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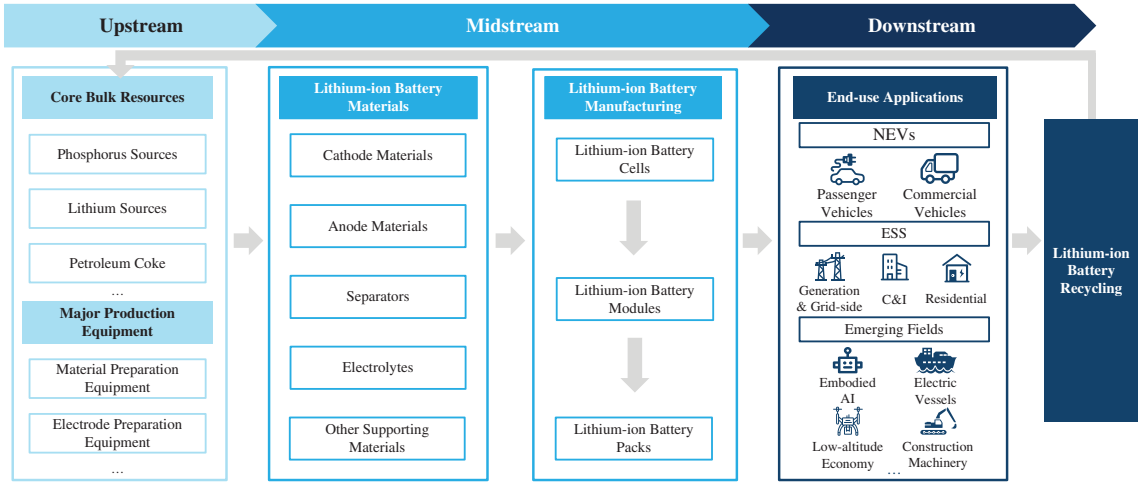
OVERVIEW OF THE GLOBAL LITHIUM-ION BATTERY INDUSTRY

Development Status of Global Lithium-ion Battery Industry

As the core cornerstone of the global green energy transition, the lithium-ion battery industry comprehensively leads the low-carbon transformation of transportation and power. Its core application scenarios focus on power batteries, energy storage batteries, and other emerging fields. As lithium-ion battery shipments enter the TWh era, the industry is simultaneously ushering in a new stage characterized by the surge in demand for high-end production capacity and qualitative leap. In the development path of market technologies, lithium-ion batteries primarily include LFP batteries, ternary lithium-ion batteries, and other lithium-ion batteries. Among them, LFP batteries possess advantages such as long cycle life, high safety, and high cost-effectiveness, occupying the majority markets of the mass-market passenger vehicle, commercial vehicle, and energy storage applications. With the improvements of new products in energy density and fast-charging technologies, traditional performance shortcomings have been successfully overcome, driving LFP batteries to accelerate their penetration into the traditional stronghold of ternary lithium-ion batteries, resulting in a steady increase in market share. In 2025, LFP batteries accounted for 67.8% of global lithium-ion battery shipments. In the future, with the expanding demand in downstream lithium-ion battery terminal application scenarios, the demand for cathode materials — which account for the highest proportion of costs among the core main materials of lithium-ion batteries — will expand synchronously. Among them, the shipment volume of phosphate-based cathode materials, which are the most core components with a continuously increasing penetration rate, will experience rapid growth. The following diagram illustrates the full industry chain segments of lithium-ion batteries:

Global Lithium-ion Battery Industry Chain Diagram



Source: Frost & Sullivan

Meanwhile, based on application scenarios, the technological evolution of lithium-ion batteries is focusing on three core development scenarios:

- As the core power source for passenger and commercial NEVs, power batteries are comprehensively entering the era of extreme-speed energy replenishment and flash charging. The deep synergy between extreme-speed energy replenishment networks and large-capacity power batteries significantly reduces energy replenishment frequency, eliminates users' dual anxiety regarding mileage and energy replenishment time, and optimizes the NEV travel experience. According to data from the China Association of Automobile Manufacturers (CAAM), the per vehicle battery capacity for passenger NEVs and commercial NEVs in China increased from 37.8 kWh and 128.5 kWh in 2020 to 46.1 kWh and 162.4 kWh in 2025, respectively, and is expected to further rise to 66.9 kWh and 181.7 kWh in 2030. The increase in battery capacity per vehicle and the application of 6C and above high-rate fast-charging technologies will drive the R&D of power batteries to focus more on the balance among energy replenishment efficiency per vehicle, battery cycle life, safety, and battery cost. In addition, the global NEVs industry is still in a high-speed growth cycle with significant market increment and potential; it is expected that the penetration rates of global passenger and commercial NEVs will grow from 29.5% and 5.6% in 2025 to 50.4% and 20.5% in 2030, respectively.

- The core applications of energy storage batteries include power generation side, grid side, commercial and industrial (C&I), and residential scenarios. While the overall energy storage industry is growing rapidly, the wave of large battery cells is emerging to adapt to scenarios demanding high system efficiency, safety, and economic efficiency, such as long-duration energy storage of 4 hours or more for ESS and AI data centers. According to data from China Energy Media Group, the average energy storage duration of electrochemical energy storage in China has increased from less than 2.0 hours in 2020 to over 2.5 hours in 2025; with the accelerated grid integration of renewable energy and the surging demand for power from emerging computing power infrastructures such as AIDC, the average energy storage duration is expected to further increase to nearly 3.5 hours in 2030. Among them, large-capacity battery cells of 500Ah and above have been mass-produced on a large scale, increasing capacity per unit of battery materials significantly promotes cost reduction, efficiency enhancement, and safety upgrades for large-capacity and large-scale ESS, driving the demand for lithium-ion batteries with features of long cycle life, high safety, and high cost-effectiveness.

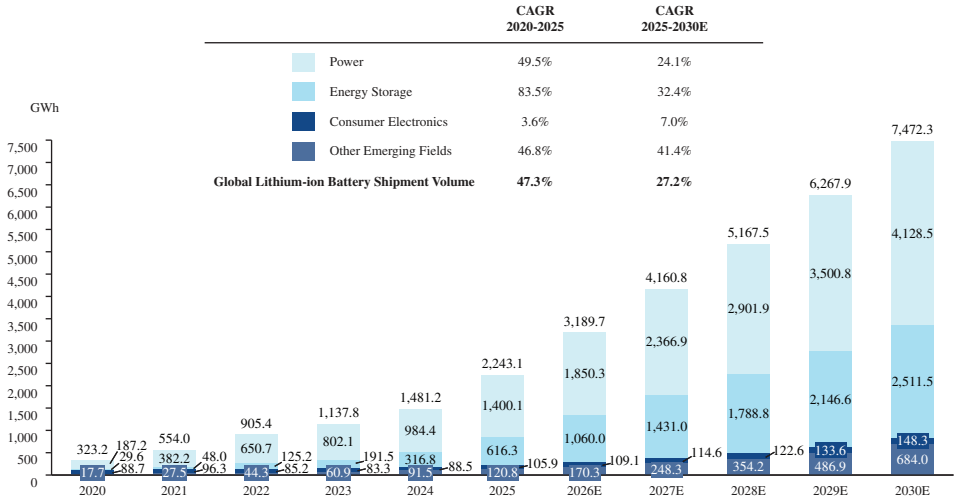
- Other emerging fields cover downstream applications such as embodied AI, electric vessels, low-altitude economy, construction machinery, forklifts, and light vehicles (such as electric two-wheelers). Market demand presents a trend that the stock conversion of traditional applications and the increment of emerging scenarios experience mutual growth.

