

# Harvard Business Review

## How One Chinese EV Company Made Battery Swapping Work

by [Chengyi Lin](#) May 28, 2024



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### Summary.

Battery swapping is a technology that could solve one key barrier for EV adoption: consumers' range anxiety and the long waiting time for battery charging. Wouldn't you feel more assured on a weekend trip if you knew you could stop at a swap station and replace depleted battery packs with fully charged ones in five minutes? But this isn't easy to do, as Tesla and Better Place's past failures. In China, however, battery swapping has been a reality for a couple of years. How did Chinese companies like Nio make it work with 2,300 swapping stations nationwide? What can companies outside China learn from the Chinese experience?

Range anxiety has been one of the most significant barriers for electric vehicle (EV) adoption among consumers. For example, if I wanted to drive a Tesla Model 3 from Paris to the famous Mont Saint-Michel, which is roughly 360 km (or 220 miles away), I would need to carefully plan my route and stop at one of Tesla's Supercharger stations near Paris before heading east, as there are simply no other Supercharger stations along the way.

Despite the EV sales drop across the world (except China), increased EV adoption is still one of the most important options of energy transition to combat global warming. How can EV companies address consumers' range anxiety to allow for a better travel experience and further fuel sales?

One direction is to improve battery technology, including faster charging batteries and those with longer driving range. As of 2023, long-range batteries can push north of 350 miles on a single charge, and fast charging technology can add more than 100 miles to a battery within 15 minutes. However, the push to improve battery technology is both expensive and slow.

Recently, the Chinese EV company Nio challenged the conventional approach with an interesting alternative: battery swapping. Here's how they did it.

### How Nio Made Battery Swapping Work

In 2014, a series entrepreneur in the auto industry called William Li established Nio as a Chinese domestic brand to challenge Tesla in the higher-end sports car segment. Not

long after that, Tesla opened a battery swap demonstration station at Harris Ranch in California, starting its exploration in battery swapping. But the site received little to no demand and Tesla closed it down in less than a year.

Unlike Tesla, Nio did not give up on battery swapping. Over the next eight years, it experimented with and expanded the battery-swapping approach across China and Europe. By November 2023, Nio owned and operated more than 2,300 battery-swapping stations globally, including 30 in Europe.

### **Focus on service**

The battery swapping concept isn't new. The Israeli clean tech company Better Place developed it as early as 2007. By 2015, Tesla had demonstrated the possibility of swapping a battery within two minutes.

What Nio managed to do differently was to invest in creating a seamless experience that could make the practice appealing to customers. When a driver enters their automated station, the station will connect directly to the vehicle, drive and park it at the platform, have the depleted battery be dropped out from the bottom of the vehicle and replaced it with a fully charged battery while charging the user's account — all within three minutes. The driver doesn't even need to control or step out of the car.

### **Build a subscription for batteries**

Since launching its first commercial SUV, called Nio ES8, Nio has differentiated itself from other EV makers by offering a battery subscription model. (For its electric vehicle Zoe, the French automaker Renault used to have battery rental services as a revenue model. It provided a good piece of evidence that consumers are open to such models in order to reduce upfront payment and that rental helps with adoption.)

For Nio vehicle owners, they can choose from different tiers of subscription services and lease batteries based on their expected usage. This battery-as-a-service (BaaS) model has many advantages for consumers. First, Nio users enjoy the reduced risk of owning a default battery, and a lowered price of the initial purchase. Because the battery pack accounts for nearly one third of the cost of owning an EV. Second, there is guaranteed battery quality, as the batteries are regularly inspected and maintained by the company. Third, users purchasing Nio's battery subscription get to upgrade to the latest generation of the technology, and worry nothing about end-of-life hassles.

This business model innovation does not only accelerate adoption of the new technology, but also help address some key bottlenecks of the new industry. While western companies often focus primarily on technological innovations, Chinese EV firms including Nio keep consumers' needs at the central of their strategy to create a competitive edge among fierce domestic competitions. This lesson could be valuable as incumbent firms explore new strategic directions.

### **Pick the right infrastructure network**

To establish its battery-swapping station network, Nio examined the needs of its users and asked one essential question: What are the heaviest use cases for battery swap?

They found that users want battery swapping when long hours of intensive driving exacerbate range anxiety, or when spending a long time charging is simply not practical. As a result, the company built stations in major highways, and densely populated metropolitan locations.

In 2023, China reported a 26% EV share of the country's total auto sales. Yet such volume's charging needs are hardly fulfilled: a residential building with 30 to 50 floors in China's big cities may only have a handful of charging stations.

