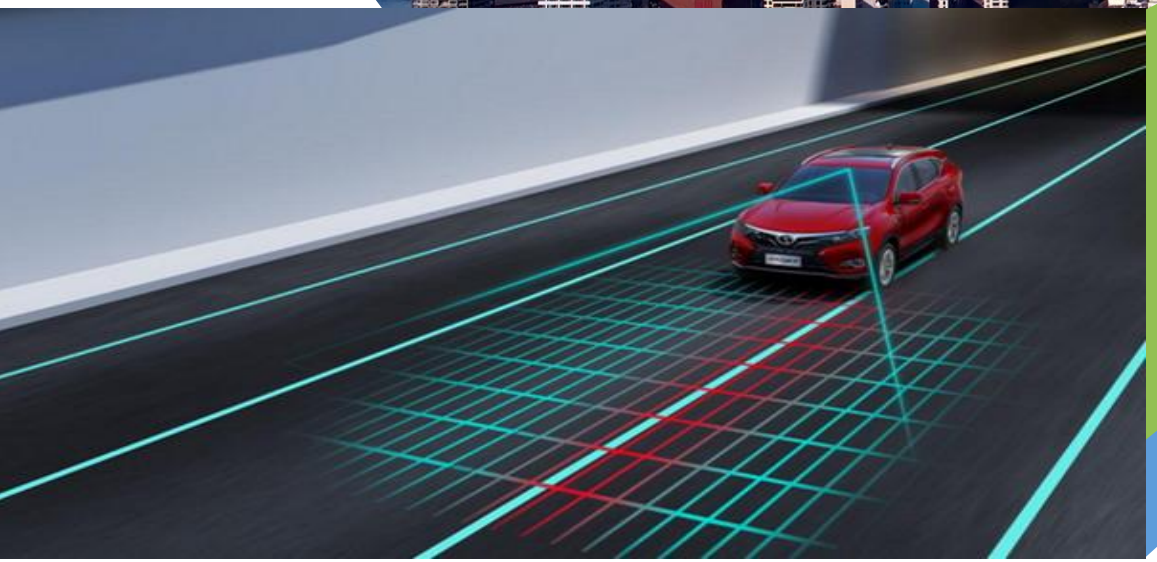

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# China Charging/Swapping (Liquid Cooling Overcharging System, Small Power, Swapping, V2G, etc.) Research Report, 2024