Market Size Analysis of Global Lithium-ion Battery

The downstream NEV and energy storage industries continue to inject strong growth momentum into the lithium-ion battery market. Therefore, the global shipment volume of lithium-ion batteries increased from 323.2 GWh in 2020 to 2,243.1 GWh in 2025, representing a CAGR of 47.3% during the period, and is expected to further grow to 7,472.3 GWh by 2030, representing a CAGR of 27.2% from 2025 to 2030.

By applications, power batteries represent the largest application sector, primarily driven by the increasing penetration of global NEVs and stock replacement. The shipment volume is expected to increase from 1,400.1 GWh in 2025 to 4,128.5 GWh in 2030, representing a CAGR of 24.1% during the period. Driven by the increasing proportion of renewable energy integrated into the grid and the surging demand for AIDC energy storage, the shipment volume of energy storage batteries is expected to increase from 616.3 GWh in 2025 to 2,511.5 GWh in 2030, representing a CAGR of 32.4% during the period. Meanwhile, the shipment volume of lithium-ion batteries in other emerging fields is expected to grow rapidly from 120.8 GWh in 2025 to 684.0 GWh in 2030, representing a CAGR of 41.4% during the period.

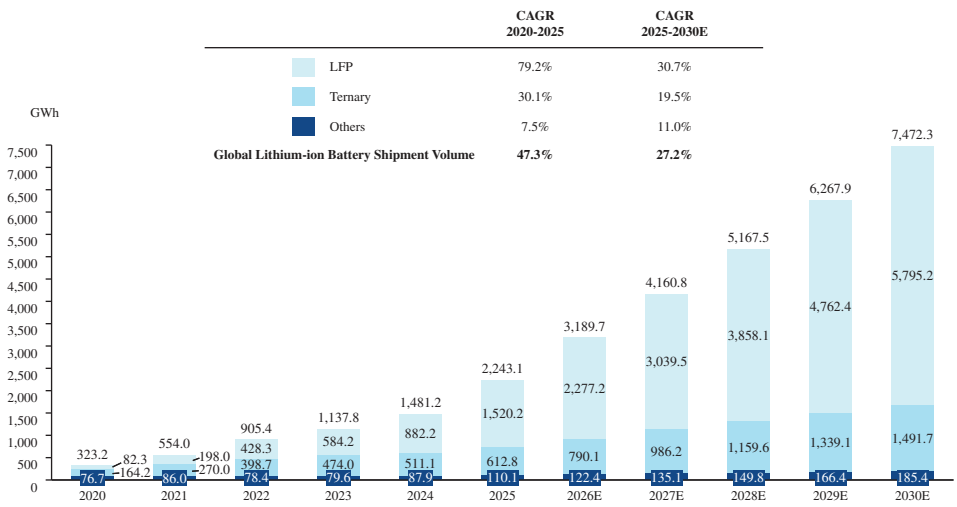
Global Shipment Volume of Lithium-ion Batteries, Breakdown by Power, Energy Storage, Consumer Electronics and Other Emerging Fields, 2020-2030E



Source: International Energy Agency (IEA), BloombergNEF, Frost & Sullivan

By technical routes, LFP batteries have become the dominant technical route for lithium-ion batteries globally. Driven by their increasingly prominent advantages in safety, cycle life, and cost, the shipment volume of LFP batteries surged from 82.3 GWh in 2020 to 1,520.2 GWh in 2025, and is expected to further grow to 5,795.2 GWh in 2030, representing a CAGR of 30.7% from 2025 to 2030. Their share of the global lithium-ion battery shipment volume rapidly increased from 25.5% in 2020 to 67.8% in 2025, and is expected to further increase to 77.6% in 2030.

Global Shipment Volume of Lithium-ion Batteries, Breakdown by LFP, Ternary and Other Lithium-ion Batteries, 2020-2030E



Source: IEA, Shanghai Metals Market (SMM), Frost & Sullivan

Note: LMFP batteries are categorized under the LFP battery system; semi-solid-state batteries adopt the LFP or ternary lithium-ion battery systems, and therefore their shipment volumes are included in the statistics of the corresponding technical routes; all-solid-state batteries (such as lithium-rich manganese-based batteries) are calculated separately in the other lithium-ion batteries category.

The technical route of global power lithium-ion batteries has shifted from early dominance of ternary lithium-ion batteries to a core technical path focused on LFP batteries. The global shipment volume of LFP power batteries surged from 46.8 GWh in 2020 to 849.9 GWh in 2025, representing a CAGR of 78.6% during the period, and is expected to further grow to 2,786.7 GWh by 2030, representing a CAGR of

26.8% from 2025 to 2030, continuing to consolidate its dominant position. The proportion of LFP batteries in the global power lithium-ion battery shipment volume surged from 25.0% in 2020 to 60.7% in 2025, and is expected to reach 67.5% in 2030.

In the field of global energy storage lithium-ion batteries, continuously driven by the ESS demand for long cycle life, high safety, and high cost-effectiveness, LFP batteries have long remained as the mainstream technical route. From 2020 to 2025, the shipment volume of LFP energy storage batteries increased from 27.5 GWh to 597.8 GWh, representing a CAGR of 85.1% during the period. It is expected that by 2030, the shipment volume of LFP energy storage batteries will further grow to 2,461.3 GWh, representing a CAGR of 32.7% from 2025 to 2030, and the proportion of LFP batteries in energy storage lithium-ion batteries will reach approximately 98.0% in 2030.

From a regional perspective, China will continue to be the world's largest lithium-ion battery market, and lithium-ion battery shipments in China are expected to increase from 1,501.4 GWh in 2025 to 4,585.5 GWh in 2030, representing a CAGR of 25.0% during the period. Meanwhile, driven by the growth in demand for NEVs and ESS, as well as the construction of local battery production capacity, shipments in the European and North American markets are expected to increase from 333.5 GWh and 238.4 GWh in 2025 to 1,307.7 GWh and 836.9 GWh in 2030, respectively, representing CAGRs of 31.4% and 28.6% during the period. In addition, as the global lithium-ion battery industry chain accelerates its multi-regional layout, the shipment volume of lithium-ion batteries in other regions is expected to increase from 169.8 GWh in 2025 to 742.2 GWh in 2030, representing a CAGR of 34.3% during the period.

Market Drivers and Development Trends of the Global Lithium-ion Battery Industry

Electrification of Transportation Accelerating the Demand for Power Lithium-ion Batteries

The increasing number of NEV models, the upgraded demand for intelligent automotive experiences, and the comprehensive coverage of charging and swapping infrastructure have accelerated the sales penetration of NEVs. The increase of battery capacity per NEV have further driven the continuous expansion of the global power battery market.

- **Broad growth potential in the downstream NEV market:** Global sales of new energy passenger and commercial vehicles grew rapidly from 3,125.0 thousand and 159.0 thousand units in 2020 to 22,713.0 thousand and 1,127.0 thousand units in 2025, respectively, and are expected to reach 45,578.0 thousand and 5,454.0 thousand units in 2030. The penetration rates of global new energy passenger and commercial vehicles grew rapidly from 5.3% and 0.9% in 2020 to 29.5% and 5.6% in 2025, respectively, and are expected to reach 50.4% and 20.5% in 2030.

