



Newsletter No.7, August 2022

The Sweden-China Bridge project, funded by The Swedish Transportation Administration (Trafikverket, TRV), formally started on the 1st of September 2020.

The research team intends to regularly publish Newsletters to update readers on what is going on in the Chinese context regarding the electrification of the transportation system.

Autonomous driving & Sales update on new energy heavy trucks in China, July 2022

This newsletter contains two main news updates on the development of electrification in China.

1. In the development of autonomous driving, where China currently occupies a leading position.
2. In the electrification of transport, where battery swapping technology occupies a leading position in charging infrastructure.

China's autonomous driving policy takes a lead position as two Chinese cities are the first to carry out fully unmanned commercial operations in real-life situations

In August, the municipalities of Wuhan and Chongqing took the lead in implementing the pilot policy for the commercialization of completely unmanned self-driving vehicles, on level 4 (SAE). The two cities issued the first batch of permits to tech company Baidu allowing self-driving vehicles without safety personnel to carry out commercial services on public roads under real-life conditions.

With the implementation of this policy, the residents of Wuhan and Chongqing will be the first to enjoy driverless travel services in China. It will also usher in a turning point of rapid growth and put the country in a leading position in global competition. In the autonomous driving industry, real operation data forms the basis for driving the technology from written on paper to implementation in practice¹.



Photo 1: Baidu Apollo RT6 passenger car. Baidu "Apollo Go" launched an unmanned service in the economic development zone in Wuhan city.

Source: <https://xw.qq.com/cmsid/20220808A0420000>

According to the policy requirements, applicants need to undergo a complex process consisting of testing, demonstration, unmanned testing, and finally unmanned operation to implement the complete system of unmanned vehicle operation. To apply for unmanned operation, applicants must have accumulated mileage of several thousand kilometers on a single vehicle and completed a certain number of orders with passengers. No accidents must have happened where the operator has been responsible.

Baidu is the only company approved to operate driverless taxis after the policies of

Wuhan and Chongqing are released. Through its "Apollo Go" ride-hailing platform, the company will officially provide a driverless transport service without safety personnel in the two cities.



Newsletter No.7, August 2022

Baidu's representative said that the company would ensure the safe operational ability of unmanned vehicles on the road through multiple measures such as single vehicle intelligence, monitoring redundancy of systems, parallel driving, and safe operational management. The system is expected to make every effort to ensure the safety of passengersⁱⁱ.

At present, Apollo Go has launched 20 fully self-driving vehicles in the economic development zone in Wuhan city. Among them, five are fully unmanned self-driving demonstration vehicles, which means that when Wuhan citizens call the vehicle, there will be no safety personnel in the vehicle. Until now, most unmanned self-driving vehicles have safety personnel on board when driving on public roads under real-life conditions. Sixty-three recommended pick-up points are set up on 166 km of roads within 30 square km of the economic development zone, and the service period will initially be from 9:00 a.m. to 5:00 p.m.,

compared to the commercialization of fully unmanned autonomous vehicles in San Francisco in the United States, where operators operate at night with fewer customers, fewer pedestrians, and lower traffic intensity, the operation in Wuhan city in the daytime with heavier traffic is more complex.

At the policy level, China has issued more than 10 national policies in the last six years to ensure the all-round development of self-driving vehicles from the perspectives of digital transportation, infrastructure construction, development of intelligent connected vehicles, and the development of intelligent connectivity standards.

This development in the cities of Wuhan and Chongqing is only the start of empirical large-scale testing and development of autonomous driving on level 4. We have reason to believe that more cities will follow, and later level 5 will also be introduced.



Photo 2: Baidu " Apollo Go " autonomous driving vehicle view.
Source: xw.qq.com/cmsid/20220808A0420000



Newsletter No.7, August 2022

According to Baidu, here are some of the key specs of the Apollo RT6:

- Purposefully designed from the start for fully autonomous driving, with a detachable steering wheel allowing for more passenger space and installation of extra seating, vending machines, laptops, or gaming consoles.
- Level 4 autonomous driving capabilities, 1,200 TOPS of computing power, and sensor architecture to handle complex urban environments based on 38 sensors: eight LiDARs, 6 mm-wave radar, 12 ultrasonic radars, and 12 cameras.
- Sensors are seamlessly integrated into the panoramic glass roof.
- The industry's first seven-layer full redundancy throughout the EV.
- Interactive lights indicate key signals for communicating with passengers and other cars on the road.



