



## Newsletter No.2, April 2021

Sweden-China Bridge – Collaborative Academic Platform for the Electrification of Transportation Systems project is funded by Trafikverket-TRV (Swedish Transport Administration), and started on 1 September 2020.

The authors of Newsletter No 2 are Prof. Mike Danilovic & Dr. Jasmine Lihua Liu.

### Exploring Battery-Swapping For Electric Vehicles In China 1.0.

#### The electrification is here to stay

Over the years, the number of electric vehicles (EV) has grown substantially in number, the batteries have become larger in size providing vehicles with longer ranges, the efficiency of batteries has improved, and the prices have decreased substantially, etc. The dominant global solution to battery charging, is stationary charging using cables. There is, however, another battery charging technology, that of battery-swapping, i.e. replacement of the discharged battery with a charged battery from outside the vehicle.

The early exploitation of battery-swapping by Better Place and Tesla failed due to the high cost of battery-swapping systems and batteries, lack of standards, lack of openness and divergent technical and economic interests among key stakeholders and objections from car manufacturers to opening up their vehicle structure.

#### Battery-swapping take-off in China

From 2012 to 2016, battery-swapping charging stations underwent large-scale development as the major complementary energy solution in China. BAIC (Beijing Electric Vehicle Marketing Co.), Lifan, NIO and some other Chinese OEM brands together with third-party battery-swap station operators, such as Aulton, insisted on exploring the battery-swapping option and made substantial progress.

In 2020 Chinese central government included battery-swapping technology in the National New Energy Vehicle Development Strategy 2021 to 2035.

China's Ministry of Industry and Information Technology issued a statement:

*"We will actively promote the demonstration application of battery-swap mode and improve the system and standardization. As the next step, we will optimize the development environment, guide enterprises to improve battery-swap technology, promote the formation of a more mature business model, and further improve the convenience of new energy vehicle usage."*

Given that the Chinese government has expressed its attitude in this clear way, it is highly likely that they will strongly support the further development of the technology.

Since 2020, there has been fast growth in battery-swapping infrastructure in Chinese cities and along the main highways. Modularly designed cars with fully integrated automated fast battery-swapping system solutions are available. There are also other emerging application areas for battery-swapping such as buses, trucks, heavy-duty vehicles etc.

#### Political decisiveness to adopt battery-swapping

A combination of local provincial governments, the automotive industry, IT-developers, entrepreneurs, state grid system operators, swapping system operators, electricity suppliers, institutes and universities are developing a new ecosystem and placing large-scale systems in operation.

The placement of battery-swapping on the national strategic list demonstrates the systematic approach to the electrification of transportation that needs to



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be seen and understood starting from energy production, distribution, charging, and the creation of a balancing component in overall energy sourcing and energy storage. Thus, the new ecosystem comprises the major part of the main players in the energy and electrification system. Battery-swapping is a strategic solution to the entire energy system transformation and part of the ongoing energy and transportation transformation.

### Battery-swapping progress in China by 2020

At the end of January 2021, there were 562 battery-swap stations operative in China, providing a service to taxis, online car-hailing vehicles, private passenger vehicles and business operation vehicles. More than 100,000 cars have been sold with battery-swapping systems. Battery-swapping's status as an important complementary solution to EV energy supply has been recognized by various parties. The feasibility of developing battery-swapping for taxis, online car-hailing vehicles, logistic vehicles and other business operation vehicles has been preliminarily verified.

### BAIC

- BAIC started R&D on battery-swapping in collaboration with Better Place in 2009.
- In 2010 BAIC and Better Place established a pilot swapping station in Shenzhen.
- By November 2020, BAIC had developed and established 225 battery-swap stations in 19 cities in China and launched 22,000 battery-swapping vehicles on the market.
- 6.8 million battery-swapping services have been realized.
- Beijing authorities decided to add 6,000 battery-swapping electric vehicles to its taxi fleet in 2019 and another 20,000 in 2020.
- BAIC plans to build 100 new battery-swap stations in 2021 to provide a service for 10,000 vehicles.

- BAIC will replace 50,000 existing taxis with EVs equipped with swapping batteries for the 2022 Winter Olympic Games in Beijing and Zhangjiakou.
- The 4th generation of battery-swapping only takes 30 seconds.
- The station occupies 75 square meters and can hold 60 batteries; the designed service capacity is up to 400-500 swaps per day.
- BAIC/BJEV plan to invest more than 10 billion yuan (\$1.4 billion) to build 3,000 battery-swap stations capable of serving 500,000 electric vehicles by the end of 2022.

