
The Chinese EV Company That Made Battery Swapping Work



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Automotive company Nio's battery-swapping technology offers a viable alternative to charging stations.

Range anxiety has been a significant barrier to electric vehicle (EV) adoption among consumers. For instance, if I were to drive a Tesla Model 3 from Paris to the famous Mont Saint-Michel, I would need to carefully plan my 360-kilometre route and charge the vehicle near Paris before heading east, as there are no other Tesla Supercharger stops along the way.

Despite Tesla's popularity, its charging networks simply cannot match the number of petrol stations for internal combustion engine (ICE) vehicles. How can EV companies fuel sales by better addressing consumers' range anxiety and providing a better travel experience?

One solution is battery technology, including faster charging and longer driving range. As of 2023, long-range batteries can push north of **560 kilometres** on a single charge, and fast charging can add more than **160 kilometres** to a battery within 15 minutes. However, improving battery technology is both expensive and slow.

The recent rise of **Chinese EV company** Nio challenges the conventional approach with an interesting alternative – battery swapping. Could this technology address range anxiety and increase EV uptake? This piece examines the key success factors for battery swapping and explains how Nio makes the technology work in China.

Making battery swapping work

In 2014, automotive veteran William Li established Nio as a Chinese domestic brand to challenge Tesla in the higher-end sports car segment. Tesla debuted a battery swap station at Harris Ranch in California, United States, in 2015, starting its exploration in battery swapping. But this demonstration site saw little to no demand and was eventually shuttered in 2016.

Unlike Tesla, Nio did not give up on the technology. Over the next eight years, it pursued a multi-stage strategy to experiment with and expand the battery-swapping approach in China and Europe. By November 2023, Nio owned and operated **more than 2,300** battery-swapping stations globally, including **30 in Europe**.

How did Nio achieve this scale in such a short period of time? For starters, it invested in creating a **superior customer experience**. The company claimed it could achieve a fully automated swap in just one minute. Nio's unique chassis system allows the entire battery pack to be removed from the bottom of the vehicle and replaced.

This concept isn't new. Better Place, one of the first EV battery charging and swapping service companies, developed it as early as 2007. By 2015, Tesla had already demonstrated the possibility of swapping a battery within two minutes.

What Nio did differently was to satisfy consumers' needs by building an integrated experience beyond the battery swap. When a driver arrives at the automated facility, the vehicle will be conveyed to a designated station for the battery replacement and the driver's account will be charged for the service – all within three minutes without the driver even stepping out of the car.

Nio has also created a unique business model. Since launching Nio ES8, its first commercial SUV (sports utility vehicle), the company has differentiated

itself from other EV makers by offering a battery **subscription model**. As the battery accounts for nearly one-third of the cost of owning an EV, setting this cost apart from the main vehicle significantly lowers the initial purchase price. This makes Nio's offering more appealing than the that of higher-end EVs.

Customers can select from the different tiers of the subscription service and lease the batteries based on their expected usage. This BaaS (battery-as-a-service) model offers many advantages. Nio users enjoy guaranteed battery quality with reduced risks of failure, since the batteries are regularly inspected and maintained by the company. Users also get upgrade offers to the latest generation of the technology, and don't have to concern themselves with end-of-life disposal hassles.

To establish its battery swap station network, Nio has focused on high-usage sectors and high-volume locations. It examined the needs of its users and asked one essential question: What are the use cases with the greatest need for battery swap? Its conclusion was situations where long hours of driving exacerbates range anxiety, or when spending a long time charging the battery is simply not practical. As a result, Nio built stations in densely populated metropolitan locations, as well as along major highways connecting these areas.

In Chinese cities, residential buildings with 30 to 50 floors may only have a handful of charging stations, which makes overnight charging impractical and anxiety-inducing. The situation is worse for independent drivers offering taxi or ride-sharing services in major cities. EV batteries generally hold a charge for only four to six hours, which is insufficient to complete an 8- to 10-hour shift. Taxi companies are able to rotate their fleet for charging, but independent drivers would have to stop and charge for an hour or more during the day.

