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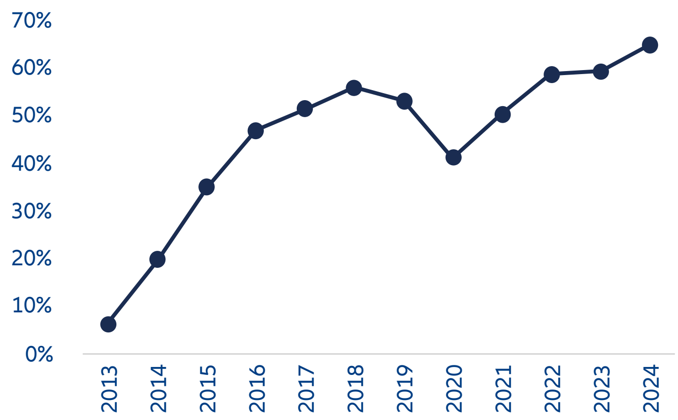
Battery technology

Investors are increasingly aware of China's growing dominance in electric vehicles (EVs). BYD cars are now commonly seen on the streets of Europe and Latin America. Yet while the headlines often focus on the volume of EV sales, the story of China's rise to global leadership lies in large part "beneath the hood" – making the right bet on batteries.

China has developed dominance in battery technology and related supply chains, such that its position at the center of the EV industry is likely to become even more. More broadly, batteries are essential for powering everything from smartphones and laptops to renewable energy systems. They are a critical input for industries such as AI data centres, electricity networks, defence technologies and high-tech manufacturing.

This piece builds on our "Created in China" series to examine how China is extending this lead beyond today's lithium-ion batteries into next-generation battery technologies. And in doing so, we believe this creates significant long-term growth opportunities for equity investors.

Exhibit 1: China EV sales as a percentage of global



Source: Allianz Global Investors, EV Volumes, as of 31 December 2024.

Albert Yuen
Associate Product Specialist

William Russell
Head of Product Specialists Equity AP

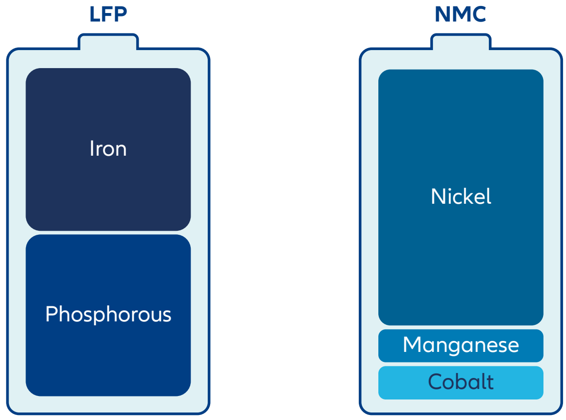
Embracing Disruption

Batteries – Towards a global standard

China was an early adopter of battery technology, but its dominance has only become apparent more recently. By 2024, China produced more than six times the number of batteries as the US.[1] This lead stems from strategic decisions and sustained investments over the past decade, which positioned China at the forefront of the industry. Today, it leverages massive economies of scale that are not only driving down costs but also allowing for accelerated innovation in new chemistries and advanced manufacturing techniques.

By way of background, the battery landscape today is defined by two primary lithium-ion battery chemistries: lithium iron phosphate (LFP) and nickel-manganese-cobalt oxides (NMC).

Exhibit 2



Source: Battery Swap Cabinet.

Historically, automakers in the West, including major US EV producers such as Tesla in its earlier models, gravitated towards NMC batteries. This was mainly due to their higher energy density and more resilient performance in low temperatures. This, in turn, allowed for longer driving ranges and better performance in cold weather conditions.

However, NMC batteries have several structural disadvantages. For example, they rely on more expensive metals such as cobalt and nickel, making them more costly and more vulnerable to price volatility. This has become increasingly problematic given that battery prices overall have fallen by more than 90% over the last 15 years.[2] NMC batteries also present greater thermal management challenges, requiring more sophisticated cooling systems to prevent them from overheating.

