 0.04 EUR/kWh (0.36 RMB /kWh) for registered renewable energy for hydrogen production enterprises. The equipment manufacturing and other related enterprises that have made special contributions to the development of the hydrogen energy industry in Zhangjiakou are also covered by related policies, giving them privileged access to resources and encouraging them to carry out joint venture development for hydrogen production and refuelling systems.

Zhangjiakou also gives local subsidies to hydrogen refuelling stations, including one-time construction subsidies of EUR 512,820 (RMB 4 million)[77]. These subsidies are available to hydrogen refuelling stations with a daily hydrogen refuelling capacity of 200-500 kg. Furthermore, a one-time construction subsidy of EUR 1.02 million (RMB 8 million) are given to hydrogen refuelling stations with a daily hydrogen refuelling capacity of 500 kg or more, once they start regular operation.

The leading domestic fuel cell power pack company Beijing SinoHytec Co. Ltd, the vehicle company Beiqi Foton Motor Co. Ltd (Foton), and the hydrogen supply company Zhangjiakou Haipel New Energy Technology Co. Ltd have already completed initial hydrogen energy industrial layout planning processes.

(3) Support the demonstration role of FCEVs

Zhangjiakou has issued Ten Measures to Support the Development of Hydrogen =Energy Industry in Zhangjiakou City policy to support demonstrations of potential applications of FCEVs, promote their operation in urban bus networks and rental car industries, and guide their application in passenger, freight, and other public and private transportation systems.

In addition, Zhangjiakou has compiled a vehicle promotion catalogue, formulated a detailed promotion plan for the industry, clarified the responsibilities of relevant departments, and focused on working with selected enterprises to steadily promote the demonstration of how various models of these vehicles can be applied in the city, particularly in the form of sanitation and logistics vehicles.

4.6.4 Problems and Obstacles

(1) High purchase and operation cost of FCEVs

At present, the purchase cost of hydrogen FCEVs is high. For example, a 4.5-ton truck sells for approximately EUR 10,256 (RMB 80,000). Currently, the promotion of hydrogen vehicles mainly relies on national and local subsidies. However, despite these various subsidies, the

final price of hydrogen vehicles is still higher than that of lithium battery vehicles and diesel vehicles.

Furthermore, NEV subsidies are being phased out, yet the cost of FCEVs cannot be reduced to the price level of lithium battery vehicles and diesel vehicles in the short term without a disruptive technology breakthrough that could lower the overall cost of the vehicles. The current refuelling price for these units in Zhangjiakou City has dropped to EUR 3.84-4.48/kg (RMB 30-35/kg), but the overall cost of running these vehicles is still 2-3 times that of electricity price for BEVs and 1-2 times that of conventional vehicles.

(2) Key technology breakthroughs are needed

There are still technical gaps between China and other countries when it comes to sourcing and processing the key components needed to develop hydrogen fuel cells. China depends on imports for some of the components required to build these cells, especially for core technological components such as membrane electrodes. In relation to these technologies, domestic know-how and existing products cannot match the performance and reliability of products available outside of China.

4.7 Summary of the promotion of NELVs in investigated cities

Four of the six cities discussed in this report section focused on BELV promotion, while the other two cities focused on supporting FCEVs (see Table 4-2). While the fuel types are different for these vehicles, the cities employ similar measures for their advancement, including through providing financial subsidies, right of way privileges, and support for the new energy infrastructure that they require for their operations. The progress in NELV development between cities varies due to different emphasis and effort used within these common measures. There are also individual local measures being implemented, such as formulating relevant standards, building information platforms, optimising the approval process for the new energy infrastructure, and raising public awareness, which impact how the vehicles are being rolled out A summary of the key characteristics of each case city are presented in Tables 4-2 and 4-3.

Table 4-2 Summary of NELV Promotion Status among Investigated Cities

City	Number of NELVs	Infrastructure	Leadership Team	Authorities	Subsidy Policy	Access Priority
Yinchuan	3000 BEVs	1,067 charging piles planned for 2022	Yes	Business Bureau	Vehicle acquisition link with national subsidies, local subsidies	NELVs are completely unlimited, and fuel logistics vehicles are restricted during some hours in the Xinhua business district
Zhengzhou	15000 BEVs	More than 20,000 charging piles	Yes	Transportation Bureau	There are national subsidies for vehicle acquisition, local subsidies for infrastructure construction, and local subsidies for operation	Differential traffic management measures are implemented for NEVs with green number plates, and the classification management system for NELVs is improved to facilitate the road passage of qualified van-type logistics vehicles. In the third ring, NEVs are not restricted except in the morning and evening rush hours. New energy trucks cannot drive into elevated roads.
Chengdu	30000 BEVs 100 FCEVs	23,700 charging piles	Yes	Department of Transportation Port and Logistics Office	Vehicle acquisition link with state subsidies	Allows NELVs (BEVs) to pass through urban areas for the full time and not subject to tail number restrictions; In 2020 and subsequent years, there will be no longer issue entry permissions for fuel logistics vehicles (except those that are determined to be necessary to retain)
Shenzhen	25208 BEVs	60,953 charging piles	No	Transportation Bureau	There are national and local subsidies for the acquisition and use of vehicles	Battery electric light and micro trucks (including light vans and light enclosed trucks) that have completed electronic filing and are subject to supervision are allowed to drive on the rest of the roads in Shenzhen, except for the section of Shennan Avenue (Shennan/Yanhe Interchange to Xiangmei) that is prohibited from 7:30 to 21:00 from Monday to Friday; medium BEVS and heavy trucks that are subject to supervision and whose body length does not exceed 6 metres are allowed to drive on the sections and times where ordinary large trucks are restricted
Foshan	448 FCEVs	16 hydrogen refuelling stations, 6,109 charging posts	Yes	Transportation Bureau	There are national and local subsidies for the acquisition and use of vehicles	Except for the morning rush hour from 7:00 to 9:00, the evening rush hour from 17:00 to 19:00, and the road sections around government agencies, schools and bridges that do not meet the conditions of height and weight restrictions, all other time periods and road sections in Foshan City have been abolished for medium-sized vehicles with an authorised load capacity of less than 5 tons (including) with new energy plates at the provincial level.
Zhangjiakou	5 FCEVs	Over 5,600 charging piles 4 hydrogen refuelling stations	No	No	There are national and local subsidies for the acquisition and use of vehicles	No special access priority