The situation is worse for independent drivers offering taxi or ride-sharing services. EV batteries generally hold a charge for only four to six hours. Taxi companies may have the financial power to rotate their fleet, but independent drivers would have to stop and charge for an hour or more during the day.

Battery swapping can significantly reduce this time and prevent revenue loss when waiting around. In addition, the price is comparable to charging at a supercharging station or a public charger. So swap stations in densely populated urban areas are greatly appreciated.

Beyond metropolitan areas, Nio also built stations along the busiest highways in China, such as the G2 expressway between Beijing and Shanghai. The project nearly doubled the total number of the company's battery-swapping stations to more than 1,300 across 31 provinces in China.

This strategy to center on high-usage sectors and areas paid off handsomely in terms of user usage. Nio reached over 15 million swaps by December 2022, with about 40,000 daily swaps on average.

Nio was not alone in this expansion strategy. In Taiwan, an electric scooter company Gogoro had built a network of 2,000 GoStations that handle 265,000 daily swaps in major cities by 2021. By 2022, they had expanded into three cities in mainland China, with 250 swapping stations.

Beyond the product, EV companies in the U.S. and Europe can also work on the supporting infrastructure. An examination of the car sales data across countries reveals that countries invested in charging infrastructure, such as the Netherlands, Norway, and China, saw a continued EV share increase, while EV sales plateaued in others.

The European Union has set aggressive target for EV transition by 2035. A successful implementation of that goal will partially depend on the supporting infrastructure in the member nations.

### **Collaborate with energy players**

EV charging adds pressure to electricity production, distribution and storage. To prevent potential problems, Nio has partnered with electricity producers and grid operators in China, including Anhui Province Energy Group Company Limited and China Southern Power Grid.

Besides optimizing the locations of Nio charging stations, these collaborations aim to improve relevant smart solutions to charge the batteries at off-peak times, store the electricity and supply it back to the grid during peak periods – all without any human intervention.

### **Challenges Nio Still Needs to Overcome**

Despite the impressive expansion so far, it remains too early to confirm Nio's success in battery swapping. Better Place – which went bankrupt in 2013 – and Tesla offer vivid examples that challenge the viability of the battery-swapping model.

Although battery swap makes upgrades more convenient and less costly, it can increase other costs. For example, when new technology breaks through, Nio may need to hold inventories of multiple generations of batteries. And EV companies better keep their battery designs across multiple generations compatible with the chassis of the vehicle. So far, Gogoro managed to maintain the shell design of its batteries consistent while upgrading the internal components. In the short term, Nio may be safe on this front. Additionally, charging the drained batteries and managing real-time demand can be costly. How many fully charged batteries should a charging station hold to deal with peak demand? While Nio's digital system can provide visibility into the inventory availability, there's still work to do on real-time logistic support.

Another issue is that higher returns on capital expenditure and operating costs spent on swapping won't be possible without a common industry standard for battery design. Similar to gas stations, it is most ideal for battery-swapping stations to serve multiple brands and vehicles. However, it is far from easy to establish this standard as proprietary battery technology is the battlefield for EV manufacturers and technologies are constantly updating. Nio has made some progress by securing agreements with fellow manufacturers like Chang'an Automobile, Geely, JAC and Chery Automobile. It has also formed a strategic partnership with battery maker CATL.

Finally, forging partnerships with gas stations can be challenging because of conflicting interests between the parties (yet still cheaper than building your own battery swap stations along the highway). The rise of EVs has prompted many gas stations to install Level 3 EV chargers. The logic seems natural. A 60-minute charge is even better than a 10-minute gas refill, when the driver spends more money on purchasing beverage and snacks. A battery swap without the driver getting out of the car may do just the opposite.

However, in 2021, Shell announced a strategic partnership with Nio to improve battery-swapping technologies, open Shell Recharge Solutions to Nio users in Europe and work together on co-branded pilot sites for battery swapping. So traditional players will need to find an optimal balancing point between attracting EV companies' users and maximizing own profits during their transition to renewable energies.

Despite these hurdles, Nio's early success in battery swapping so far provides a meaningful complement to the dominant business models of most EV brands, namely battery ownership and super charging. Battery swap directly addresses range anxiety and allows a company to claim their follower segments, but not without increasing costs involved in technology upgrades and demand-supply operations. On December 17, 2023, Nio's CEO William Li completed a test drive for their latest large-capacity battery — a 150-kWh semi-solid-state battery pack, which offers a range of 1,055km, or 655 miles. The ultra-capacity pack will likely require a longer charging time. Perhaps Nio will continue to prove the use cases for battery swap.

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