In contrast, Chinese companies have invested heavily in developing and refining LFP technology. One of the key advantages of LFP batteries is cost – they are around 30% cheaper than NMCs.[1] This is because, in addition to minerals such as lithium carbonate, they use relatively cheaper materials such as iron and phosphate. LFP technology is also thermally more stable than NMC batteries, reducing the risk of fires and simplifying battery pack design. And the overall chemistry is more durable, with a longer cycle life that translates to better residual value for vehicles over time.

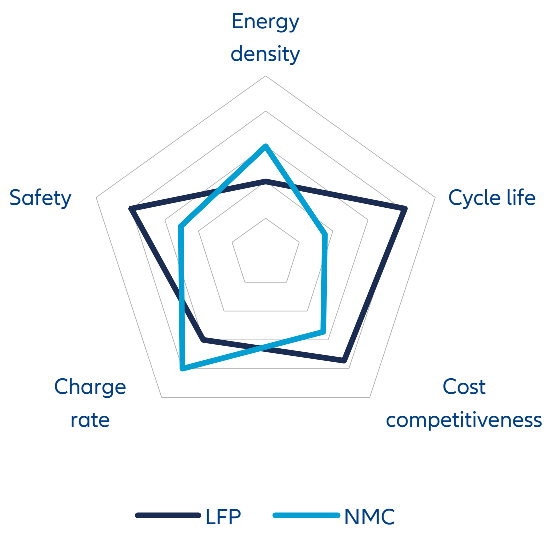
While early LFP batteries offered lower energy density than their NMC counterparts, continuous innovation and refinements have narrowed this gap. Indeed over time, the benefits of LFP technology over NMC are expected to widen.

These advances are already driving a broader shift in the industry. As automakers prioritise cost and safety alongside range, LFP is gradually gaining ground even in markets that previously favoured NMC. For example, more global automakers, including Tesla, are starting to adopt LFP batteries in their standard-range models.

As a result, while LFP technology has already become the standard in EVs in China, over time we expect it to also become dominant in other global markets.

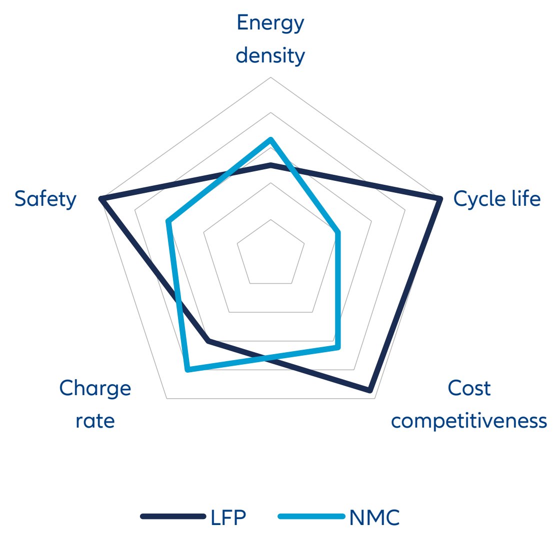
[1] "Global EV Outlook 2025", IEA, 14 May, 2025.
[2] "Batteries and Secure Energy Transitions", IEA, 24 Apr 2024.