- **Increasing number of NEV models, the intelligent transformation of automobiles and upgraded extreme-fast charging experience matching new consumer demands:** In the first half of 2026, among the newly launched models in China's passenger vehicle market, the proportion of NEVs exceeded 85% for the first time, occupying the dominant position. NEV models better facilitate intelligent experiences such as autonomous driving and smart cockpits, precisely satisfying modern consumers' core demands for in-vehicle experience and convenience. In 2025, the global penetration rate of passenger vehicles equipped with L2 and above intelligent assisted driving functions reached 45%, and it is expected to increase to approximately 80% in 2030, driving up the incremental demand in the NEV market. Further, the number of global charging and swapping infrastructure continues to increase, and the increasingly mature infrastructure configuration optimizes the energy replenishment user experience for NEVs, improving the overall economic efficiency of electrification, accelerating global demand for NEVs.

- **Increase in per-vehicle battery capacity speeding up the expansion of the power lithium-ion battery market:** According to data from CAAM, the average per-vehicle battery capacity of Chinese plug-in hybrid (including extended-range) passenger vehicles, pure electric passenger vehicles, plug-in hybrid (including extended-range) commercial vehicles, and pure electric commercial vehicles increased from 19.3 kWh, 42.3 kWh, 48.4 kWh, and 132.0 kWh in 2020 to 29.3 kWh, 56.0 kWh, 56.5 kWh, and 172.5 kWh in 2025, respectively. It is expected to further rise to 48.0 kWh, 75.0 kWh, 70.0 kWh, and 200.0 kWh in 2030. The demand for large-capacity lithium-ion batteries accelerates the expansion of the power battery market, leading the industry-wide multi-dimensional demand for the performance, safety, and cost of power batteries.

High-Proportion Integration of Renewable Energy and Exponential Expansion of Computing Power Boosting the Demand for Energy Storage Lithium-ion Batteries

Against the backdrop of the continuous advancement of the global "Dual Carbon" goals, renewable energy capacity is expanding rapidly worldwide. The implementation of China's supportive policies, such as the full market integration of renewable energy and capacity pricing mechanisms, has rapidly unleashed the demand for energy storage paired with renewable energy projects. Coupled with the explosive demand for energy storage in AIDC, these factors are jointly driving a massive surge in demand for energy storage lithium-ion batteries. Meanwhile, to enhance grid flexibility, renewable energy consumption, and regional energy security, European Union has successively introduced key policies such as REPowerEU plan and electricity market design reforms. Furthermore, other countries and regions are continuously introducing policies to actively support and drive the development of the energy storage industry.

- **The new power system fostering the rigid demand for energy storage:** The cumulative installed capacity of photovoltaics (PV) and wind power in the global energy mix increased from 4.4% in 2010 to approximately 33.4% in 2025, and is expected to reach 68.0% in 2050. Wind and PV power generation are characterized by significant intermittency and volatility, and the rapid growth of their installed scale has brought enormous regulation pressure to the stable operation of the power grid. Against this backdrop, ESS effectively address the pain points on the power generation side by virtue of their core functions such as peak shaving and valley filling, volatility smoothing, and improving new energy consumption, strengthening demand for energy storage batteries.

- **Large-scale penetration of global AIDC computing power pairing with energy storage:** As AI technology drives a continuous increase in computing power density, it has spurred the large-scale deployment of AI servers, leading to rapid growth in electricity demand from data centers. Faced with massive computing power electricity demand for carbon reduction, emission reduction, and stable operation, the comprehensive shift of AIDC towards a model of new energy power supply paired with energy storage has become a core development path to ensure data centers' extremely high requirements for continuous operation, grid stability, backup power demand, and power quality. Therefore, ESS have become critical infrastructure supporting green power supply for AIDC, realizing peak shaving and valley filling, and enhancing power supply safety. By 2030, the global shipment volume of AIDC energy storage lithium-ion batteries is expected to exceed 300 GWh.

- **Continuous improvement in the economic efficiency of energy storage accelerating large-scale application:** With the dual support of technology iteration and economies of scale, the levelized cost of storage (LCOS) over the full life cycle of ESS is expected to continue showing a significant downward trend. According to data from the U.S. Department of Energy, the global LCOS of ESS decreased from approximately US$0.099/kWh in 2020 to approximately US$0.078/kWh in 2025, and is expected to drop to approximately US$0.063/kWh in 2030. The improved economic efficiency of ESS has become a core factor driving industry growth.

Emerging Fields Generating New Incremental Growth in the Lithium-ion Battery Industry

Driven by the accelerated development in industries such as embodied AI, electric vessels, the low-altitude economy, and construction machinery, lithium-ion batteries are becoming increasingly competitive regarding to their core advantages including low-carbon attributes, high instantaneous power output, and lightweight design. Further, they are achieving price parity with traditional fuels and perfectly fulfilling the stringent power requirements of these sectors. By 2030, the global shipment volume of lithium-ion batteries across these emerging fields is projected to reach 684 GWh, signaling an explosive surge in incremental demand within the vast market.

OVERVIEW OF THE GLOBAL LITHIUM-ION BATTERY PHOSPHATE-BASED CATHODE MATERIALS INDUSTRY

Development Status of the Global Lithium-ion Battery Cathode Materials and Phosphate-based Cathode Materials Industry

Lithium-ion battery cathode materials are the core active substances that determine the energy density, safety performance, and technical route of the battery. They are also the core materials accounting for the highest proportion of cell manufacturing costs. Their technical iteration and capacity expansion directly affect the cost reduction, efficiency enhancement, and commercialization process of the power batteries and energy storage batteries. Currently, the cathode material system is mainly composed of phosphate-based and ternary cathode materials. Phosphate-based cathode materials are dominated by LFP cathode materials, and also include a small amount of LMFP cathode materials. In 2025, LFP cathode materials accounted for over 99% of the global shipment volume of phosphate-based cathode materials and

73.3% of the global shipment volume of lithium-ion battery cathode materials, having become the most widely used cathode material system globally. This primarily benefits from the comprehensive advantages of LFP batteries in terms of cycle life, safety, thermal stability, and cost, which enable their wide application in the NEVs and ESS fields.