July 2024

# OEMs quicken their pace of entering liquid cooling overcharging, V2G, and virtual power plants

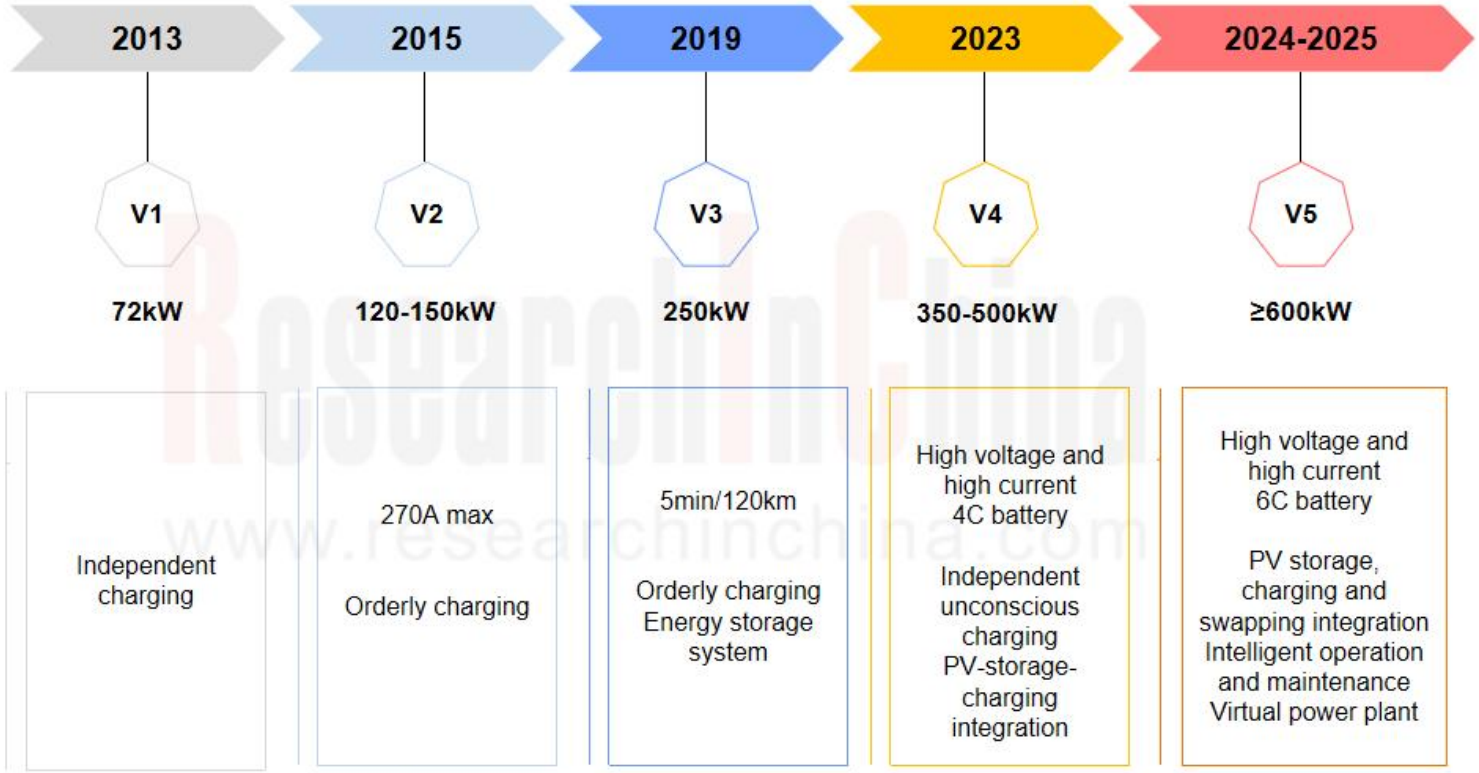
**Research on charging and swapping: OEMs quicken their pace of entering liquid cooling overcharging, V2G, and virtual power plants.**

China leads the world in technological innovation breakthroughs in electric vehicles. New technologies such as high-power liquid cooling overcharging, intelligent swapping, vehicle-to-grid (V2G), PV-storage-charging integration, and virtual power plants have become the new development trends of charging infrastructure in the next stage.

**A single liquid cooling overcharging gun features power of >480kW, and 4C-6C fast charging batteries will become standard configuration of flagship models.**

"Overcharging", namely, ultra-fast charging, uses high-power DC charging mode, reducing a lot of charging time, and can charge from 0% to 80% in 10-20 minutes or less. There are two main ultra-fast charging technology routes: high current and high voltage. The former requires thermal management technology and is difficult to implement, while the latter can reduce energy consumption and weight, increase cruising range, and save space.

## Overcharging Technology Development Roadmap




Source: ResearchInChina

# The application of liquid cooling charging technology has significantly improved the charging efficiency of vehicles

Liquid cooling technology can effectively dissipate the heat generated during charging, increase the cable transmission power, and ultimately achieve high-power charging. The application of liquid cooling charging technology has significantly improved the charging efficiency of vehicles, featuring high charging efficiency, low heat generation, high safety, and low noise.

As of now, there have been more than 2,400 >360kW stations with liquid cooling overcharging in China, but with less than 1% market share. Multiple OEMs, operators and solution providers have announced a plan to build a large-scale overcharging network:

* OEMs: NIO has deployed over 20,000 liquid cooling overcharging guns; Li Auto has put into use 600 overcharging stations; Xpeng's S4 overcharging stations have covered 100 cities;
* Operators: leading charging operators like TELD and StarCharge have released overcharging products;
* Solution providers: Huawei plans to implement more than 100,000 overcharging stations in 2024.

Comparing the configuration, charging efficiency and other parameters of overcharging stations of major OEMs, currently their overcharging stations still use the overcharging pile + fast charging pile combination. The charging power of a single overcharging gun has been higher than 480kW, even up to 800kW.

Seen from the policy orientation of local governments, a single >480kW gun is defined as an overcharging pile; in March 2024, the Development and Reform Commission of Shenzhen City and the Shenzhen Administration for Market Regulation formulated standards for the grading evaluation of overcharging equipment and the design of overcharging stations, clarifying that the rated power of a single overcharging gun should not be lower than 480kW.