Photo 3: Baidu Apollo RT6 Level 4 autonomous robotaxi with detachable steering wheel

Source: *electrek*, July 21 2022



Newsletter No.7, August 2022

The sales volume of battery swapping heavy-duty trucks increased by 15 times in the first half of 2022

Battery swapping mode has become a major driving force of heavy truck electrification in China ⁱⁱⁱ

In the first half of 2022, a total of 10,120 new-energy heavy trucks were sold in China, a year-on-year increase of 491%. Among them, 4,887 battery swapping new-energy heavy trucks were sold, a year-on-year increase of nearly 15 times (308 battery swapping new-energy heavy trucks were sold in the first half of 2021),

outperforming the 491% increase of new-energy heavy trucks in the same period, accounting for 48.29% of the market share of new-energy heavy trucks and becoming the main factor driving the rapid growth of new-energy heavy trucks in China.

	Battery swapping electric heavy trucks	Charging electric heavy trucks	Fuel cell electric heavy trucks	Hybrid electric heavy trucks	New-energy heavy trucks in total
First half year 2022 sales volume (units)	4,887	4,655	566	12	10,120
First half year 2021 sales volume (units)	308	1,150	238	16	1,712
Year-on-year growth rate	1,487.0%	304.8%	137.8%	-25.0%	491.0%
First half year 2022 percentage	48.29%	46.0%	5.60%	0.12%	100.0%
First half year 2021 percentage	17.99%	67.2%	13.9%	0.93%	100.0%
Year-on-year percentage change	30.3%	-21.2%	-8.3%	-0.81%	0.00%

Table 1: New-energy heavy truck sales volume comparison between the first half of 2022 and the first half of 2021.

Source: <https://baijiahao.baidu.com/s?id=1738924872901484506&wfr=spider&for=pc>

- In the first half of 2022, the battery swapping heavy electric truck leads the growth of the new-energy heavy truck and is the only segment that sees an increase in its share year-on-year.

- It is also the first time the battery swapping mode gets a higher market share than the charging mode in the Chinese new-energy heavy truck market.



Newsletter No.7, August 2022

Factors contributing to the rapid increase in sales of battery swapping heavy electric trucks in the first half of 2022 in China

According to industry observers, the situation results mainly from the following factors:

a. First, driven by China's national carbon emission reduction targets, regional governments have implemented policies promoting the development of battery swapping heavy trucks.

Electrification of commercial vehicles has become a key policy area against the background of carbon emission reduction. Battery swapping mode provides the most feasible fast track for achieving targets for the electrification of heavy trucks.

The Chinese government announced in 2020 its strategic support for the development of the battery swapping mode. In October 2021, the Ministry of Industry and Information Technology issued a notice on starting a pilot project exploring battery swapping mode in new-energy heavy trucks and proposed to carry out the pilot project in Yibin, Tangshan, Baotou, and other cities. Since then, the development of battery swapping heavy trucks has entered the fast lane.

In terms of development planning for the battery swapping heavy truck industry, the objectives of key cities are clear.

- According to statistics, in the first half of 2022, more than 1,500 battery swapping heavy trucks were applied in Tangshan (northeast China).
- Yibin, Sichuan, plans to build more than 20 battery swapping stations within two years and promote the operation of more than 1,000 battery swapping heavy trucks. In the first half of this year, Yibin applied nearly 200 battery swapping heavy trucks (central China).

b. Second, many places have introduced policies to support the development of the battery swapping heavy truck industry.

For example, in March 2022, the Department of Industry and Information Technology of Hainan Province introduced measures to encourage the use of new-energy vehicles, proposing that during the pilot period 2021-2022, a one-time reward of 4 million yuan would be given to medium and heavy truck projects operating at least 50 battery swapping electric trucks.

On April 20, 2022, the Chongqing Finance Bureau and other departments jointly issued a notice on the financial subsidy policy for new-energy vehicles and charging and battery swapping infrastructure in Chongqing 2022. The document stipulates that the subsidy standard for medium and heavy truck battery swapping stations is to give a one-time subsidy of 400 yuan / kW according to the battery-swapping equipment module's rated charging power. The maximum subsidy for a single station is no more than 800,000 yuan, and the subsidy for a single enterprise is no more than five million yuan.



Newsletter No.7, August 2022

Jiangsu and Sichuan provinces are committed to solving the current problems concerning battery pack standards that are hindering the development of battery swapping heavy trucks

On April 23, 2022, Jiangsu Province took the lead in publishing a review of Jiangsu Province Technical Specification's group standard for the battery pack system for pure electric heavy trucks. This is China's first standard concerning battery packs for pure electric heavy trucks. It also marks the first unified battery pack standard in the field of battery swapping heavy trucks.

lower cost, reducing the economic loss caused by battery decay. The real economic benefits and convenience offered to customers increase motivation to purchase battery swapping heavy trucks.