LFP cathode materials are mainly divided into regular products and premium products. Although regular LFP cathode materials already possess characteristics such as long cycle life, relatively high safety performance and cost-effectiveness, their performance in energy density, fast-charging capability or energy efficiency is relatively moderate. Premium LFP cathode materials not only inherit these advantages, but also achieve an increased compaction density through the optimized control of particle size distribution, thereby enhancing energy density. Furthermore, through synergistic optimization and modification at the microscopic level of the material, fast-charging capabilities or energy efficiency, safety performance, and cycle life are further improved. The following chart compares the technical indicators of LFP and ternary cathode materials, which are the core lithium-ion battery cathode materials:

Comparison Chart of Core Technical Indicators Between LFP and Ternary Cathode Materials, 2025

	LFP Cathode Materials		Ternary Cathode Materials
Core Parameters	Regular Products	Premium Products	Mid and High-nickel Products
Cycle Life	Relatively Long (3,000-5,000 cycles)	Long (≥6,000 cycles; some exceeding 10,000 cycles)	Moderate
Safety	High	High	Moderate (relatively higher risk of thermal runaway)
Temperature Adaptability	Excellent performance except under low-temperature conditions	Improved low-temperature performance	Excellent performance except under high-temperature conditions
Cost-effectiveness	High	High	Moderate
Energy Density	Moderate	Relatively High	High
Fast-charging Capability	Moderate	Good	Relatively Good
Energy Efficiency	Moderate	Good	/
Compaction Density	Moderate	Relatively High	High

Source: China Battery Industry Association, China Industrial Association of Power Sources, Frost & Sullivan

Looking ahead, cathode materials are evolving towards premium and multi-material systems. Premiumization is primarily based on mature, commercialized materials; by optimizing manufacturing processes and micro-structure, the potential of these materials is fully unlocked to meet the continuously evolving and differentiated application demands in scenarios such as power and energy storage. Specifically, high-compaction-density LFP cathode materials are one of the key routes to achieve premiumization, the core value of which lies in their ability to accommodate more active materials within the same electrode volume, thereby increasing battery energy density. Simultaneously, premium LFP cathode materials will also achieve a leap in overall performance through advanced production processes and micro-level technological innovations — such as particle size distribution optimization, crystal structure regulation, carbon coating, and doping modification. These advancements enhance core metrics including fast-charging capability (for power scenarios), energy efficiency (for energy storage scenarios), cycle life, and safety performance. Premium LFP cathode materials precisely align with the rigid industry demands for long-range, fast-charging power batteries and large cells for energy storage. With the large-scale volume rollout in 2026 of power batteries equipped with ultra-fast charging capabilities and ultra-large capacity energy storage cells exceeding 500Ah, premium LFP cathode materials from leading cathode material enterprises are operating in short supply. At the same time, alongside the advancement of next-generation battery technologies, the industry is actively pioneering new material pathways. New phosphate-based cathode materials such as LMFP and NFPP, as well as other novel cathode materials compatible with semi-solid-state/all-solid-state batteries, such as high-voltage lithium nickel manganese oxide (LNMO) materials, are becoming the new direction of industry development.

Enhancing compaction density is one of the crucial directions for the premium development of LFP cathode materials, and the industry typically uses compaction density as the standard for categorizing LFP materials by generation. Currently, third-generation LFP still accounts for the majority of the market share. Generation 3.5 and fourth-generation LFP have already achieved commercial mass production, with their

market shares growing rapidly. Meanwhile, fifth-generation LFP is on the verge of entering the stage of large-scale application. The following chart illustrates the comparison of core indicators across different generations of LFP cathode materials:

Comparison of Core Indicators Across Different Generations of LFP Cathode Materials, 2025

	Compaction Density (g/cm^3)	Energy Density	Fast-charging/Energy Efficiency Requirements	Production Stage
Second Generation	~2.4	Relatively Low	None	Large-scale production; declining market share
Third Generation	~2.5	Moderate	Relatively High Requirements	Large-scale production; currently mainstream in the industry
Fourth Generation	~2.6	Relatively High	High Requirements	Large-scale production by leading enterprises
Fifth Generation	~2.7	High	High Requirements	Not yet mass-produced

Source: China Battery Industry Association, China Industrial Association of Power Sources, Frost & Sullivan

Note: The industry typically utilizes compaction density as the primary basis for categorizing LFP materials by generation. Compaction density is closely correlated with energy density; however, merely increasing compaction density does not inherently improve fast-charging performance or energy efficiency. It is also worth noting that there are products on the market tailored for specific application scenarios — such as LFP materials with modest compaction density but exceptional fast-charging capabilities — which may not strictly correspond to the characteristics outlined in the table. Furthermore, premium transitional products, such as generation 3.5 and generation 4.5, also exist in the market, falling between the distinct generations listed above.

Regarding new phosphate-based cathode materials, LMFP cathode materials are new materials developed by incorporating manganese on the basis of LFP, which can increase the operating voltage platform while maintaining the advantages of cost-effectiveness and safety. The theoretical energy density is increased by approximately 20% compared with regular LFP cathode materials. Currently, this material is gradually moving towards large-scale application. NFPP cathode materials are new materials developed on the traditional polyanion system, which can effectively solve the volume expansion problem during the sodium-ion extraction and insertion process while maintaining the advantages of high safety and low cost, thereby improving battery cycle life. Currently, this material is gradually moving towards large-scale application in the fields of ESS and light vehicles. In addition, new solid-state battery cathode materials, such as high-voltage LNMO cathode materials, refer to those utilizing nickel and manganese as the primary transition metals, featuring an operating voltage plateau significantly higher than conventional cathode materials, and combining the advantages of high energy density with a low-cost, cobalt-free composition. Currently, these materials are in the phase of industrial introduction and small-batch application.

Comparison of Manufacturing Processes of LFP Cathode Materials

As the core material among phosphate-based cathode materials, the main technical routes for the manufacturing process of LFP cathode materials include the solid-state process such as iron phosphate process, ferrous oxalate process, iron oxide process, and the liquid-phase process such as ferric nitrate process. Among them, the solid-state iron phosphate process is currently the prevailing process, accounting for over 80% of global LFP cathode material shipment volume in 2025. The solid-state iron phosphate process primarily involves mixing and grinding iron phosphate, lithium source, and carbon source, followed by high-temperature solid-state sintering under inert gas protection. During sintering, the raw materials undergo crystal phase reconstruction, ultimately generating LFP with carbon-coated surface.

Compared with the other three processes, the solid-state iron phosphate process possesses advantages such as low raw material costs, high technological maturity, and strong adaptability for large-scale production, while through the secondary sintering process, enabling the stable preparation of material systems with high compaction density and long cycle life. On the basis of cost advantages, leading enterprises further strengthen cost control capabilities and enhance batch consistency of products by establishing self-supplied raw material systems, in order to better match the demands of power batteries, energy storage batteries, and emerging fields for cost-effectiveness and large-scale supply.

In addition, against the backdrop of rapid penetration of premium LFP cathode materials, a small number of leading enterprises have achieved breakthroughs in premium preparation processes, represented by the secondary sintering solid-state iron phosphate process. Through precise control over particle quantity and size, and high-standard control over the powder handling process, this process significantly enhances the compaction density, structural stability and electrochemical performance of the materials, thereby forming relatively high process thresholds and industrialization barriers.

Industry Chain Analysis of Phosphate-based Cathode Materials

The upstream of the phosphate-based cathode materials industry chain primarily comprises core resources such as lithium, phosphorus, and iron sources, along with materials like iron phosphate and lithium carbonate formed through purification and preparation processes. Because price fluctuations of bulk resources such as lithium have significant impact on production costs, the ability to secure upstream resources and the self-production capacity of core materials have become critical factors influencing the production costs and product delivery of midstream enterprises.

The midstream of the industry chain primarily involves the R&D, preparation, and testing of phosphate-based cathode materials, with its products covering regular LFP cathode materials, premium LFP cathode materials, and other new phosphate-based cathode materials. Leading enterprises continuously optimize material formulations and upgrade production processes to improve fast-charging capability, energy efficiency, safety, and cycle life. Simultaneously, leveraging mature R&D platforms, production processes, and manufacturing systems, midstream enterprises are actively expanding into other phosphate-based cathode materials such as LMFP and NFPP to meet the demand for differentiated performance in power batteries, energy storage batteries, and other emerging fields.