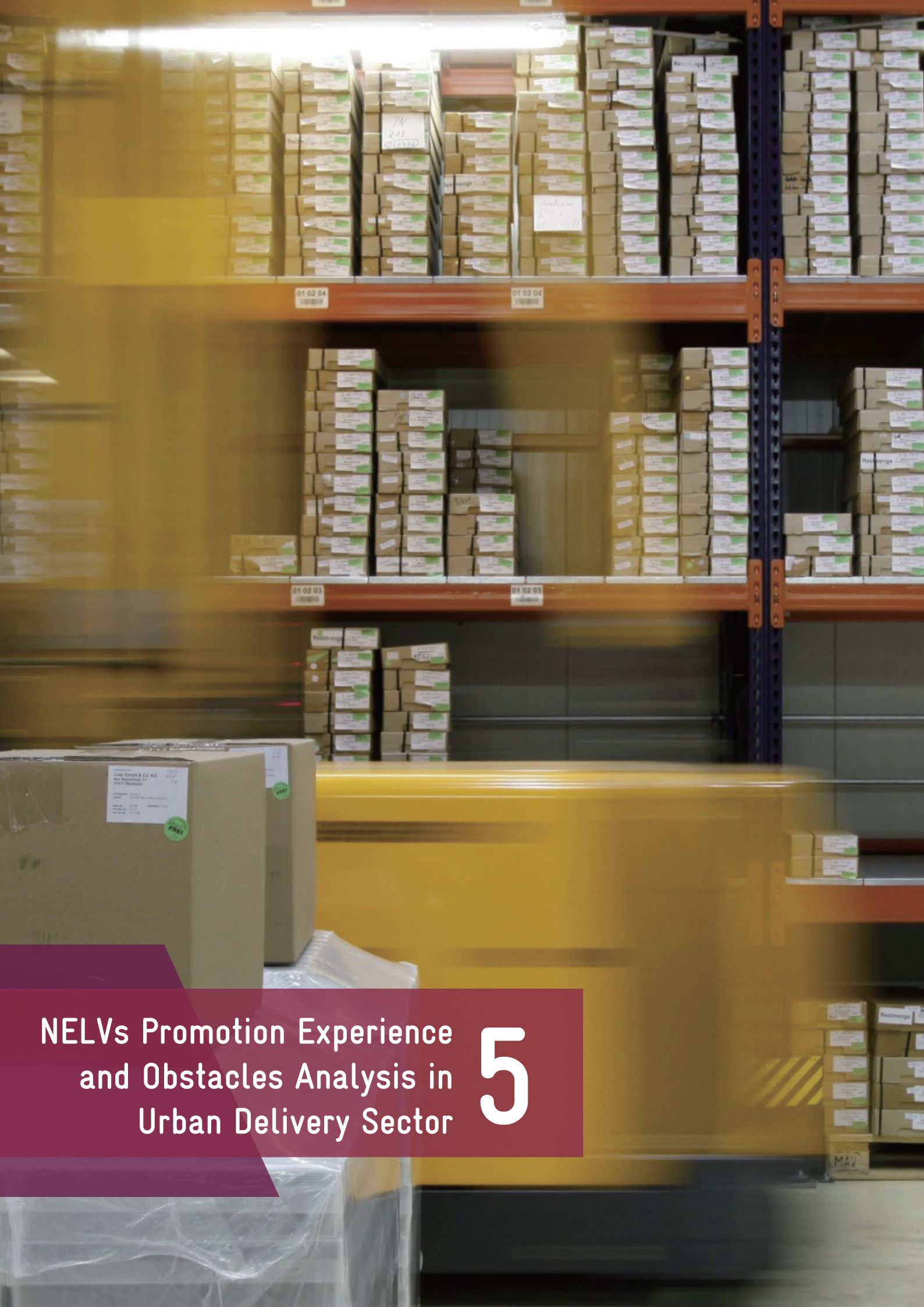
City	Number of NELVs	NEV Infrastructure（数据能否更准确）	Description
Yinchuan	3,000 BEVs	Plan to reach 1,067 charging piles in 2022	The promotion progress of NELVs in Yinchuan lags behind many other cities, since its comparatively colder geographic and climatic conditions pose high demand on battery capacity (mileage per charge) for NELVs. In addition, subsidies are provided only for purchasing NEVs, and there is little difference from diesel trucks in terms of road priority.
Zhengzhou	15,000 BEVs	More than 20,000 charging piles	Zhengzhou displays good performance in the promotion of NELVs. It provides a range of subsidies, not only for the purchase and operation of NEVs, but also for the construction and operation of charging infrastructure. However, the development still faces challenges as affected by limited road access priorities for NEVs.
Chengdu	30,000 BEVs 100 FCEVs	23,700 charging piles	Chengdu is one of the cities with the best performance in the promotion of NELVs in China. NEVs have been promoted mainly through the completely open road access policies, supplemented by basic financial subsidy policies, and led by the government.
Shenzhen	65,000 BEVs	60,953 charging piles	Shenzhen is also one of the cities with the best performance in the promotion of NELVs, where the NEVs have been promoted through the combined efforts of financial subsidies and right of way policies in a market-oriented manner.
Foshan	448 FCEVs	6,109 charging piles 16 hydrogen refuelling stations	Foshan features differentiated promotion of NELVs. Since it has concentrated efforts in promoting hydrogen energy, most of its policies were mainly aimed at hydrogen energy vehicles and related supporting facilities. In addition, its road access policies have generally been favourable to NEVs.
Zhangjiakou	5 FCEVs	More than 5,600 charging piles 4 hydrogen refuelling stations	Zhangjiakou performs well in the promotion of NELVs, with strong subsidies for the purchase of hydrogen FCEVs and the construction of hydrogen refuelling stations, a relatively complete planning policy system for the hydrogen energy industry has been formed, and the overall layout of the hydrogen fuel industry has been initially completed.

■ Table 4-3 Specific Analysis on Key Characteristics in Promotion of NELV among Investigated Cities

City	Leading Group (¡In Place —Void)[15]	Government department involved (¡Coordination óIn Charge —Void)					Policies and Measures (¡In Place óParticularly Good —Void)				Problems and Challenges (¡Exist óParticularly Prominent)							
		Transport	Commerce	Public Security	Municipal Port & Logistics Office[16]	Environment	Subsidies	Road Access	Charging Infrastructure	Management Innovations	Energy Supply	Vehicular Technology	Road Access	Charging Infrastructure	Safety	After Sales	Climate Restriction	Cost
Yinchuan	□	□	ó	□	—	□	□	□	□	—	□	□	□	□	□	□	ó	□
Zhengzhou	□	ó	□	□	—	□	ó	□	□	—	□	□	ó	□	□	□	□	□
Chengdu	□	ó	□	□	ó	□	□	ó	□	ó	□	□	□	□	□	□	□	ó
Shenzhen	—	ó	□	□	—	□	ó	ó	□	ó	□	□	□	□	□	ó	□	□
Foshan	□	ó	□	□	—	□	□	ó	□	ó	ó	□	□	□	□	□	□	□
Zhangjiakou	—	□	□	□	—	□	□	—	□	—	□	ó	□	□	□	□	□	□

[15] A steering and coordination mechanism, with participation of all relevant departments in the city, for better implementation of the Green Urban Freight Pilot Programme. It is usually led by municipal leadership (Vice Mayor or Mayor).

[16] Only Chengdu City has set up a Municipal Port and Logistics Office.



5 NELVs Promotion Experience and Obstacles Analysis in Urban Delivery Sector

Based on the above analysis and case studies of pilot cities, this chapter systematically summarises the effective promotion measures for the promotion of NELVs, including the active implementation of preferential policies for NEVs, the guiding and leading role of comprehensive special planning strategies for these vehicles, the effective promotion of local prioritisation for them via right of way policies to allow special access to different areas of cities at set time periods, and innovative operation models for the overall management of the use of these vehicles This chapter also summarises the various models taken to date for the promotion of NELVs, and then analyses the barriers to the promotion of new energy logistics vehicle (including the shortcomings of existing actions such as right of way policies, challenges with the cost efficiency of the vehicles, the need for supporting facilities, incomplete standards and norms relating to their operation, and poor after-sales service standards). The chapter lays the foundation to consider these challenges and opportunities, then makes specific recommendations for the further promotion of NELVs in China.