Exhibit 3a: Status of battery performance metrics in 2022



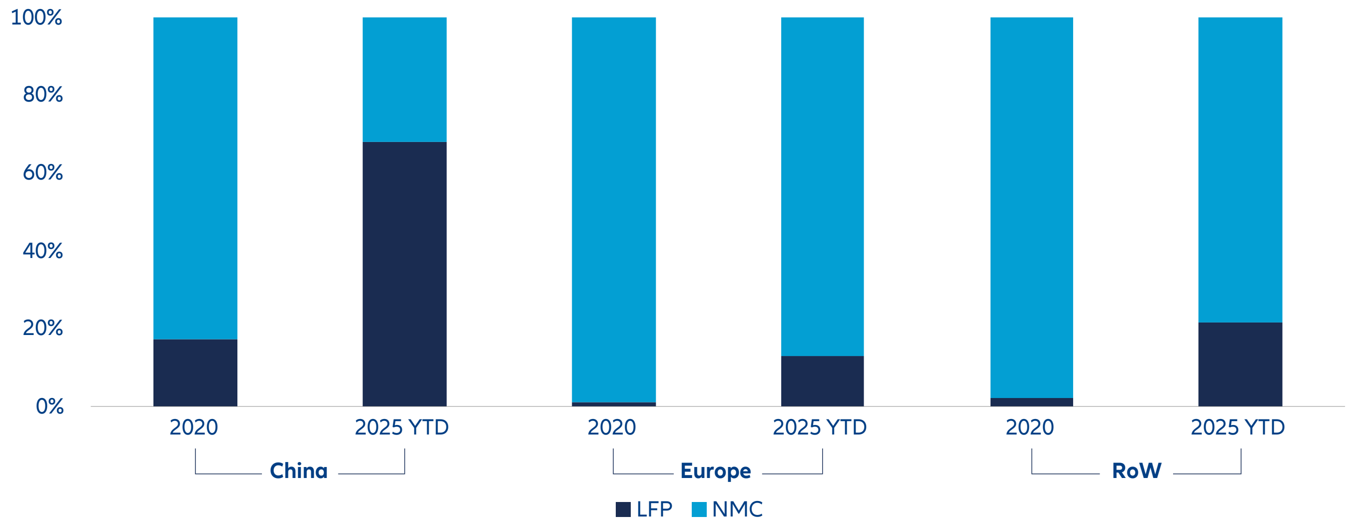
Source: Allianz Global Investors, BloombergNEF.

Exhibit 3b: Status of battery performance metrics in 2035



Source: Allianz Global Investors, BloombergNEF.

Exhibit 4: Battery chemistry breakdown by region (2020 vs. 2025 YTD)



Source: Allianz Global Investors, EV Volumes, as of 30 September 2025.

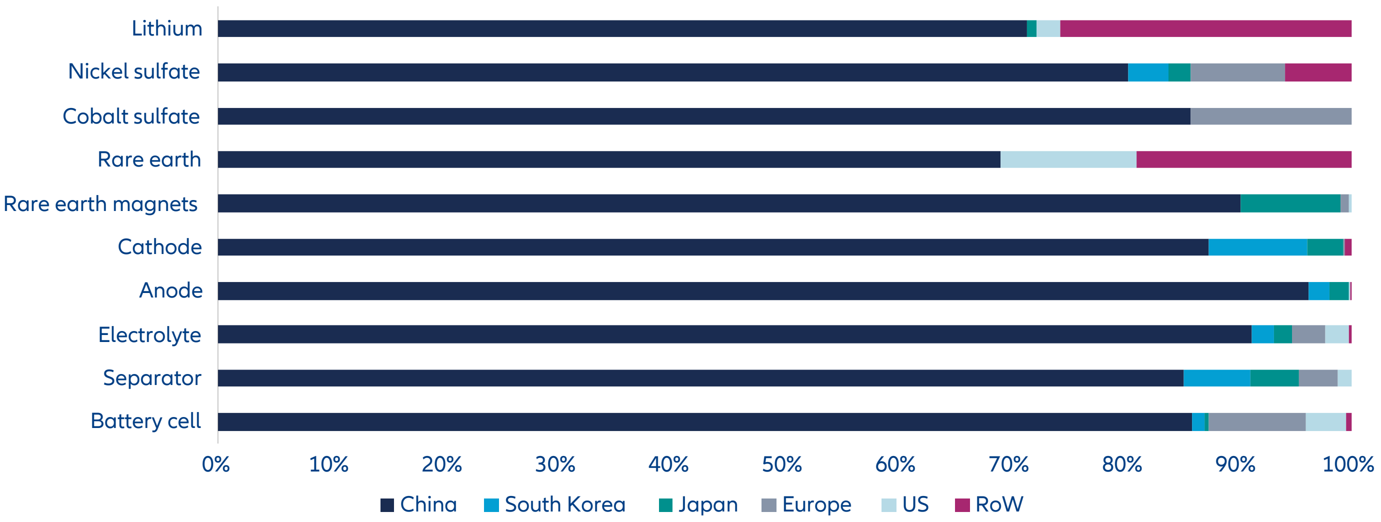
The search for next-generation batteries

The increasing global adoption of LFP batteries has cemented the EV industry's reliance on China's battery supply chain. Across every stage of the production process, from upstream critical minerals to manufacturing finished battery cells, China has a dominant market position.