Battery swapping can significantly reduce the time and potential revenue lost. In addition, **the price** is comparable to charging at a super-charging station or a public charger. For the Nio EL6, a 100-kWh battery pack costs **€30 per swap** after the first four free swaps included in the subscription.

Beyond metropolitan areas, Nio focuses on China's busiest highways. Its first target was the G4 expressway connecting Beijing with Shenzhen and Hong Kong, where Nio constructed 18 battery-swapping stations in **14 locations**. It then built stations along the G2 expressway between Beijing and Shanghai

in less than three months, and nearly doubled its total number of battery-swapping stations to over 1,300 across all 31 provinces in China. Its strategy paid off handsomely. Nio reached over 15 million swaps by December 2022, with an estimated **40,000 daily swaps** on average.

Nio was not alone in this expansion strategy. In Taiwan, Gogoro, an electric scooter company, provides a similar battery-swapping plan in large cities. By 2021, it had built a network of 2,000 GoStations that handle **265,000 daily swaps**. By 2022, Gogoro had expanded into three cities in mainland China, with 250 battery-swapping stations for e-scooters.

EV charging adds pressure to electricity production, distribution and storage. To establish its network of battery-swapping, super-charging and charging stations, Nio has **partnered** with many electricity producers and grid operators, including Anhui Province Energy Group Company Limited and China Southern Power Grid. Besides optimising charging station locations, the collaborations focus on improving EV battery technologies for smart solutions. The latter can charge batteries at off-peak times, store electricity and supply it back to the grid during peak periods – all without any human intervention.

The challenges that lie ahead

Despite the impressive expansion so far, it is too early to cement Nio's success. Better Place and Tesla offer vivid examples that challenge the viability of the battery-swapping model.

Although battery swaps make battery upgrades more convenient and less costly, it can increase other costs, including the need to keep all battery designs across multiple generations compatible with the old vehicle chassis. When new technology breaks through, the company needs to hold inventories of multiple generations of batteries. So far, Gogoro has managed to maintain the shell design of its batteries consistent while upgrading the internal components. For now, Nio may be safe on this front.

Charging drained batteries and accurately meeting real-time demand is another challenge. How many fully charged batteries should a charging station hold to cope with peak demand? While Nio's digital system provides visibility into inventory availability, there's still work to do on real-time logistical support.

A further challenge Nio faces is that a common industry standard is needed to generate higher returns on capital expenditure and operating costs. Similar to petrol stations, it is ideal for battery-swapping stations to serve multiple brands and vehicles. But it's far from easy to establish this standard as proprietary battery technology is the battlefield for EV manufacturers. Nio has made progress by securing agreements with Changan Automobile, Geely Holding, JAC Motors and Chery Automobile. It has also formed a strategic partnership with battery maker [CATL](#).

Finally, forging partnerships with petrol stations may be challenging, albeit still cheaper than building your own battery swap stations along the highway. The rise of EVs has prompted many petrol stations to install Level 3 EV chargers. The logic seems natural. A 60-minute charge is even better than a 10-minute petrol refill in generating additional revenues in food, beverages and snacks. A battery swap without the driver getting out of the car may do just the opposite.

Traditional players must find an optimal point between attracting EV companies' users and maximising their profits during their transition to renewable energies. As an example, in 2021, [Shell](#) announced its strategic partnership with Nio to improve battery-swapping technologies, opening Shell Recharge Solutions to Nio users in Europe and working together on co-branded pilot sites for battery swapping.

Despite various hurdles, Nio's success so far provides a meaningful complement to the dominant business model of most EV brands, namely battery ownership and super charging. Battery swaps directly address range anxiety and allow Nio to claim their follower segments.

In December 2023, Li, Nio's CEO, completed a test drive of their ultra-large-capacity battery - a 150-kWh semi-solid-state battery pack that offers a range of 1,055 kilometres. The ultra-capacity pack will likely require a longer charging time, which could be yet another use case for Nio to prove the case for battery swap.

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