5.1 NELVs promotion experience analysis

5.1.1 NELV promotion measures

Policies and measures for NELV's include priority right of way planning, parking conveniences, industrial management support and related plans. are issued locally and nationally to promote the use of NELVs in the urban delivery sector. Some pioneer cities like Shenzhen, Chengdu, and Zhengzhou have earned valuable experience and learnt lessons in these processes, and therefore serve as examples and references for the better promotion and adoption of NELVs in the future.

(1) Implementation of preferential policies for NEVs

To maintain the momentum of new energy development, national purchase subsidies for NEVs, as well as purchase tax exemption policies have been extended to the end of 2022. Locally, subsidies for the purchase of NEVs have been replaced by financial and operational support for vehicle use and operation, in accordance with the national policy, with a view to promote them in an orderly manner. For example, NEVs are provided with special license plates by local governments as an incentive policy, with which they are permitted to access low emission zones. These measures are adopted to cushion the impact caused by cancelling the preferential purchase policy.

(2) Improvement of integrated and specialised planning to enhance NELV's guiding and leading roles

Integrated NEV promotion plans and specialised plans for developing charging facilities have been issued at provincial and municipal levels, supporting the industry's development. Cities such as Shenzhen have integrated plans for the building of charging stations into their city planning, for example, by reserving space for charging piles in NELV drivers' residential compounds. Some cities, like Zhengzhou, have formulated specialised plans for the promotion of NEVs and the construction of charging facilities, and have set goals for supporting the use of NELVs in city planning. These plans have provided the foundation for the development of plans to use NELVs, and tackled problems that operators of the vehicles might face, such as insufficient power capacity without changing facilities, and the lack of standardised charging service fees.

(3) Promotion of preferential right of way for NELVs

The provision of right of way privileges, or priority access to areas of the city at different times for NELVS, hold the key for the vehicles to be seen as a preferred method of transport and distribution for delivery vehicles in urban areas. Therefore to promote the role of NEVs in urban transportation and delivery, Chengdu has clarified their policy relating to the road privileges of different types of vehicles, and imposed no restrictions on the passage of NELVs in urban areas. Shenzhen, Chengdu, and Zhengzhou have completed digital registrations for the right of way of BELVs, with which the normal admittance certificate is not required before they can operate on roads within the cities, except for roads under special regulations.

(4) Innovative operation models to drive NELV application

Cities like Shenzhen and Chengdu are actively exploring innovative operation and management models for promoting and adopting NEVs in their urban delivery sectors. Several cities, such as Shenzhen, have launched the "Internet + new energy freight transportation" model, helping to reduce information gaps in the freight and logistics sectors by providing information on where and how NELVS can and may operate , such as through

programs like the "Green Truck Taxi," a platform similar to passenger ride-hailing business models and created by Green Wheel Electric Vehicle Co. Ltd. In addition, a considerable number of NELVs are employed in such freight transportation apps as Lalamove and GoGoVaN, providing new opportunities for sharing information about NELVs in operation.

The electric vehicle company Chengdu Yajun New Energy Vehicle Co., Ltd (RAJA EV) based in Chengdu has adopted a financial instalment policy in their business cooperation with cities adopting NEVs for delivery. Clients are required to submit a down payment of EUR 3,846 (RMB 30,000) for a vehicle and a monthly instalment of EUR 512 (RMB 4,000) for five years. After five years, the vehicle can be returned with a refund of the EUR 3,846 (RMB 30,000) down payment. This policy makes the overall cost of a NELV, including the purchase, electricity, and administrative fees, EUR 30,769 (RMB 240,000) lower than that of the cost of conventional vehicles.

5.1.2 NELV promotion models

For those cities with a developed economy and a high degree of marketisation, it is suggested to learn from the "Shenzhen model" (a small government and big market model) when promoting NELVs, for example encouraging the market to stimulate NELV demand as a main driving factor to purchase or lease these vehicles, with government management in a supporting role to facilitate the healthy development of the industry. For cities where the "Shenzhen model" is not applicable and the government plays the leading role in promoting NELVs, the following models can be used for reference on the basis of establishing a leading group led by municipal government leaders and making relevant planning decisions relating to these vehicles:

Firstly, cities with a developed economy and good financial foundation can learn from Zhengzhou's financial measures to provide financial subsidies for NELVs and the required new energy infrastructure, mainly by means of capital subsidies. Zhengzhou offered additional local subsidies, in addition to national subsidies, for infrastructure construction and operation, (this was significant as not all cities offer subsidies for new energy infrastructure).

Secondly, cities with a less developed economy and weaker financial foundation, but with room for innovation to roll out preferential vehicle right of way policies can learn from the right of way policy of Chengdu, to allow NELVs to maximise their use of right of way privileges and gain a clearer advantage over fuel vehicles.

Thirdly, cities with a developed economy and room for innovation in right of way policies, can learn from Shenzhen's example and promote NELVs through the combined efforts of financial subsidies and right of way planning.

5.2 Obstacle analysis for the promotion of NELVs

The development of NELVs still faces many restrictions and obstacles, mainly including the following: insignificant right of way planning (for example no prioritised right of way is given to most NELVs over conventional logistics vehicles in terms of traffic permits for entering urban areas), low cost effectiveness (for example . the costs for vehicle purchase, battery replacement, and related services of NELVs are higher than those of conventional vehicles), or insufficient charging facilities (where the current deployment of public charging facilities, in terms of quantity or spatial coverage, still cannot meet the development requirements of current and future NELVs). Further obstacles such as incomplete standards and norms for the assembly and use of these vehicles, a, lack of new business management standards and maintenance standards, and inadequate after-sales services also lead to inconvenient maintenance systems and high costs.

(1) Insignificant road access privileges

Despite the improvement in the development of right of way policies for NELVs, these systems are still inadequate. NELVs have few advantages over conventional fuelled vehicles in many cities due to a lack of practical guidelines on issuing preferential urban admittance permits for NELVs. Consequently, they are still treated the same as conventional fuelled vehicles. Preferential policies should be introduced to further attract businesses to choose NELVs over traditional vehicle types, and with weakening advantages in terms of purchase and operational costs, the provision of right of way privileges could play an increasingly key role in the promotion of NELVs.

In 2019, the Department of Transport Services of the MoT announced the 2nd batch of pilot cities of the Green Urban Freight Pilot Programme, including Tangshan, Qinhuangdao, Nanjing, and Xuzhou, increasing the overall number of participating cities to 46. To further facilitate green freight in urban areas and as a key measure to support the uptake of NELVs, support for the development of right of way policies in these cities should be improved.