The downstream of the industry chain involves lithium-ion battery manufacturing and end applications. After cell manufacturing and battery pack integration, phosphate-based cathode materials are widely applied in NEVs, ESS, and other emerging fields. With the continuous increase in the global penetration rate of NEVs and the rapid development of the global ESS market, power batteries and energy storage batteries have become the core driving forces for the growth in demand for phosphate-based cathode materials. Meanwhile, as the recycling system for spent lithium-ion batteries continues to improve, the recycling and utilization of renewable resources are gradually becoming an integral part of the industry chain, helping to enhance the utilization efficiency of key resources and driving the sustainable development of the industry.

Currently, the phosphate-based cathode materials industry is accelerating its transition towards vertical integration. Leveraging an integrated layout spanning "mineral resources — precursors — cathode materials — recycling," leading enterprises are achieving a stable and independent supply of key raw materials, effectively enhancing their cost control capabilities and resilience against cyclical fluctuations.

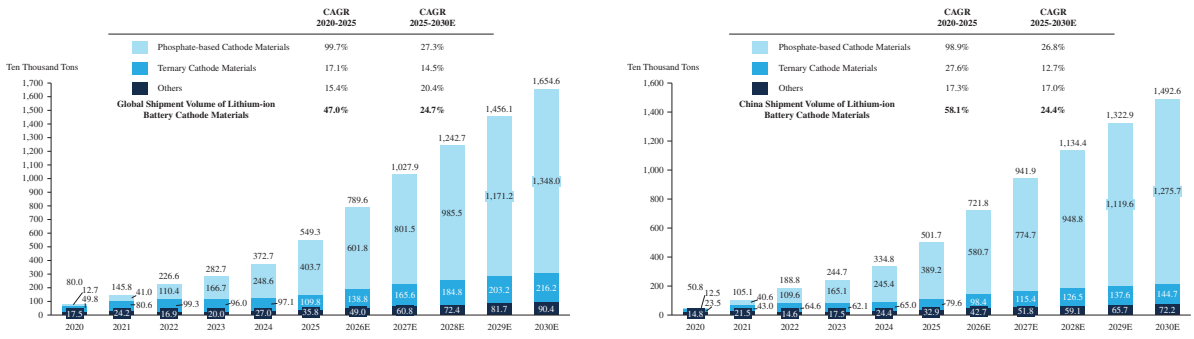
From the perspective of the global industry chain division of labor, over 95% of the global production capacity for phosphate-based cathode materials is concentrated in China as of 2025, while Chinese lithium-ion battery enterprises concurrently hold dominant position in the global market. Supported by comprehensive supply chain, large-scale manufacturing capabilities, and continuous technological iterations, leading Chinese phosphate-based cathode materials enterprises possess significant cost and competitive advantages. As China's lithium-ion battery industry continues to globalize, relevant enterprises are achieving coordinated overseas expansion of the supply chain by accompanying with the overseas presence of downstream battery manufacturers, and actively advancing the construction of overseas production capacity to accelerate global market penetration, thereby translating their locally accumulated manufacturing advantages into global competitive barriers.

Market Size Analysis of Global and China Lithium-ion Battery Cathode Materials

Driven by the growth in market demand for power and energy storage lithium-ion batteries, the global shipment volume of lithium-ion battery cathode materials increased from 800.0 thousand tons in 2020 to 5,493.0 thousand tons in 2025, representing a CAGR of 47.0%. It is expected to further increase to 16,546.0 thousand tons in 2030, representing a CAGR of 24.7% from 2025 to 2030. Among them, phosphate-based cathode materials exhibited the most significant growth relying on their balanced advantages across multiple application scenarios, and the global shipment volume of phosphate-based cathode materials is expected to increase from 4,037.0 thousand tons in 2025 to 13,480.0 thousand tons in 2030, representing a CAGR of 27.3% during the period.

China, as the core market, leads the development path of the global lithium-ion battery cathode materials industry. The shipment volume of lithium-ion battery cathode materials in China increased from 508.0 thousand tons in 2020 to 5,017.0 thousand tons in 2025, representing a CAGR of 58.1%. It is expected to reach 14,926.0 thousand tons in 2030, representing a CAGR of 24.4% from 2025 to 2030. Among them, the shipment volume of phosphate-based cathode materials in China is expected to increase from 3,892.0 thousand tons in 2025 to 12,757.0 thousand tons in 2030, representing a CAGR of 26.8%.

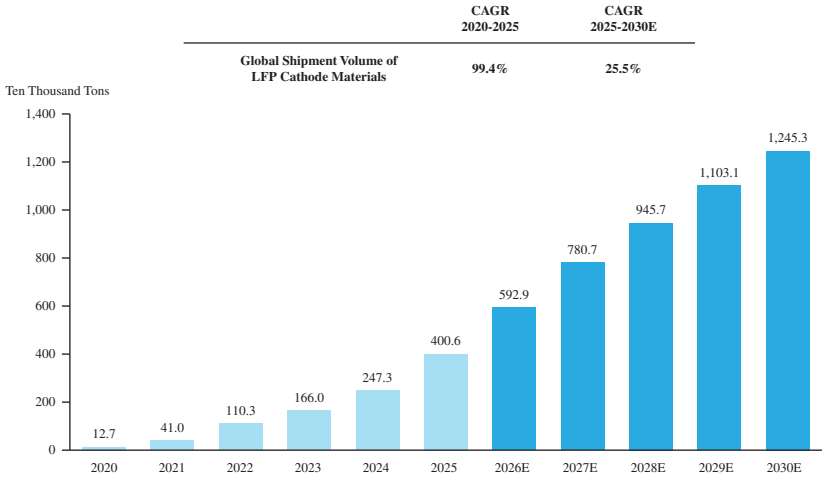
Global and China Shipment Volume of Lithium-ion Battery Cathode Materials, Classified by Material Types, 2020-2030E



Source: IEA, SMM, China Industrial Association of Power Sources, Frost & Sullivan

As the major category of phosphate-based cathode materials, the global shipment volume of LFP cathode materials increased rapidly from 127.0 thousand tons in 2020 to 4,006.0 thousand tons in 2025, representing a CAGR of 99.4%. Going forward, downstream NEVs, ESS, and emerging fields will continue to drive the demand for LFP batteries, resulting in robust demand in the LFP cathode material industry. Consequently, the global shipment volume of LFP cathode materials is expected to further increase to 12,453.0 thousand tons in 2030, representing a CAGR of 25.5% from 2025 to 2030.

Global Shipment Volume of LFP Cathode Materials, 2020–2030E



Source: SMM, China Industrial Association of Power Sources, Frost & Sullivan

Global premium LFP cathode materials achieved large-scale mass production around 2023, with their shipment volume surging from 133.0 thousand tons in 2023 to 1,062.0 thousand tons in 2025, representing a CAGR of 182.6% during the period. Meanwhile, their share of the global LFP cathode material shipment volume rapidly increased from approximately 8.0% in 2023 to 26.5% in 2025. Driven by the rigid industry demand for long-range, fast-charging power batteries and large cells for energy storage, the global LFP cathode material industry is expected to continuously evolve towards premium products in the future. The penetration rate of premium LFP cathode materials will continuously increase, and its growth rate is expected to be significantly higher than the overall level of the LFP cathode material industry.