On June 15, 2022, a technical standard for charging and battery swapping in transport infrastructure construction equipment was also released in Chengdu. The standard addressed practical application problems in the field of electrification of transport infrastructure construction equipment and also standardized core technical fields such as equipment structure and interaction with charging and battery swapping, power battery frame and base, fast battery swapping connector, communication protocols, multi-terminal identification, data security, and risk management.



Figure 1: The number and proportion of battery swapping heavy truck models that were newly launched on the Chinese market in the first half of 2022.

Source:

https://baijiahao.baidu.com/s?id=1738924872901484506&wfr=s_pider&for=pc

c. Third, the battery swapping heavy electric trucks can offer convenience to customers and improve transportation efficiency.

Battery swapping mode can shorten the power replenishment time, free up more time for customers to do business, and enable customers to acquire trucks at a



Newsletter No.7, August 2022

d. Fourth, the supply side actively invests in battery swapping heavy truck products to provide support for end customers.

In the first half of 2022, the Ministry of Industry and Information Technology issued the 352nd to 357th batches of new-energy heavy truck models newly launched on the market by truck OEMs. Among them, the proportion of battery swapping heavy truck models is more than 40% (except the 352 batches), which indicates that truck suppliers are actively supporting the application of battery swapping heavy trucks in the terminal market.

volume of battery swapping EHTs and its percentage among all new energy heavy trucks in the first half of 2022 is shown in Table 2. With the change of weather in the second half of the year and the increase in environmental protection pressure, the sales volume is expected to further increase.

	January	February	March	April	May	June	January to June
Sales of battery swapping electric heavy trucks (units)	1,022	447	661	536	940	1281	4,887
Sales of new-energy heavy trucks (units)	2,283	940	1,506	1,123	1,825	2,443	10,120
Percentage of battery swapping electric heavy trucks	44.77%	47.55%	43.89%	47.73%	51.5%	52.43%	48.29%

In the first half of 2022, the number and proportion of battery swapping heavy trucks listed in the 352nd – 357th batches announced by the Ministry of Industry and Information Technology are in Figure 1.

In the first half of 2022, the sales volume of new-energy heavy trucks exceeded 10,000 units, which was close to the total sales volume of last year. Detailed monthly sales

Table 2: Monthly sales volume of battery swapping heavy electric trucks in the first half of 2022.

Source:

https://baijiahao.baidu.com/s?id=1738924872901484506&wfr=s_pider&for=pc

Sales volumes of different types of battery swapping EHTs

In terms of different types of battery swapping heavy electric trucks, battery swapping tractor trucks have become the main sales model of battery swapping heavy electric trucks. Table 3 shows the sales of different types of battery swapping EHTs in the first half of 2022. We can see that of the total sale of 4,887 vehicles the tractor

trucks have a dominant position with a total sale of 3,633 vehicles.

Battery swapping tractor trucks have become the main sales model of battery swapping heavy electric trucks. Battery swapping tractor trucks have been applied in batches in steel plants, power plants, ports, branch lines,



Newsletter No.7, August 2022

and other fields. It has played a significant role in transportation and got acceptance by users.

Compared to tractors, dumpers are mainly used on construction sites in urban areas. Building battery swapping stations in urban areas is more difficult and expensive. Thus, in the dumper segment, the charging mode still occupies the largest market share.

Compared to tractors, dumpers are mainly used on construction sites in urban areas. Building battery swapping stations in urban areas is more difficult and expensive. Thus, in the dumper segment, the charging mode still occupies the largest market share.

	Battery swapping tractor trucks	Battery swapping dumpers	Battery swapping mixer trucks	Battery swapping electric heavy trucks in total
Sales volume January to June (units)	3,633	1,121	133	4,887
Percentage January to June	74.34%	22.94%	2.72%	100.0%

Table 3: Sales volume of different types of battery swapping heavy electric trucks in the first half of 2022.

Source: <https://baijiahao.baidu.com/s?id=1738924872901484506&wfr=spider&for=pc>

The key is to further decrease the cost of battery swapping solution

According to expert opinions, in the future, new-energy heavy trucks will form a pattern whereby the battery swapping and charging modes coexist. Under the battery swapping mode, the purchase cost of the vehicle is high (300,000 yuan^{VI} (450,000 SEK) more than a diesel truck), and the use frequency (mileage) of the vehicle is the key factor determining whether the operator can make a profit.

At the same time, due to the high investment in the battery swapping station, the investment cost is 10 million yuan per station including batteries.