Among all investigated cities, Chengdu is the only city allowing NELVs (BELVs) to enter urban areas all day without putting additional restrictions on conventional fuelled vehicles. It is also planning to phase out permits for conventional fuel logistics vehicles, so that NELVs can have greater advantages regarding right of way. By contrast, cities such as Shenzhen, Yinchuan, Foshan, and Zhengzhou still have temporal and spatial restrictions on NELVs to different degrees. These vehicles mainly face traffic restrictions during peak hours and in the downtown areas. However, delivery services are currently most needed precisely in those times and locations, therefore these restrictions have therefore reduced the delivery efficiency of NELVS.

In some cities, such as Zhengzhou, the illegal retrofitting of passenger vans for freight delivery, due to fewer restrictions for passenger vehicles than for logistics vehicles, has caused excessive competition and brought enormous pressure on those operating NELVs legally. Some cities have not even adopted differentiated policies for different vehicle types, which has led to no advantages being awarded to NELVs in terms of passage rights.

(2) Lack of cost effectiveness

Without the already decreasing financial incentives, the purchasing price of NELVs alone still does not have significant cost advantages to conventional fuel vehicles. Firstly, the purchase cost of NELVs is higher than that of conventional fuel logistics vehicles. Furthermore, the declining national and local purchase subsidies, and high insurance expenses have further discouraged enterprises from purchasing NELVs[41]. Additionally, the costs of NEV battery replacement, maintenance, and spare parts, are also higher than for traditional vehicles. Despite the lower cost in fuel (electricity), they still have, in some cities, higher operational costs than conventional fuel logistics vehicles due to high charging service fees. This is illustrated by the situation in Shenzhen (see Table 5-1), where BEVs do not have a cost advantage over conventional vehicles due to high charging service fees (EUR 0.13/RMB per kWh, including service fee). Finally, technical problems, such as shorter ranges per charge, long charging times, heavy dead weight, or unstable charging problems caused by high or cold temperatures have added to the comparatively higher costs and operational inconvenience of NELVs.

Table 5-1 Comparison of the Cost of Conventional Fuel Logistics Vehicles and NELVs

Vehicle brand and model		Light-duty enclosed truck		Van		
		DFSK C35	SOKON-RCEV EC35	Jiangling Shunda	SAIC ChaoYue C300	Dongfeng KaiPuTe EV300
Full purchase cost including tax EUR (RMB)		7,128 (55,600)	N/A	11,256 (87,800)	18,897 (147,400)	N/A
Cost of use	Depreciation period	5 years	N/A	5 years	5 years	N/A
	Depreciation per month EUR (RMB) /month	97 (760)	N/A	157 (1,230)	273 (2,130)	N/A
	Rent EUR (RMB) /month	N/A	314 (2450)			557 (4,350)
	Mileage per day (km)	150	150	150	150	150
	Oil consumption (L/100 km)	8	N/A	12	12	N/A
	Energy	Gasoline 93	Electricity	Diesel 0	Diesel 0	Electricity
	Cost of oil EUR (RMB)/L	0.82 (6.4)	N/A	-6.1	0.78 (6.1)	N/A
	Charging fee EUR (RMB)/kW hour	N/A	0.12 (1)	N/A	N/A	0,12 (1)
	Range per charge (km)	N/A	200	N/A	N/A	150
	Maintenance EUR (RMB)/km	0.012 (0.1)	N/A	0.019 (0.15)	0.019 (0.15)	N/A
	Inspection and examination EUR (RMB)/month	8.9 (70)	N/A	16 (125)	16 (125)	N/A
	Cost EUR (RMB)/month	503 (3,928)	429 (3,350)	754 (5,884)	881 (6,875)	788 (6,150)
	Drivers' salary EUR (RMB)/month	833 (6,500)	833 (6,500)	897 (7,000)	897 (7,000)	897 (7,000)
Comparison of cost	Overall cost EUR (RMB)/month	1,336 (10,428)	1,262 (9,850)	1,651 (12,884)	1,778 (13,875)	1,685 (13,150)

(Note: data from Shenzhen's 2017 annual report on the promotion and adoption of electric logistics vehicles.)

(3) Inadequate supporting facilities to match demand

Despite the continuous increase in the number of charging stations in construction and operation in all provinces and cities, their quantity and spatial coverage still cannot meet the current demand. The geographical distribution of charging facilities is unreasonable in many cases. With continuing urbanisation, transportation companies running logistics businesses have been increasingly migrating from urban to suburban areas, but existing public charging stations are mainly situated in urban areas.

In addition, a lack of sufficient charging facilities in logistics parks, urban hubs, and arterial roads, have restrained the promotion and adoption of NELVs. Difficulties remain in building new charging stations in logistics parks due to land shortages, complex administrative application procedures, and leased sites. Shortages of charging stations for BELVs also exists in Chengdu, Yinchuan, and Zhengzhou. Companies cannot easily build new stations due to a lack of available land, a high capital investment needed for their implementation, and complex administrative approval procedures. The lack of planning and mismatching between the deployment of vehicles and demand for charging stations leave some public facilities unused and others oversaturated.

The capital cost of hydrogen refuelling stations for FCEVs is significantly high, and these vehicles also face a lack of green hydrogen supplies. The high costs of these stations has led to insufficiency in them being rolled out where needed. In addition, the dangerous goods transportation restriction regulations for hydrogen in cities and the lack of local hydrogen sources (such as. Foshan) could cause a severe shortage during peak seasons (for example, on public holidays) as hydrogen tank trucks are banned on roads.

The current geographical distribution and number of public charging stations cannot keep pace with the current demand that FCEVs have for this resource, and this shortage may have significant implications on the future development of NELVs. The problem of charging these vehicles will remain significant in the foreseeable future[20].

(4) Incomplete standardisation

New businesses models such as NELV leasing or the Internet + NELVs model are operating in a "grey zone." According to article 33 of the People's Republic of China Road Transport Regulations, road transportation vehicles shall be equipped with a vehicle operation certificate, and it shall not be transferred or leased, which brings the risk of violating the law to NELVs.

There is a lack of comprehensive regulation standards regarding the loading limit of different types of NELVs and of maintenance companies. Batteries are heavier than motor engines and therefore cause more dead weight on NELVs, making them heavier than conventional fuel logistics vehicles of the same size. It is therefore unreasonable to apply the same standards to both NELVs and conventional fuel vehicles. The conventional fuel vehicle workshop standards are also not fully applicable to electric vehicle maintenance companies. It is yet to be determined how standards might be adjusted to meet the needs of NELVs.

(5) Large room for after-sale service improvement

NELV companies still lack common and standardised quality assurance and policies for vehicle parts replacement. Currently, the increasing number of after-sale service centres established by vehicle operators and producers still fails to meet demand. Complex procedures for after-sale services, the long duration of maintenance, and delayed responses for support lead to low efficiency and longer service durations. Furthermore, maintenance services require different equipment, different vehicle models, and specialists in new energy technologies. To improve after-sale services, specialised maintenance personnel need to be employed, which will increase the cost of human resources and equipment. As a consequence, there are far less NELV maintenance workshops than the market demand requires.

6 Application Scenario and Promotion Policy Suggestions for NELVs

6.1 Application scenarios for different types of NELVs

NEVs mainly include two vehicle types, each based on a different charging technology; they are BEVs and FCEVs. This study has provided technical suggestions for their development, which are outlined below.