### NIO

- NIO built its first battery-swap station in May 2018.
- By 2020, NIO had established 178 battery-swap stations across the country in 64 different cities in the eastern part of China.
- The stations cover two major highways between Beijing-Guangzhou and Beijing-Shanghai.
- Their plan is to reach 500 battery-swap stations by the end of 2021.
- By March 2021 NIO has completed more than 2,000,000 battery swaps.
- On August 20, 2020, NIO officially launched its Battery as a Service (BaaS). BaaS is a breakthrough innovation both in terms of technology and business model, which allows consumers to buy a car without a battery, and provides battery rental together with recharge, replace and upgrade services and options.
- In 2021 a new 150 kWh battery pack will be introduced enabling NIO cars to run for 1000 km on one charge.

### GEELY

- In 2020 Geely announced its entry into the battery-swapping business by establishing operations in Chongqing.



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- On February 2 2021, Geely completed and put into service its first 10 smart battery-swap stations in the Chongqing Expressway Service area.
- The new battery-swapping station occupies 126 square meters and has 39 battery charging positions. The station can support nearly 1000 battery swaps per day. It takes 60 seconds to complete a battery swap.
- Geely is planning to build 35 battery-swap stations in Chongqing alone, rapidly expanding by an additional 100 in 2021 and 200 in 2023.

### Aulton New Energy Automotive Technology (largest third-party battery-swapping operator in China)

- Aulton began to explore the battery-swapping technology in 2000. In 2005, the world's first experimental charging and swapping station was set up in Lanzhou.
- The 2020 fourth generation Aulton battery-swapping service can change a battery in 20 seconds.
- The service capacity of a single battery-swap station is 500-1000 vehicles.
- By the end of 2020, more than 300 battery-swap stations had been set up in China, equal to 50% of the total number of battery-swap stations in China. The total service capacity exceeds 50,000 vehicles spread across 20 cities.
- In 2021, Aulton will build 500 battery-swap stations covering more than 50 cities, increasing the battery-swapping capacity to 320,000 commercial vehicles or 3.2 million passenger vehicles.
- By 2025, the company plans to build 5,000 battery-swap stations in 100 cities across China, serving 2 million battery-swapping enabled NEVs.
- To promote standardization, Aulton plans to provide standard exterior packaging for batteries.

### Challenges

The major challenges include investment required for battery-swapping station, the high financial cost of batteries in the swapping stations, and battery depreciation, difficulty in achieving unified standards, overlap of the division of responsibilities, limited space for station construction and safety issues. A multi-player, new ecosystem is investing jointly in battery-swap stations and battery asset companies are also starting up.

Third-party operator Aulton is initiating the exploration of battery standardization by unifying the interfaces of the battery outer package and the vehicles, leaving the content of the battery to OEMs. Government agencies are also driving a discussion on the standardization issue. Innovative collaborations on space sharing is providing space for battery-swap stations. Active and passive safety technologies are being developed that address the safety issue.

### Emerging new business models for commercialization of battery-swapping in China

The new emerging business model for commercialization of battery-swapping is based on the idea of separating the price of the electric car from its costliest part, the battery. Batteries can be chosen flexibly based on their size and can either be purchased or rented on a monthly basis to reduce anxiety and uncertainty among customers. Also, the charging of batteries can be cable-based or based on a monthly subscription according to the required amount of energy, resulting in great flexibility for the customer. Thus, the investment cost for customers is based on their purchasing power, risk taking attitude, level of uncertainty and driving habits. The swapping time is reduced down to 1 minute. This system enables great flexibility because the customer can choose and, if necessary, subsequently change the battery size depending on



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their needs as well as choosing the charging system and payment methods.

The future of battery-swapping stations in China

*"In the next 5-10 years, the number of commercial vehicles with potential demand for battery-swapping will reach 4 million. We believe that by 2025, the number of battery-swapping NEVs will reach 1.24 million, with 12,370 battery-swap stations needed." (Zhang Feng, deputy general manager of Blue Park Smart Energy (Beijing) Technology, speech at 2020 China International Battery Switching Mode Industry Summit Forum, December 2020, in Shanghai.)*

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