## Overcharging Station Configurations of Some OEMs

| | Xiaomi Overcharging Station | Huawei Zhuzhou Fully Liquid Cooling Overcharging Station | NIO 500kW Ultra-Fast Charging Station - Anyang Service Zone | Li Auto 5C Overcharging Station | Zeekr V3 Ultra-Fast Charging Station | Xpeng S4 Liquid Cooling Overcharging Station |
|---|---|---|---|---|---|---|
| **Overcharging Technology** | 600kW liquid cooling overcharging solution | Huawei's liquid cooling overcharging technology | NIO's 500kW ultra-fast charging technology | / | / | Xpeng's S4 liquid cooling ultra-fast charging technology |
| **Overcharging Station Configuration** | Under preparation | 1 overcharging terminal<br>10 fast charging terminals | 2 500kW ultra-fast charging piles<br>2 200kW fast charging piles | 1-2 5C overcharging piles (520kW)<br>2-7 2C charging piles (250kW) | 8 800kW V3 ultra-fast charging piles | 4 480kW S4 ultra-fast charging piles |
| **Maximum Overcharging Power** | 600kW | 600kW | 500kW (660A) | 520kW (1000V, 740A) | 800kW (1000V, 8000A) | 480kW (670A) |
| **Charging Efficiency** | charge 510km in 15 minutes (Max Version 871V)<br>Charge 350km in 15 minutes (Standard Version 486V) | Charge 80% in 15 minutes | Charge from 10% to 80% in 12 minutes | Charge 500km in 12 minutes - Li MEGA | Charge from 10% to 80% in 11.28 minutes - peak power 546.4kW (95kWh measured in Zeekr 001 WE Edition) | Charge from 10% to 80% in 15 minutes<br>Charge 200km in 5 minutes |

Source: ResearchInChina

# The decline in cost of lithium battery raw materials has brought about the shift from cost orientation to performance orientation

In terms of battery, the decline in cost of lithium battery raw materials has brought about the shift from cost orientation to performance orientation. OEMs such as NIO, Zeekr and Aion have launched models with a range of 800km on market. EV range of over 800km will become the standard for flagship models.

OEMs' deployment of self-operated overcharging stations has a significant impact on the pricing strategy, sales and user experience of flagship models.

## Some 800V & Overcharging Models on Sale

| Brand | Model | Edition | Price (RMB10,000) | Battery Capacity (kWh) | EV Range CLTC(km) | Battery Type | Cell Brand | Battery Charging Time | Fast Charging Capacity (%) |
|---|---|---|---|---|---|---|---|---|---|
| EXEED | STERRA ES | STERRA ES 2025 Ultra Flagship Ultra Long Range Edition | 30.99 | 100 | 710 | LiFePO4 | CATL | Fast charging: 0.25 hours | 30-80 |
| | | STERRA ES 2025 Pro Long Range Edition | 22.59 | 77 | 680 | LiFePO4 | CATL | Fast charging: 0.15 hours | 30-80 |
| | | STERRA ES 2025 Pro Ultra Long Range Edition | 25.59 | 100 | 880 | LiFePO4 | CATL | Fast charging: 0.25 hours | 30-80 |
| | | STERRA ES 2025 Pro Urban Intelligent Driving Long Range Edition | 24.69 | 77 | 680 | LiFePO4 | CATL | Fast charging: 0.15 hours | 30-80 |
| | | STERRA ES 2025 Pro Urban Intelligent Driving Ultra Long Range Edition | 27.69 | 100 | 880 | LiFePO4 | CATL | Fast charging: 0.25 hours | 30-80 |
| | | STERRA ES 2025 Pro 4WD Long Range Edition | 24.69 | 77 | 605 | LiFePO4 | CATL | Fast charging: 0.15 hours | 30-80 |
| LUXEED | LUXEED S7 | LUXEED S7 2024 Pro RWD Long Range Edition | 24.98 | 82 | 705 | Ternary lithium + LiFePO4 | Jiangsu Contemporary Amperex | Fast charging: 0.25 hours | 0-80 |
| | | LUXEED S7 2024 Max RWD Long Range Intelligent Driving Edition | 26.98 | 82 | 705 | Ternary lithium + LiFePO4 | Jiangsu Contemporary Amperex | Fast charging: 0.25 hours | 0-80 |
| | | LUXEED S7 2024 Max+ RWD Ultra Long Range Intelligent Driving Edition | 29.98 | 100 | 855 | Ternary lithium + LiFePO4 | Jiangsu Contemporary Amperex | Fast charging: 0.25 hours | 0-80 |
| | | LUXEED S7 2024 Max RS 4WD Performance Edition | 32.98 | 82 | 630 | Ternary lithium + LiFePO4 | Jiangsu Contemporary Amperex | Fast charging: 0.25 hours | 0-80 |
| | | LUXEED S7 2024 Ultra 4WD Flagship Edition | 34.98 | 100 | 751 | Ternary lithium | Jiangsu Contemporary Amperex | Fast charging: 0.25 hours | 0-80 |