(1) Characteristics of Battery Electric Logistics Vehicles (BELVs)

From 2014 to 2018, the production and sales of BELVs increased, then from 2018 onwards, they have followed a declining curve. This shift reflected the trend of the overall vehicle market. It also demonstrated that the increasing penetration rate of BELVs from 0.1% in 2014 to 3.7% in 2018 was not a continuing trend. Meanwhile, the composition of vehicle models among BELVs differs from that of conventional vehicles. BELVs are mainly composed of light-duty vehicles and minivans, while the number of medium- and heavy-duty vehicles is negligible.

Between 2018 and 2019, the maximum power of BELVs improved significantly and their travel range per charge almost doubled, with the range per charge increasing from 135 km to 254 km, the average power from 90.5 kW to 115.6 kW, and the battery energy density from 123 Wh/kg to 133.8 Wh/kg[41]. Despite these improvements in performance in recent years, the market still has not fully recognised their advantages over other vehicles.

(2) Characteristics of Fuel cell electric logistics vehicles

Substantial improvements have been achieved with regards to the FCEV bottlenecks of cost and core technologies, including on advancements in battery power density, life span, and cold starts. The document Recommended NEV models for promotion and adoption[78] issued by the MIIT in 2020 included commercial FCEVs with the power of 40-100kW. Nationally, the cold starting temperature of FCEVs ranges between -30℃ and -10℃. In support of these vehicles, related domestic supply chains of fuel cell power pack have been established, and their system integration ability has been considerably improved.

Currently, the development of hydrogen fuel cell logistics vehicles is still dependent on government subsidies and policy support due to their high production costs. The hydrogen FCEV market scale is still very small. It is believed that the production cost of vehicles, fuel systems, and hydrogen storage systems can be reduced through larger-scale production. It is hoped that costs would decline in the next two to three decades due to technological breakthroughs on proton exchange membrane fuel cells and an upscaling in production. However, China's hydrogen is mainly sourced from "grey hydrogen"[17], and if electrolysis via green electricity is used, the electricity to hydrogen conversion energy loss is still high, at roughly 30%[79][80]. Therefore, BELVs are considered a more environmentally effective solution than hydrogen vehicles, especially when battery intensity or faster charging technology experience breakthroughs in near future as expected. A comparison of the parameters of pure electric logistics vehicles and hydrogen fuel cell logistics vehicles is as follows.

Based on the above analysis of BELVs and FCEVs, it is concluded that the former has been promoted and adopted in most areas of China on a large scale, and the commercialisation of these vehicles is mature, especially for freight transportation within 400 km. FCEVs remain more costly, but enjoy certain technical advantages compared to BELVs, such as shorter refuelling times, higher travel ranges per refuel, and adaptability in low temperatures.

To conclude, in most NELV application scenarios in the urban delivery sector, BELVs are found to be more suitable, except for cold-chain delivery, as current BELVs cannot meet the high-power requirements for refrigeration during goods transportation. Considering that cold-chain delivery usually serves high value goods, the relatively higher-cost of hydrogen FCEVs may be used for these high value services..

	Travel range per day (km)	Fuel sources	Temperature range (°C)	Acquisition cost (million yuan)	Cost of use EURO (million yuan/year)
BELVs	200-300	Electricity grid (coal and green power)	0-40	20	2.2-4.5 (17-35)
FCEVs	≥300	Hydrogen (grey hydrogen, green hydrogen)	Cold start temperature -30 to -10	80	3.3-10.8 (26-84)

[17] Grey hydrogen is hydrogen produced from fossil fuels (such as oil, natural gas, coal, etc.), and there will be carbon dioxide emissions in the production process.

6.2 Policy Suggestion for promoting NELVs

6.2.1 Recommendations at the national level

(1) Develop a policy agenda for NELV promotion

With the purpose to accelerate the promotion of NELVs, their purchase cost can be reduced through fiscal policies. Purchase subsidy policies for NELVs should be considered after the phasing out of the current NEV purchase subsidies.

Governments at all levels should develop policies to subsidise the replacement of high emission vehicles of the China III and China IV emission standards with those of China VI and with vehicles powered by natural gas, electricity, and hydrogen. Preferential tax policies for scrapping and replacing older vehicles should be formulated, and the implementation of the exemption from vehicle purchase tax for NELVs should be continued.

The operational cost of NELVs should also be reduced through fiscal subsidies. An operation subsidy for NELVs based on their operation mileage should be developed and/or enhanced. The government should also formulate charging subsidy policies (for both the construction and operation of these services). In addition, more R&D funds should be planned to curb technological bottlenecks such as the development of high-performance batteries, the improvement of battery energy density, the upgrading of thermal management systems, the increase of range per charge, and the reduction of fuel cost.

The development and implementation of a New Energy Vehicle Credits (NEVC) mandate for commercial vehicles should be accelerated. Studies should be carried out on conventional commercial vehicles and new energy commercial vehicle manufacturers to understand the characteristics of commercial vehicles under various types, uses, scenarios, users, and regional conditions, as well as the progress and difficulties of the new energy transformation of commercial vehicles. With the consideration of technology and market factors, NEVC regulation for commercial vehicles should be grounded by phases based on different implementation regions, vehicle models, and application scenarios. In addition, the introduction of the NEVC system should consider how to be better at seamlessly transforming from the phasing out progress of subsidy policies to sustaining market momentum.

(2) Complete standards and norms for NELVs

Authorities should accelerate the standardisation development for NELVs and their key components and parts. A timetable and roadmap of standardisation for batteries, core components, and charging ports should be studied and put forward.

Standards for vehicle battery reuse/recycling should be developed as soon as possible. This includes clarifying a unified process and the responsibility and cost allocation among all stakeholders. Through regulations and standards ensuring the vehicle quality of the original OEM, normalising vehicle operation, and controlling the vehicle scrapping process, resource recycling and subsequent effects on environmental protection could be maximised.

In summary, a comprehensive standard for managing the whole life-circle of NELVs should be established. This includes the processes of R&D, production, operation management, after-sale maintenance, scrapping, and recycling.

(3) Improvement of NELV after-sale service systems

After-sale services for NELVs should be regulated. This includes several aspects of these processes, including clarification of responsibilities in maintenance, vehicle recall and replacement, after-sale dispute resolution, battery recycling, and safety risk control.

The after-sale services network should also be improved. Customer convenience should be considered when planning after-sale service networks. The service scope should consider covering businesses along the NEV industrial chain, such as battery recycling, second-hand vehicle trade, and other related services. Timely settlement in after-sales services is paramount. The after-sale service quality should be strengthened. A standard service procedure needs to be established, including a service hotline for consultation and complaints, and the timely processing of customer requirement should be assured.

A training/education system of high-skilled specialists for after-sale technical services and management on NEVs should be developed to meet increasing personnel

demands. Consultation and technical training should be conducted for freight companies to increase their understanding of NELV operation and troubleshooting for higher vehicle utilisation efficiency.

6.2.2 Recommendations at the local level

(1) Continuous implementation of NELV road privileges

New city admittance permits should only be granted to NELVs. The existing permits currently used by conventional fuel vehicles could thereby only be kept if the vehicle is replaced by a NELV.