The battery swapping mode can achieve rapid profit only under the high-frequency use scenario, while the investment in the charging station is relatively low, and the charging mode is more cost-effective for medium and low-frequency transportation scenarios.

At present, the main restricting factor affecting the promotion of new-energy heavy trucks is the high cost.

In the future, three aspects should be worked on to decrease the cost:

- The first is **the price of complete vehicles**. With the growth of production and sales, the price of complete vehicles is falling. The unit price of pure electric tractors has dropped from 850,000 yuan to about 720,000 yuan in 2022 (a 15% decrease).
- The second is **the operating cost**, such as the price of recycling batteries after five years and whether the battery can be used in the echelon.
- The third is **the price of electricity**. The peak valley electricity price is used in daily operations to save operating costs. For example, from 11:00 p.m. to 6:00 a.m., the electricity price is far lower than in the daytime.

Energy storage at night and charging during the day are more conducive to the realization of the optimal total cost of ownership of pure electric heavy trucks^{IV}.



Newsletter No.7, August 2022

Summary

From the annual data, since 2021, the sales of new-energy vehicles in the Chinese market have shown rapid growth. During the period from 2018 to 2020, the annual sales volume of new-energy vehicles was about 1.2 million vehicles. In 2021, this figure increased by 156% year-on-year, reaching 3.266 million – 2 million more than in 2020.

According to statistics from China Automobile Association, in the first half of 2022, China's new-energy vehicle market completed 2.6 million retail sales, with a year-on-year increase of 120%.

By the end of June 2022, the number of new-energy vehicles in China had reached 10.01 million, of which 8.104 million were pure electric vehicles, accounting for 81% of the total number of new-energy vehicles.

It is worth mentioning that the huge growth in sales of new-energy vehicles is a result achieved against the background of a shrinking automobile market, which also means that new-energy vehicles are accelerating to replace traditional fuel vehicles in the Chinese market.

As a comparison of data, from January to June of 2022, the total sales volume of China's automobile market was 12.057 million, a year-on-year decrease of 6.6%. It is

estimated that the sales volume of new-energy vehicles in China in 2022 will be more than five million.

According to data released by BYD, the cumulative sales volume of new-energy vehicles in 2022h1 is about 641,000, with a year-on-year increase of 314%. Meanwhile, Tesla recently released its Q2 production and delivery report. According to the report, Tesla delivered 564,000 electric vehicles worldwide in the first half of this year. According to the above data, BYD leads Tesla in sales by nearly 80,000 vehicles and becomes the world leader in electric vehicle sales.

It is estimated that the development of new-energy commercial vehicles will accelerate shortly in the commercial vehicle field. Mining, ports, steel plants, coal bases, urban logistics, engineering and environmental sanitation, and other scenarios will apply a large number of new-energy commercial vehicles. New-energy commercial vehicles will also be diffused further from megacities to second-tier cities in China.

Based on our observations, the development and commercial diffusion of battery swapping EHTs in China are speeding up. Key stakeholders are joining the field actively. Institutions and infrastructure supporting the battery swapping solution are being developed rapidly.

It seems that 2022 is a turning point that marks the battery swapping EHTs entering the high-speed commercial growth stage and the year when battery swapping solutions is passing the threshold of becoming one major solution for electrification of heavy trucks in China.

^I https://www.guancha.cn/economy/2022_08_09_653006.shtml

^{II} <https://xw.qq.com/cmsid/20220808A0420000>

^{III} <https://baijiahao.baidu.com/s?id=1738924872901484506&wfr=spider&for=pc>

^{IV} <http://www.cvwworld.cn/news/sycnews/sector/220805/201678.html>

^V <https://baijiahao.baidu.com/s?id=1738423687029197705&wfr=spider&for=pc>

^{VI} One CNY is about SEK 1.54 currently



Newsletter No.7, August 2022

Reflections on battery swapping acceleration - “Joint Action Plan” for establishing a large-scale charging infrastructure system in China

As we can see from the numbers, heavy electric trucks are rapidly expanding in China. We also notice the fast-growing charging infrastructure based on battery swapping technology. Battery swapping does not get much attention in the west. However, it is seen as a strategically important complement to cable-based charging for passenger vehicles, heavy trucks, and special vehicles in China.

In our research on the electrification of transport in China, we have noticed that collaboration is one key aspect of technology development and diffusion of solutions, initially in demonstration sites and later in large-scale establishments. This collaboration is three-dimensional, vertical, horizontal, and lateral. The vertical refers to collaboration within the domain of different ministries on national, provincial, and local levels. The horizontal refers to collaboration among actors along the value chain, from material, and components to system suppliers. The lateral refers to collaboration across ministry levels and between key actors along different

value chains. To achieve a high degree of electrification all are needed.