Source: ResearchInChina

# Battery structure innovation and process optimization continue to improve system specific energy

Battery structure innovation and process optimization continue to improve system specific energy:

- There is still potential for diversity in cell structure designs, for example: (1) CALB's "top-class" cylindrical cell; (2) CALB's One-Stop square cell; (3) EVE Energy's cylindrical π battery system; (4) ZENERGY's Qiankun battery system.
- Large modules and CTP continue to iterate, over 10,000-ton integrated die-casting is introduced into battery trays, CTB technology optimizes battery volume utilization, and mass production of large cylindrical batteries speeds up.

## 4C-6C Fast Charging Battery Layout of Some Suppliers

| Charging Rate | Battery Brand | Fast Charging Battery | Material Type | Cell Energy Density | Applied Model(s) |
|---|---|---|---|---|---|
| 4C | CATL | 4C Qilin Battery | Ternary/LiFePO4 | 255Wh/kg - ternary cell<br>160Wh/kg - LiFePO4 | AITO M9 BEV Edition, Zeekr 009, Li Auto, Chery EXEED STERRA ES, Zeekr 001 FR, Zeekr 007, Xpeng X9, etc. |
| | | 4C Shenxing Superfast Charging Battery | LiFePO4 | 205Wh/kg | Neta Auto |
| | BYD | Blade Fast Charging Battery | LiFePO4 | 180Wh/kg | Hiace |
| | CALB | 4C Square Battery | LiFePO4 + medium nickel high voltage ternary lithium | - | - |
| | SVOLT Energy | 46950 Cylindrical Battery | High nickel ternary + graphite system | 300Wh/kg | - |
| | | Dragon Armor Battery | High voltage medium nickel ternary | 220Wh/kg | Cover 1.6C~6C fast charging systems |
| | EVE Energy | 46 Series Large Cylindrical Battery | Nickel + silicon carbon material system | 350Wh/kg | JAC Refine RF8, Changan NEVO |
| | Sunwoda | Flash Charging Battery | LiFePO4 | 235Wh/kg | Xpeng G9 |
| 5C | CATL | 5C Qilin Battery | Ternary lithium | 255Wh/kg | Li MEGA |
| | | 5C Shenxing Superfast Charging Battery | - | - | Zeekr 001 |
| 6C | EVE Energy | Omnicell | - | 266Wh/kg-292Wh/kg | - |
| | CALB | "Top Class" 46 Series Cylindrical Battery | High nickel ternary + graphite system | 300Wh/kg | SOP in 2024Q4 |
| | Farasis Energy | SPS Battery | | 330Wh/kg | 2.2C-6C |
| | Sunwoda | 3rd Generation Flash Charging Battery 3.0 | - | - | - |
| | REPT BATTERO | Wending Ternary Battery | Lithium iron, ternary medium nickel, high nickel | - | Under testing |
| | CATL | CATL will launch a power battery with charging rate of 6C, which is the second-generation product of Qilin Battery. | | | |
| | BYD | BYD's 6C battery is under development. | | | |
| 8C | Greater Bay Technology | Phoenix Battery | - | 260Wh/kg | SOP and installation in 2025 |
| | BAK Battery | Full-tab 2170-55B Battery Cell | - | 300Wh/kg | - |

Source: ResearchInChina

# The fully liquid cooling charging piles put into operation on the market deliver the maximum single-gun power of 600-800kW

At present, the fully liquid cooling charging piles put into operation on the market deliver the maximum single-gun power of 600-800kW, still far from the limit of ultra-fast charging. According to GB/T20234.1-2023 Connection Set of Conductive Charging for Electric Vehicles - Part 1: General Requirements, a new national standard for new energy vehicle charging guns, which was issued and took effect in September 2023, this document applies to DC charging connection sets with rated voltage not higher than DC1500V and rated current (continuous maximum operating current) not higher than 1000A. This means that when the technology is mature, overcharging piles can achieve the maximum charging power of 1500kW.