Policies on NELV parking privileges for loading/unloading should be implemented while also considering the road share of public bus lanes. Preferential measures on roadside parking should be put into practice. New technologies such as parking sensors and GPS units together with artificial intelligence should be employed to better implement these measures. A feasibility study on sharing bus lanes with NELVs during certain periods should also be conducted.

Road priority for NELVs should be maximised. By establishing green logistics zones and imposing restrictions on conventional fuel logistics vehicles in central areas, fossil fuel related emissions could be further reduced. Fines should be increased, and road access restriction should be enforced for illegally retrofitted freight delivery purposes passenger vans to avoid harmful competition for freight companies.

(2) Accelerating the construction of the new energy infrastructure

The layout planning of charging facilities should be optimised. Based on the analysis of the data from vehicle operation platforms and heat maps of urban logistics vehicles, relevant authorities should better plan the layout of charging stations geographically to match with NELV operation areas and speed up the improvement of charging networks. The service radius of the supporting infrastructure should be reduced.

To speed up the construction of charging infrastructure, the following measures should be adopted: Fiscal subsidy policies on the construction and operation of battery charging and battery-swapping infrastructure and hydrogen refuelling stations should be studied and formulated; Financial support should be proportionally given to the construction of charging piles; Market-oriented development should be encouraged and freed, attracting investments of multiple parties for the construction and operation of charging piles, and; The construction of the NELV charging network should be prioritised in places like logistics parks, urban hubs and arterial roads.

(3) Fostering of innovative NELV application and organisation models

The feasibility of battery-swapping should be further explored to establish a business model to separate the sales of vehicles and batteries (for example, introducing models like Battery-as-a-Service). New vehicle models should be developed based on practical real-world demand. In addition, power packs for battery-swapping vehicles should be standardised, the responsibility of battery safety should be clarified, and pilot programmes of battery-swapping models should be launched as soon as possible.

Innovative models of cooperation between NELV operators and financing institutions should be encouraged. The government should play a coordinating role of connecting financing institutions with operators to strengthen their credit and loan support for NELV programmes, and to establish dedicated capital and innovation funds to attract and leverage more investment for industrial development.

New technologies, such as Internet+, IoT, and cloud computing, should be employed to help establish a smart NELV operation platform for freight efficiency optimisation via big data analysis. The cumulative NELV operation data could then support the selection and customisation of NELV models to better serve various application scenarios, as well as to better strengthen the management of urban logistics vehicle fleets, and to improve the efficiency of transportation organisations, thus making NELVs stand out in market competition.

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Annex I

Table 1 National Policy on the Promotion and Application of NELVs

Date of Issue	Name of the Policy	Contents Related to NELV
2018.10	Three-Year Action Plan to Promote Transport Restructuring	We should comprehensively promote urban green freight delivery, as the document clearly puts it, by 2020, the country should launch about 100 urban green freight delivery demonstration projects, with newly added or updated light logistics vehicles and other NEVs that meet the national VI emission standards taking up more than 50% of the total number (80% for key regions).
2019.5	Opinions on Accelerating the Transformation and Upgrading of the Road Freight Industry for High-Quality Development	We should provide traffic priority to NELVs that meet the standards, and no restrictions should be imposed on battery electric light trucks, expect for special areas.
2019.8	Implementation Opinions on Conscientiously Implementing General Secretary Xi Jinping's Important Instructions to Promote the High-Quality Development of the Postal Industry	We should accelerate the replacement and update of postal and express vehicles in urban built-up areas with NEVs, of which the proportion in key regions should reach 80% by the end of 2020. From July 1, 2019 onwards, new and updated gas postal and express vehicles should meet the national VI emission standards.
2020.4	Notice on Improving the Financial Subsidy Policy for the Promotion and Application of NEVs	The national subsidies for NEVs shall expand to 2022.
2020.6	Notice on the Implementation Opinions to Further Reduce Logistics Costs	Urban green freight delivery demonstration projects should be continued to promote, and more traffic priority of NELVs should be provided.
2020.10	The New Energy Vehicle Industry Development Plan (2021-2035)	From 2021, in public sector within national ecological civilisation pilot zones, and key areas for air pollution prevention and control, the proportion of newly added or updated NEVs in public transport, rental, logistics and delivery vehicles should be no less than 80%.

Annex II

Table 2 Preferential Policies for NELVs in Major Cities

City	Name of policy issued	Right of way	Subsidy	Others
Beijing	"Implementation Plan for Traffic Priority to NELVs in Beijing" "Incentive Plan for Operation of New Energy Light Trucks"	From 2019 Q4, Beijing will increase the proportion of ownership permits of electric trucks and implement differentiated traffic measures on a quarterly basis to achieve that "except for the cold chain transportation vehicles, the proportion of electric trucks in light logistics vehicles with the capacity below 4.5t that are allowed to pass the roads within the fifth ring in daytime by handling the truck traffic permit will meet relevant requirements by the end of 2020". Among them, the proportion of new energy trucks to the trucks with traffic permit would reach 25% in 2019 Q4, 50% in 2020 Q1, 65% in 2020 Q2, 80% in 2020 Q3 and 90% in 2020 Q4.	The latest Incentive Plan for Operation of New Energy Light Trucks was issued in August 2020, specifying the range and standards of the incentive, fund application procedures and time and other matters for operation of new energy light trucks in Beijing, and tilt the subsidy towards the operation section.	
Shanghai	Interim Procedures for Encouraging the Purchase and Use of NEVs in Shanghai Several Measures for Promoting the Automobile Consumption in Shanghai	According to the regulations in Shanghai, logistics vehicles of the city are not allowed to enter the restricted areas during 07:00-20:00 from Monday to Friday. Logistics vehicles of other cities are not allowed to enter the restricted areas during 7:00-20:00. However, electric trucks with Shanghai's traffic permit are not restricted. Except for roads with "No Logistics vehicle Passing" sign (including elevated roads), 3,000 Traffic Permits for Logistics vehicles will be issued to electric logistics vehicles at early stage.	The subsidy amount provided by Shanghai for electric logistics vehicles is 50% of the national subsidy.	Priority will be given to issuing relevant special operation quota for purchasing NEVs for operation involving industry license management. No fee will be charged for obtaining traffic permit of new energy trucks.