Market Drivers and Development Trends of Global Lithium-ion Battery Phosphate-based Cathode Materials Industry

Downstream NEVs, ESS, and Emerging Fields Driving LFP Batteries' Demand

Amid global carbon neutrality, the electrification of NEVs is steadily advancing, and the accelerated construction of new power systems centered on new energy is driving energy storage demand, while emerging fields continue to expand. With advantages such as high cost-effectiveness, long cycle life, and high safety, the demand for LFP batteries and phosphate-based cathode materials is continuously growing.

- **Power batteries:** As the energy density of new-generation LFP batteries continues to achieve breakthroughs, the proportion of vehicles equipped with LFP batteries by sales volume in China increased from 42.6% in 2020 to 83.3% in 2025. Coupled with the coverage of fast-charging demand, the average per-vehicle battery capacity of NEVs equipping LFP batteries in China grew from 37.1 kWh in 2020 to 51.7 kWh in 2025, and the proportion of the Chinese LFP power battery market within the power lithium-ion battery market increased from 46.6% in 2020 to 72.9% in 2025, leading global demand for power lithium-ion batteries. Previously, the overseas market had a relatively small production capacity layout for LFP power batteries. Driven by the significant advantages of new-generation products in higher energy density, long cycle life, high safety, and high cost-effectiveness, the overseas market is shifting its strategy and accelerating the capacity layout for LFP power batteries. Therefore, it is expected that the penetration rate of overseas LFP power batteries in the power lithium-ion battery market will continue to increase from 32.8% in 2025 to 51.3% in 2030.

- **Energy storage batteries:** The large-scale grid integration of renewable energy sources such as wind and solar power is driving the rapid release of energy storage demand. Meanwhile, the explosive growth of AIDC has generated a continuous demand for high energy consumption and uninterrupted power supply. Consequently, the demand of these energy storage application scenarios have accelerated the large-scale deployment of LFP energy storage batteries, which possess comprehensive advantages in long cycle life, high safety, and high cost-effectiveness. The global shipment volume of LFP energy storage batteries grew from 27.5 GWh in 2020 to 597.8 GWh in 2025, representing a CAGR of 85.1%, and is expected to reach 2,461.3 GWh in 2030. From 2025 to 2030, LFP batteries are expected to maintain a penetration rate of over 95% among energy storage lithium-ion batteries.

- **Batteries for other emerging fields:** The demand for LFP batteries is extending into diversified scenarios such as embodied AI, electric vessels, and construction machinery. The advantages of LFP batteries — including long cycle life, high safety, and high cost-effectiveness — ensure adaptability and a balance of lithium-ion battery performance across diverse emerging fields, driving the penetration rate of LFP battery shipments in global emerging scenarios to reach nearly 80% by 2030.

Accelerated Development of Premium LFP Cathode Materials and Other New Phosphate-based Cathode Materials

Driven jointly by the continuous improvement of NEVs in high energy density and fast-charging performance, as well as the strengthening requirements of ESS for energy efficiency, long cycle life, and safety, LFP cathode materials are accelerating their development towards high compaction density, high energy density, long cycle life, etc. In 2025, the global shipment volume of premium LFP cathode materials exceeded one million tons, reaching approximately 1,062.0 thousand tons, accounting for about 26.5% of global LFP cathode materials. Meanwhile, new phosphate-based cathode materials such as LMFP and NFPP are developing concurrently. Among them, LMFP improves the material's voltage platform and energy density by introducing manganese, further expanding the performance boundaries while maintaining safety and cost advantages, thus becoming an important extension direction of the phosphate-based system.

Continuous Upgrades of High-Consistency Manufacturing Systems under TWh-Scale Expansion

Global lithium-ion battery production has entered the TWh-scale expansion era, driving the battery manufacturing system towards large-scale, continuous production. During this process, downstream battery manufacturers have raised higher requirements for the product consistency of cathode materials, as minor defects in the massive usage of battery cells could be amplified, affecting the yield and safety of the overall product. Leading cathode material enterprises are accelerating the construction of highly consistent, highly automated, and continuous manufacturing systems to enhance quality stability and cell yield performance under large-scale production. As the penetration rate of premium LFP cathode materials continues to increase, the industry's process system is upgrading synchronously, and leading enterprises are gradually introducing advanced preparation processes such as secondary sintering. This process

significantly improves the compaction density and electrochemical cycle life of cathode materials, and achieves high-precision quality control throughout the entire process from feeding and precursor synthesis to the finished product, aligning with the stringent requirements of downstream leading lithium-ion battery manufacturers for ultimate yield.

Differentiated Product Customization Services Reconstructing the Phosphate-Based Cathode Materials Product Matrix

With the continuous enrichment of new energy application scenarios, the performance requirements for cathode materials in power batteries and energy storage batteries present differentiated characteristics. In the power battery sector, demands for fast-charging, long cycle life, and low-temperature performance are driving the fine-tuned regulation of the microstructure and electrochemical properties of cathode materials. In the energy storage battery sector, there is a greater focus on battery cycle life of over 10,000 cycles and whole-lifecycle cost optimization. Leading cathode material enterprises are transitioning from a traditional standardized product supply model to differentiated customization services based on application scenarios. By establishing joint R&D mechanisms with downstream battery manufacturers and vehicle enterprises, companies can rapidly provide multi-dimensional customized cathode material solutions centered around core metrics such as fast-charging performance, energy efficiency, cycle life, and safety performance, further forming long-term and stable cooperative relationships.

Industry Business Models Entering the Stage of Vertically Integrated Resource Consolidation

Frequent price fluctuations of key raw materials such as phosphorus, iron, and lithium sources affect the stable supply and cost control of phosphate-based cathode materials enterprises. To cope with supply chain uncertainties and break through resource acquisition bottlenecks, the leading global phosphate-based cathode materials industry is accelerating its evolution towards a vertically integrated resource model. Industry-leading enterprises are extending upstream, penetrating deeply into key segments across the industry chain, such as the extraction of upstream mineral resources (e.g., phosphate mineral resource), basic chemical raw material processing, and core precursor manufacturing. Concurrently, they are extending downstream into the lithium battery recycling sector to mitigate the impact of price fluctuations in key raw materials. The vertically integrated layout establishes a solid resource moat, safeguarding material supply security amidst fluctuating market conditions. By reducing premiums and sunk costs in intermediate circulation processes, it achieves multi-product self-supply, synergistic cost reduction, and profit retention across the industry chain, becoming the core driver for enterprises to ensure high product quality and cost rigidity in international competition.

Globalized Industry Chain Layout Reshaping the International Supply Chain

The global industry chain for lithium-ion battery phosphate-based cathode materials is experiencing an evolution from single-product export to full-industry integration and international supply chain synergy. Leading cathode material enterprises are actively leveraging their profound accumulation of mass production processes to accelerate the deep expansion of production capacity to global core industrial hubs such as Europe. In the global reshaping of the new energy industry chain, the European market possesses unique and irreplaceable advantages: First are the exceptionally high compliance barriers and policy dividends; with the introduction of Europe's *New Battery Regulation*, *Net-Zero Industry Act*, and *Industry Acceleration Act*, constraints have been imposed on the carbon footprint and localized procurement ratios of battery materials. Second is the massive local customer demand and customer stickiness. As local European battery factories accelerate their construction and operation, enterprises with global layout can achieve rapid response and joint technological iteration with overseas customers, forming strong supply chain stickiness. By building a high-barrier internationalized operational system, leading enterprises can fully enjoy the significant development dividends of overseas markets.