We observe in the Chinese context now that this collaboration is rapidly moving from isolated, single technology development and implementation to system-related multi-dimensional collaboration integrating different solutions in integrated complementary system solutions.

In China, as well as in the rest of the world, the charging infrastructure is crucial to support electrical vehicles to run. We have seen in China large-scale diffusion of cable-based charging and isolated sites with battery swapping, inductive charging, and solar roads. Now, China focuses on moving to large system-based integrated solutions in cities and along the highways. These ambitious cable-charging and battery swapping solutions are complementary and create a large-scale system solution. To achieve this acceleration of charging infrastructure, several ministries are jointly working out action plans.

Chinese ministries and key actors entered the “Joint Action Plan” to accelerate the construction of integrated charging infrastructure and support enterprises in the construction of battery swapping stations along the highways

On the 25th of August, the Ministry of Transport, the State Energy Administration, the State Grid Corporation, and the China Southern Power Grid Corporation jointly issued The Action Plan for Accelerating the Construction of Charging Infrastructure Along the Highway, proposing to strive to provide basic charging services in the highway service areas in the country except for high altitude and cold areas by the end of 2022.

The Action Plan points out to explore and promote the application of new technologies and new equipment to improve the life-cycle efficiency of charging facilities;

formulate and implement a phased plan, promote the construction of super-fast charging and high-power charging infrastructure in the highway service areas around the city clusters, and support the construction of battery swapping stations in the highway service areas by enterprises such as electric vehicle manufacturers and large-scale transportation companies. Strengthen the collection and release of service information of charging infrastructures, provide real-time information service for the public, and actively explore charging services based on appointments.



Newsletter No.7, August 2022

Following is the major content of The Action Plan

In principle, the charging infrastructure built in each service area or the parking space reserved with construction and installation conditions (for charging infrastructure) along the highway, shall be no less than 10% of the parking space for passenger vehicles.

- **Financial support.** Based on The Implementation Opinions of the National Development and Reform Commission and Other Departments on Further Improving the Service Capacity of Electric Vehicle Charging Infrastructure, financial support will be given to the construction of charging infrastructure along the highway, and the operation subsidy standard linked to the charging service quality will be explored to strengthen the subsidy of high-power charging and other demonstration facilities.
- **Optimize construction implementation procedures.** Charging facilities are necessary public service facilities in the service area (station), and the land required is included in the scope of highway land. If it is necessary to increase land, the local government shall provide support according to the land use policy for the main works of the highway, simplify the handling procedures and organize the implementation as soon as possible. The layout and wiring of new charging facilities shall

be well connected with the road site and facilities, and the layout design of driving routes and parking lots shall be optimized.

- **Strengthen the construction of supporting power grids.** Power grid enterprises should increase investment in supporting power grid construction, reserve high-voltage, and high-power charging capacity, and meet the needs of charging facilities construction. For remote service areas (stations) where power grids have not been extended in place and do not meet the large capacity power supply conditions, priority should be given to using the distributed power supply and other methods to supply power nearby.
- **Suggestions on charging service charges.** Local governments are encouraged to introduce relevant preferential measures to reduce the rent of charging infrastructure sites in stages, to create conditions for accelerating the construction of charging infrastructure. The charging service operators are encouraged to consider the balance between the reasonable income of the investment and operation entities and the user's economy and charge reasonable service fees during the market incubation period.

Comments

As we can see from the above, the overall approach to developing charging infrastructure is that different technologies need to complement each other based on the specific societal, commercial, and consumer expectations in different parts of China. Thus, both cable charging and battery swapping will be established for passenger vehicles and heavy trucks. Now the focus is on establishing an open, public charging infrastructure along the highways enabling long-distance driving and commercial operations.

To achieve the targets of large-scale charging infrastructure establishment, different ministries and key stakeholders were involved in designing the joint plan

and ensuring that the joint plan is communicated with related actors and implemented accordingly. This also shows clearly the extensive horizontal and lateral dialogue and collaboration between energy producers, grid system operators, technology developers, operators of charging infrastructure, and vehicle manufacturers.

The major learning from this illustration is the multi-dimensional (vertical, horizontal, and lateral) collaboration across traditional administrative and organizational silos and domains, joint collaborative efforts to achieve results, and an open system integrating approach to developing solutions.

Reference:

G20 battery swapping industry alliance, <https://baijiahao.baidu.com/s?id=1742120516137400860&wfr=spider&for=pc>



Newsletter No.7, August 2022

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