From another perspective, OEMs still need to face the status quo that at present the existing charging piles with <250A charging current sweep as high as 98% and the >400A overcharging piles account for less than 1%. To solve the problem of limited charging speed caused by the current limit of public DC charging piles, BYD has explored another more cost-effective overcharging technology route.

New BYD Hiace 07 EV is equipped with an 800V vehicle voltage platform and the e-platform 3.0Evo, the world's first intelligent current-boosting fast charging technology. Hiace 07 EV packs voltage-boosting (pile-to-vehicle) and current-boosting (vehicle-to-blade battery) technologies. Based on voltage-boosting charging, the current-boosting charging technology gets upgraded, breaking the 250A current limit at the pile end and achieving maximum current of 400A at the vehicle end. Under any voltage platform, the maximum capacity of GB15 standard-compliant public DC charging piles in the existing charging networks will be brought into full play.

1. Voltage boosting: As the basic technical point of BYD's traditional high-voltage platform solutions, the rated voltage of 550V is boosted to over 700V, meeting the charging requirements of 180-240KW;
2. Current boosting: The new technology uses a high-voltage electronic control system to boost the pile-to-vehicle charging current from 250A to 400A at the blade battery end, meeting the charging requirements of 180-240KW.

# For vehicle-to-grid (V2G), OEMs set foot in the electricity sales side reform and virtual power plants, and explore business models.

**For vehicle-to-grid (V2G), OEMs set foot in the electricity sales side reform and virtual power plants, and explore business models.**

On January 4, 2024, the National Energy Administration issued a programmatic document on vehicle-to-grid (V2G), the "Implementation Opinions of the National Development and Reform Commission and Other Ministries and Commissions on Strengthening the Integration and Interaction between New Energy Vehicles and Power Grids". This document is a programmatic document for launching V2G at the national level, suggesting that V2G is officially launched as a national project, and the corresponding implementation rules and pilot plan documents will be issued subsequently.

The document is aimed at governments at all levels and power grid systems, and indicates China's intention of promoting V2G through power grids first. The document proposes a technology roadmap for implementation of V2G.

According to the document, V2G can be divided into two stages: orderly charging, and bidirectional charging and discharging.

**Orderly charging** is to reduce the load pressure on power grids caused by large-scale fast charging of vehicles, by way of dynamically adjusting the charging time and power according to the actual power demand of users, and shaving peaks and filling valleys.

**Bidirectional charging and discharging** is to give full play to the energy storage capacity of electric vehicle batteries, provide flexible adjustment capabilities for power grids through reverse power transmission to the power grids, and ensure the balance between social power supply and demand.

According to the policy document, before 2025, large-scale orderly charging should be achieved, and bidirectional charging and discharging should be initially verified through pilot projects; by 2030, large-scale application of bidirectional charging and discharging should be achieved and the adjustment capabilities of V2G should be fully utilized.

# OEMs are also stepping up deployment of V2G technology and exploration of business models

**OEMs are also stepping up deployment of V2G technology and exploration of business models.**

**NIO:** Virtual peak-shaving unit + virtual frequency regulation unit provides flexible adjustment capabilities.

As energy storage equipment, a battery swap station can naturally become a "virtual power plant". Since the construction of the second-generation station in 2022, NIO has been working to achieve the energy storage attribute of battery swap stations.

In February 2024, NIO Power and China Southern Power Grid Energy Storage signed a framework cooperation agreement. Their cooperation involves virtual power plants, battery swapping services, and battery cascade utilization and recycling, providing peak shaving, frequency regulation and demand-side response services to the society and making them distributed energy equipment.

On January 9, 2024, NIO rolled out the first 10 V2G pilot charging piles in total, with 36 piles distributed in Shanghai. Users can use these V2G pilot charging piles for reverse discharge to power grids.

**Volkswagen:** with CAMS, piloted a sequential charging (V1G) project in the Beijing-Tianjin-Hebei region.

Volkswagen Group China and CAMS jointly initiated a sequential charging (V1G) project in the Beijing-Tianjin-Hebei region. The self-built sequential charging control and management platform is used to connect to State Grid's electric vehicle supervision platform; CAMS charging equipment with V1G sequential charging technology is used to respond to and manage the sequential charging of electric vehicle owners recruited in the pilot project, in accordance with the grid control instructions.

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