Entry Barrier Analysis of Global Lithium-ion Battery Phosphate-based Cathode Materials Industry

The global lithium-ion battery phosphate-based cathode materials industry involves comprehensive barriers to entry, including R&D and processes, customer certification, industry chain synergy, and capital:

- In the field of **R&D and processes**, the product performance and mass production stability of phosphate-based cathode materials heavily rely on long-term R&D accumulation and process know-how. Product development involves multidisciplinary technologies such as materials science, electrochemistry, and powder engineering, requiring continuous optimization of material formulations, doping modification, and microstructural design to improve energy density, cycle life, and safety performance. Meanwhile, large-scale production demands high consistency control over processes such as mixing, sintering, milling, and classification. Premium products impose even higher requirements on continuous sintering, temperature control, particle morphology, and batch stability. Such manufacturing capabilities and product iteration experience are difficult to replicate in the short term.

- In the field of **customer certification**, downstream mainstream battery enterprises generally implement strict supplier certification systems, with certification cycles typically lasting one to two years, covering multiple stages including supplier audits, product testing, pilot verification, and mass production stability verification. As battery technologies continue to iterate, downstream enterprises are constantly raising their requirements for material performance and customized development. Suppliers must also possess continuous collaborative R&D and large-scale mass production capabilities, further heightening the customer certification barriers.

- In the field of **industry chain synergy**, leading enterprises in the industry have formed vertically integrated or product recycling layouts centered on key resources such as phosphorus, iron, and lithium. Among them, the layout of phosphate mineral resources is crucial from the perspective of time and resource control. With the formal implementation of the Implementation Regulations of the Mineral Resources Law of the People's Republic of China on June 15, 2026, phosphate mineral resource has been officially listed in the national strategic mineral resources catalog, facing more stringent overall control across the entire chain. In addition, the acquisition of phosphate mineral resources involves exceptionally high time barriers, as it typically takes 3 to 5 years or longer for phosphate mine to go from exploration and approval to final construction and production. Relying on forward-looking resource layouts, large-scale production, and industry chain synergy, leading enterprises can form significant cost advantages, whereas new entrants face substantial challenges in resource security and cost control.

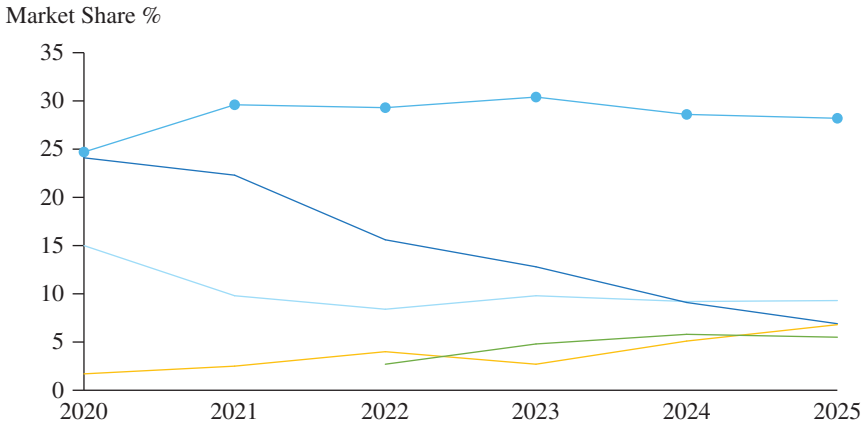
- In the field of **capital**, constructing new phosphate-based cathode materials production bases requires substantial capital investment for plant construction, sintering equipment, automated production lines, and environmental protection facilities, with the initial capital expenditure per 10 thousand tons of capacity ranging from approximately RMB150 million to RMB250 million. Furthermore, newly commissioned projects in the current industry generally exhibit ultra-large-scale characteristics, significantly increasing the requirements for enterprises' initial production capacity scale, which leads to a multiplier effect on the starting investment of overall projects. Meanwhile, enterprises must also bear the capital requirements for raw material procurement, inventory turnover, and capacity ramp-up stages, imposing high requirements on capital strength and continuous financing capabilities.

Competitive Landscape Analysis of Global Lithium-ion Battery Phosphate-based Cathode Materials Industry

China's lithium-ion battery phosphate-based cathode materials industry accounted for over 96% of global shipment volume in 2025. The global lithium-ion battery phosphate-based cathode materials industry overall exhibits a competitive landscape characterized by "one dominant leader alongside multiple strong competitors". Our Company ranked first globally in shipment volume of phosphate-based cathode materials for six consecutive years from 2020 to 2025.

In 2025, the global shipment volume of lithium-ion battery phosphate-based cathode materials reached approximately 4,037.0 thousand tons, with the global top five manufacturers recording an aggregate shipment volume of approximately 2,289.0 thousand tons, representing a market share of 56.7%. Among them, our Company achieved sales volume of approximately 1,137.0 thousand tons in 2025, representing a market share of 28.2%, which surpassed the combined market share of the second to fourth players and led the second-ranked competitor by nearly 19 percentage points. Meanwhile, demand for our Company's products remained persistently robust, and our capacity utilization rate maintained a high level in 2025, significantly exceeding the industry average of approximately 70.0%.

Market Share Analysis of the Global Top 5 Phosphate-based Cathode Material Manufacturers in 2025, 2020-2025



	2020	2021	2022	2023	2024	2025
Our Company	**24.7%**	**29.6%**	**29.3%**	**30.4%**	**28.6%**	**28.2%**
Company A	15.0%	9.8%	8.4%	9.8%	9.2%	9.3%
Company B	24.1%	22.3%	15.6%	12.8%	9.1%	6.9%
Company C	1.7%	2.5%	4.0%	2.7%	5.1%	6.8%
Company D	–	–	2.7%	4.8%	5.8%	5.5%

Source: Annual reports of listed companies, Frost & Sullivan

Notes:

1. The shipment volume for listed companies is sourced from the sales volume disclosed in their annual reports, if applicable.
2. Company A was established in 2010 and is headquartered in China. It is listed on the Shanghai Stock Exchange. Its primary business covers lithium-ion battery cathode materials and related precursor materials, with its core product being LFP cathode materials.
3. Company B was established in 2007 and is headquartered in China. It is listed on the Shenzhen Stock Exchange. Its primary business focuses on the R&D, production, and sales of core materials for lithium-ion batteries, and its main products include phosphate-based cathode materials and lithium replenishing agents.
4. Company C was established in 1997 and is headquartered in China. It is listed on the Shenzhen Stock Exchange. Its primary business covers precision engine components, intelligent electronic control systems, and phosphate-based cathode materials.
5. Company D was established in 2018 and is headquartered in China. Its primary business focuses on the R&D, production, and sales of LFP cathode materials, with its products applied in the field of NEV batteries.