City	Name of policy issued	Right of way	Subsidy	Others
Shenzhen	Management Measures for Pass of NELVs (SGJH [2016] No. 254) Guideline on Application for Operation Funding Project of Electric Logistics Delivery Vehicles in Shenzhen Announcement of the Traffic Police Department of Shenzhen Municipal Public Security Bureau on Restricted Routes and Areas for Trucks (SGJ(T) [2016] No. 4) Announcement of the Traffic Police Department of Shenzhen Municipal Public Security Bureau on Implementing Preferential Traffic Policy for NELVs (SGJ(T) [2016] No. 66) Announcement of the Traffic Police Department of Shenzhen Municipal Public Security Bureau on Continuing Implementing Preferential Traffic Policy for NELVs (SGJ(T) [2016] No. 198) Management Measures for Special Funds for Development of Modern Logistics Industry in Shenzhen Announcement on Continuing Implementing Traffic Restriction Measures for Logistics vehicles with a License Plate in Other Cities Rules for Implementation of Fiscal Subsidy for Promotion and Application of NEVs in Shenzhen in 2019-2020 (draft for comments)	Those electric light and mini trucks that have completed electronic filing and registration to accept supervision (including light cargo van and light close van) are allowed to travel on the roads in Shenzhen other than Shennan Avenue (the section from Shennan/Yanhe Flyover to Xiangmei Road) from 7:30 to 21:00 during Monday to Friday, without needing to get traffic permits. Those medium and heavy electric trucks with a body length of no more than 6m are subject to traffic restrictions at morning and evening peaks and not allowed to pass some sections in daytime or in the whole day. Those electric medium and heavy trucks with a body length of more than 6m are subject to traffic restriction in most locations in the urban area, and the traffic permit is required, which has a validity period of 6 months. Those NELVs with automobile license plates issued by Shenzhen are not subject to the traffic restriction forbidding "those with automobile license plate not issued by Shenzhen to pass all roads in the city from 7:00 to 10:00 and from 15:00 to 20:00 on working days".	Vehicle operation subsidy: It is included into the subsidy range in an innovative way, making Shenzhen the first city to grant operation subsidy for electric logistics vehicles. For those enterprises satisfying the application conditions, the electric logistics vehicles that have been connected with the supervision platform as required within the assessment period and that have a mileage up to 15,000km/year in Shenzhen, the subsidy will be granted as per EUR 96/kWh, 77/kWh and 64/kWh (RMB 750/kWh, RMB 600/kWh and RMB 500/kWh) respectively for the part below 30 (including) kWh, at 30-50 (including) kWh and above 50kWh in the total battery storage. The total subsidy amount for a single vehicle in three years shall not be more than EUR 9,615 (RMB 75,000). No purchase subsidy will be granted for NEVs that obtain license plate after August 7, 2019.	Parking of electric logistics vehicles at roadside parking spots will not be charged for the first hour. Permit: There is no need to obtain a traffic permit, but the operation permit is required, with handling regulations the same as those for fuel vehicles.
Tianjin	Announcement of Tianjin Municipal Public Security Bureau on Continuing Implementing Management Measures for Traffic Restriction of Motor Vehicles	The NEVs with license plate issued by Tianjin will not be subject to the management measures for traffic restriction of motor vehicles based on the tail number of license plate from January 1, 2016; The electric light and mini cargo vans and electric light and mini close vans with the license plate issued by Tianjin are not subject to the traffic restriction based on tail number of license plate and morning and evening peaks. However, they need the special traffic permit.	According to the new regulations for subsidies in Tianjin in 2017, special NEVs will be granted with local fiscal subsidy of Tianjin as per 50% of the national fiscal subsidy. In addition, the operation vehicles are eligible to apply for subsidy only when they meet the requirement for a mileage of 30,000km.	NEVs purchased in Tianjin can directly apply for a license plate without purchase restriction.

City	Name of policy issued	Right of way	Subsidy	Others
Chongqing	Notice on Issuing the Fiscal Subsidy Policies for the Promotion and Application of NEVs in Chongqing in 2019	According to relevant regulations in Chongqing, traffic priority is given to those new energy trucks (including special vehicles) with the total design mass no more than 2.5t within the scope of main urban area.	The subsidy criterion for electric and plug-in hybrid (including extended range) special vehicles and trucks is EUR 77/kWh (RMB 600/kWh), with the maximum subsidy no more than EUR 2,564/vehicle (RMB 20,000/vehicle). No annual road and bridge toll will be charged for those NEVs purchased and licensed in Chongqing before December 31, 2020. No purchase subsidy will be granted to those NEVs other than new energy buses and fuel cell vehicles after June 25, 2019. The focus of policies is changed from "subsidy for vehicles" to "subsidy for charging", providing more support for the construction of infrastructure, including charging piles and hydrogen refuelling stations.	A green channel is set to provide convenient services for NEVs in license applying, annual inspection, ownership transfer, second-hand vehicle trading, etc.
Chengdu	Management Measures for NEVs in Chengdu (Trial) Several Policies for Supporting the Promotion and Application of NEVs in Chengdu Rules for Implementation of Municipal Subsidies for NEVs in Chengdu	Three types of NEVs, namely electric vehicles, plug-in electric hybrid vehicles and fuel cell vehicles, are no longer subject to the traffic restriction of vehicles based on tail numbers of licence plate and can travel on all roads in the areas between the Third Ring Road (inclusive) and the Second Ring Road (inclusive) where the traffic restriction based on tail numbers of license plate is implemented on working days. The permit for entering urban area issued to fuel logistics vehicles (except for the identified special logistics vehicles) will be gradually cancelled in 3 years and electric urban logistics vehicles are not restricted to enter the urban area.	The consumers (individuals and organisation users) registered with the Vehicle Management Department of Chengdu Municipal Public Security Bureau will receive additional municipal supporting subsidies on the basis of the central fiscal subsidies, with the subsidy amount as 50% of the amount of the central fiscal subsidy for a single vehicle.	--

City	Name of policy issued	Right of way	Subsidy	Others
Zhengzhou	Rules for Implementation of Several Policies for Encouraging the Promotion and Application of NEVs in Zhengzhou	In Zhengzhou, electric logistics delivery, EMS and sanitation vehicles are not restricted in the urban area in all periods and sections.	It is specified that "Zhengzhou Finance Bureau will grant supporting subsidies to NEVs (other than buses) purchased by consumers at the proportion of 1:0.6 based on the central fiscal subsidy criteria, with the sum of provincial and municipal fiscal subsidies no more than the central fiscal subsidy criteria and 60% of the selling price of vehicles after deducting the central fiscal subsidy. " The maximum subsidy of EUR 6,410 (RMB 50,000) will be given to each new energy trucks during the period from 2019 to 2021.	No parking fee will be charged for NEVs charging at the public special parking spots.
Wuhan	Announcement on Strengthening Management Measures for Traffic of NEVs Announcement on Strengthening Traffic Management of Logistics vehicles in Wuhan	From June 1, 2016, new energy minibuses will not be subject to the traffic restriction based on odd or even tail number of license plates and the traffic restriction for new energy large buses and trucks will also be relaxed accordingly. Small NELVs with blue license plates are allowed to travel in the whole city, except for such roads as Yangtze River Bridge, Jianghan No.1 Bridge, Yangtze River Tunnel and the sections prohibiting entry of trucks for the reason of construction, as well as key areas such as Hanzheng Street. There is also no traffic restriction for them at morning and evening peaks. Logistics vehicles from other cities will be prohibited from entering areas of the Third Ring Road in the whole day from September 1, 2019, but no traffic restriction is implemented for new energy trucks in some areas. For instance, small NELVs are allowed to enter Bayi Road, Zhongbei Road and Hongshan Square Ring Road.		No traffic permit is required for small NELVs.