In 2025, the global shipment volume of premium LFP cathode materials was approximately 1,062.0 thousand tons. The top five global manufacturers recorded a combined shipment volume of approximately 1,027.0 thousand tons, reaching an aggregate market share of 96.7%, indicating a highly concentrated market. In 2025, our Company's sales volume of premium LFP cathode materials was approximately 589.0 thousand tons, with a market share of 55.4%, ranking first globally.

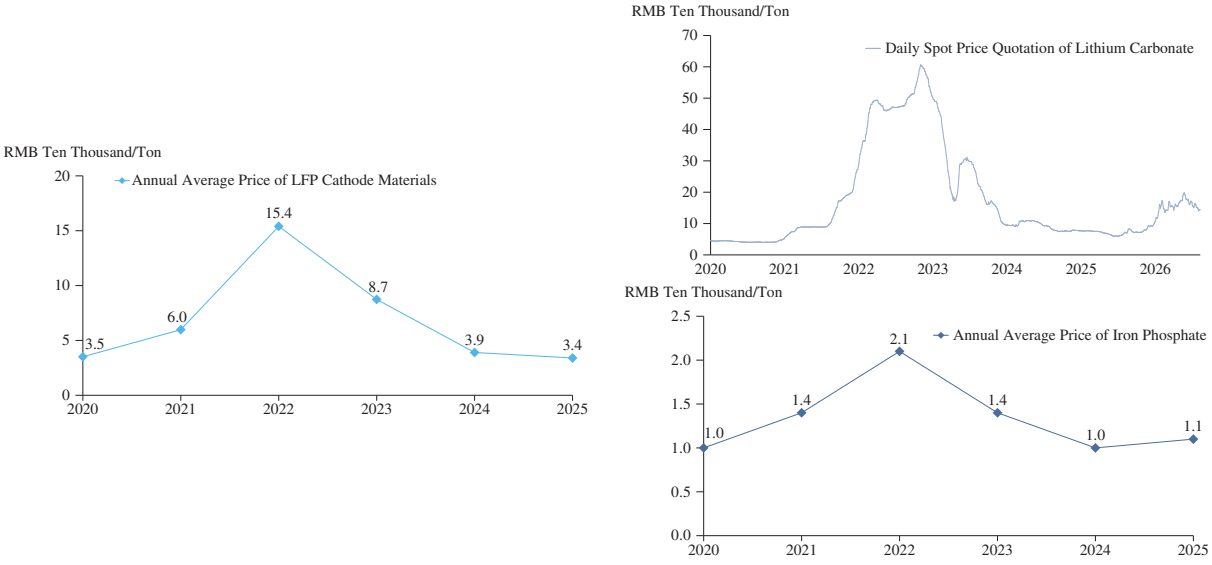
Raw Material Analysis of Global Phosphate-based Cathode Materials Industry

As the core component of phosphate-based cathode materials, LFP cathode materials are one of the core materials for LFP batteries, directly affecting battery cost, performance, and product competitiveness. Between 2020 and 2022, driven by rising prices of upstream raw materials and rapid growth in downstream demand, the average annual price of LFP cathode materials increased from RMB35.0 thousand per ton to RMB154.0 thousand per ton. From 2023 onwards, with the release of upstream raw material supply, the price of LFP cathode materials gradually fell, and the average annual price decreased to RMB34.0 thousand per ton in 2025. Since the end of 2025, the price of LFP cathode materials has experienced rapid growth on the basis of rebounding prices of raw materials such as lithium carbonate, and the price of LFP cathode materials is expected to continue fluctuating in the future affected by raw material prices.

Lithium carbonate and iron phosphate are primary upstream raw materials for LFP cathode materials, and their price changes have a significant impact on the cost of LFP cathode materials. Between 2020 and 2022, driven by the rapid growth in demand for new energy batteries and periodic tight supply and demand, the daily spot quotation of global lithium carbonate increased from a minimum of approximately RMB41.0 thousand per ton in 2020 to a peak of over RMB600.0 thousand per ton in 2022, while the average annual price of iron phosphate increased from RMB10.0 thousand per ton in 2020 to RMB21.0

thousand per ton in 2022. From 2023 onwards, as upstream production capacity was released, the prices of lithium carbonate and iron phosphate fell rapidly, with their average annual prices dropping to RMB76.0 thousand per ton and RMB11.0 thousand per ton in 2025, respectively. In the second half of 2025, due to downstream battery manufacturers' continuous increments on the demand side, and the optimization of capacity structure, the price of lithium carbonate rebounded. In the first half of 2026, the global average price of lithium carbonate recovered to approximately RMB163.0 thousand per ton. In the future, the price of lithium carbonate will remain volatile.

Price Analysis of Global Lithium-ion Battery LFP Cathode Materials, Lithium Carbonate, and Iron Phosphate, 2020-2025



Source: SMM, Frost & Sullivan

Note: All prices are based on tax-inclusive average prices. Lithium carbonate prices are compiled from the average daily spot price quoted by SMM.

From the perspective of the cost structure of LFP cathode materials, the changes in the proportion of each cost item were primarily driven by the price fluctuations of lithium carbonate. Affected by the substantial surge in the price of lithium carbonate in 2022, its cost proportion rapidly increased from 41.7% in 2020 to 82.3%, and subsequently decreased to 53.5% in 2025 as the price of lithium carbonate gradually fell. Concurrently, the cost proportion of iron phosphate declined from 40.5% in 2020 to 14.2% in 2022, and rebounded to 31.5% in 2025. The price fluctuations of other raw materials and remaining manufacturing costs remained relatively stable, with their combined cost proportion fluctuating between 3% and 20% primarily due to the impact of lithium carbonate prices.

SOURCE OF INFORMATION

We commissioned Frost & Sullivan to conduct market research on the global lithium-ion battery and global lithium-ion battery phosphate-based cathode materials industry and to prepare the Frost & Sullivan Report. Frost & Sullivan is an independent global consulting firm founded in New York in 1961, providing industry research and market strategies. We have entered into an agreement to pay Frost & Sullivan RMB500,000 for the preparation of the Frost & Sullivan Report.

In preparing the Frost & Sullivan Report, Frost & Sullivan conducted detailed primary research, including discussions with several leading industry participants regarding industry conditions and interviews with relevant individuals. Frost & Sullivan also conducted secondary research, including reviewing company reports, independent research reports, and data from its own research database. Frost & Sullivan derived the estimated statistics of total market size based on historical data analysis incorporating macroeconomic data, taking into account the aforementioned main industry drivers. Its market engineering forecast methodology combines multiple forecasting techniques with a system based on market engineering measurements and relies on the expertise of the analyst team to integrate the key market elements investigated during the project research phase. Such elements primarily include expert opinion forecasting methods, integration of market drivers and constraints, integration of market challenges, integration of market engineering measurement trends, and integration of econometric variables.

The Frost & Sullivan Report was prepared based on the following assumptions: (i) the social, economic, and political environments globally and in Chinese mainland are likely to remain stable during the forecast period; and (ii) the key relevant industry drivers may drive the market during the forecast period.

This section and other chapters of this document excerpt portions of information from the Frost & Sullivan Report, aiming to provide [**REDACTED**] with a more comprehensive introduction to the industry in which we operate. The Directors confirm that, to the best of their knowledge and after making reasonable enquiries, there have been no material adverse changes in overall market information since the date of the release of the Frost & Sullivan Report which are sufficient to make material corrections, contradict or have an impact on such information.