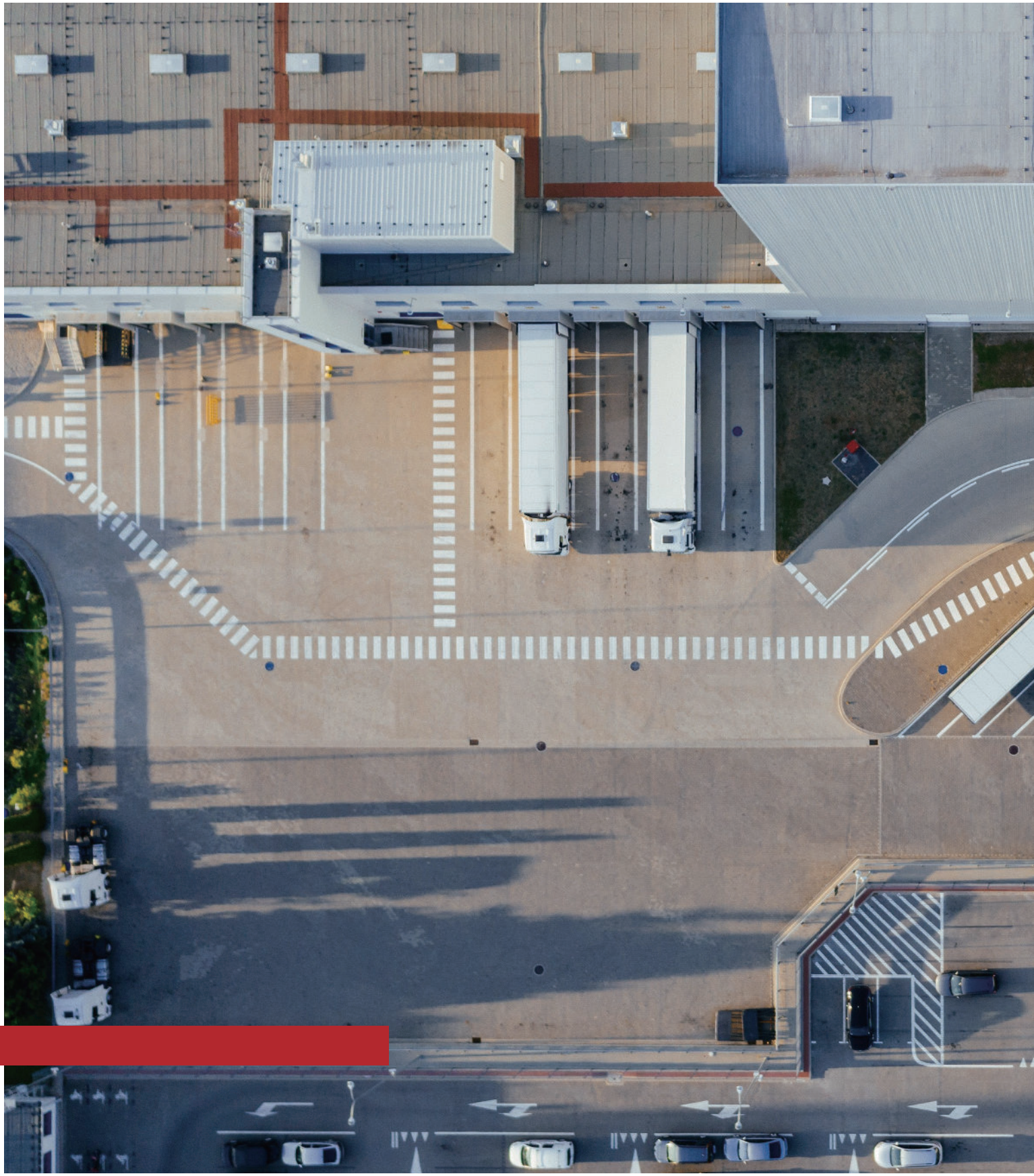
City	Name of policy issued	Right of way	Subsidy	Others
Xi'an	--	In 2017, strict regulation and traffic restriction policies were implemented for heavy-duty logistics vehicles, low-speed logistics vehicles with excessive emissions and diesel logistics vehicles within the Third Ring Road in Xi'an, while NEVs are not subject to the traffic restriction. Traffic priority is given to the NELVs for urban delivery, which are not subject to the traffic restriction at certain periods implemented in the urban area. In addition, NEVs are allowed to use the bus transit lane in the urban area and not subject to the traffic restriction on urban roads in winter precaution period.	--	Those NEVs subject to the jurisdiction of the Motor Vehicle Parking Service Centre of Xi'an parking at public parking lots (spots) will not be charged within 2h.
Taiyuan	--	Battery electric trucks are not subject to the traffic restriction. A traffic permit is issued to NELVs for urban delivery which are allowed to travel on the approved routes within the Third Ring Road.	Shanxi Province will grant the provincial marketing subsidy as per 50% of the national subsidy from January 1, 2017.	--

Annex III

Survey Form of Application of New Energy Logistics Delivery Vehicles

Filled by: _____ **Contact:** _____ **Tel:** _____

<table>
<tr><td colspan="8">I. Application of New Energy Logistics Delivery Vehicles</td></tr>
<tr><td rowspan="6">Current scale</td><td colspan="7">Total population of logistics delivery vehicles ___ (veh.):
including: Conventional diesel logistics delivery vehicles ___ (veh.),
Battery electric logistics delivery vehicles ___ (veh.),
Hybrid logistics delivery vehicles ___ (veh.),
Logistics delivery vehicles using other energy sources ___ (veh.).</td></tr>
<tr><td rowspan="5">Population by vehicle type</td><td rowspan="2">Vehicle type
Van</td><td colspan="2">Total population (veh.)</td><td colspan="2">Total population of electric vehicles (veh.)</td><td colspan="2">Total population of hybrid vehicles (veh.)</td></tr>
<tr><td>Enclosed lorry</td><td>Van</td><td>Enclosed lorry</td><td>Van</td><td>Enclosed lorry</td><td></td></tr>
<tr><td>Mini truck
(Maximum total mass ≤1.8t)</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Light truck
(1.8t<maximum total mass ≤6t)</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Medium truck
(6.0t<maximum total mass ≤14t)</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Heavy truck
(Maximum total mass >14t)</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Supplementary notes (hydrogen vehicles)</td><td colspan="6"></td></tr>
<tr><td colspan="2" rowspan="2">End of 2025 Planned scale including</td><td colspan="6">Total population of logistics delivery vehicles ___ (veh.):</td></tr>
<tr><td colspan="5">General diesel logistics delivery vehicles ___ (veh.),
Electric logistics delivery vehicles ___ (veh.),
Hybrid logistics delivery vehicles ___ (veh.),
Logistics delivery vehicles using other energy sources ___ (veh.).</td><td></td></tr>
<tr><td colspan="2">Supplementary notes</td><td colspan="6"></td></tr>
<tr><td colspan="8">II. Supporting Infrastructure of New Energy Logistics delivery Vehicles</td></tr>
<tr><td>Scale</td><td></td><td colspan="6">Qty. of charging piles for new energy logistics delivery vehicles __ (Nr.)</td></tr>
<tr><td></td><td colspan="5">Qty. of charging piles for new energy logistics delivery vehicles in 2025 as planned __ (Nr.)</td><td></td></tr>
<tr><td></td><td colspan="5">Qty. of hydrogen refuelling stations for new energy logistics delivery vehicles in 2025 as planned __ (Nr.)</td><td></td></tr>
<tr><td colspan="2">Supplementary notes</td><td colspan="6"></td></tr>
</table>



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