This concentration creates both opportunities and risks. While it enables economies of scale and rapid innovation, it also exposes the industry to potential supply disruptions and geopolitical concerns.

As such, the search for next generation batteries has been spurred by both economic and security considerations. While Chinese companies are looking

Exhibit 5: Battery supply chain by geography



Source: Allianz Global Investors, BloombergNEF, data as of 17 January 2025. Note: Capacity is by physical facility location, not manufacturer headquarters. Rare earth capacity figures are based on Morgan Stanley Research, data as of 31 December 2024.

for ways to drive down costs even further, other global companies want to reduce their reliance on Chinese supply chains. This focus is becoming more intense as LFP batteries approach their theoretical limits in terms of energy density and cost reduction.

One new technology gaining some attention is sodium-ion batteries. The Chinese company Contemporary Amperex Technology (CATL) has been at the forefront of the research effort. The main advantage is cost. The key ingredient, sodium carbonate, is one of the most abundant elements on Earth, and costs about 30% less than the lithium equivalents.[3] However, there are certain technical limitations which mean sodium-ion batteries are currently seen as more suitable for low-cost EVs and grid storage. Of more interest longer-term, and a potential game-changer, is so-called solid-state technology.

Solid-state batteries

All lithium-ion batteries share the same basic anatomy, which is based on cathodes and anodes. An electrolyte facilitates the movement of lithium ions between them, generating power, while a separator prevents direct contact to avoid short circuits. In conventional batteries, like LFPs and NMCs, the electrolyte is a liquid organic solvent. This is flammable and presents safety risks from thermal runaway. It also diminishes performance under extreme temperatures.

Solid-state batteries are very different. Instead of a liquid electrolyte, they use solid materials such as sulfide, polymer, oxide or halide-based compound to transport ions. This eliminates the need for a separator, which saves space. As such it brings several potential transformative advantages:

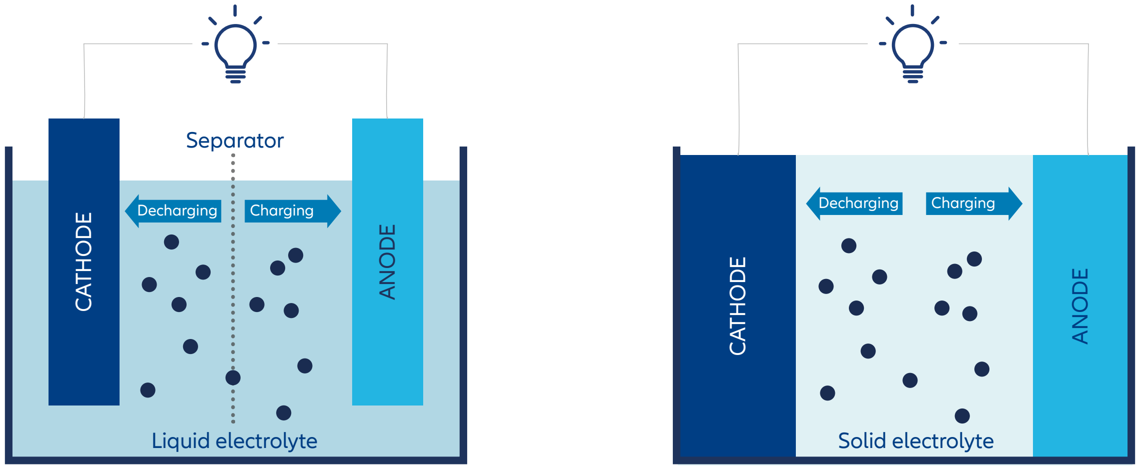
Longer range: Solid-state batteries deliver potentially 2-3 times higher energy density than current lithium-ion batteries. This would enable EVs to achieve ranges exceeding 1,000 km on a single charge.

Faster charging: Solid-state batteries can potentially achieve much higher charging rates and therefore faster charging times.

Thermal stability: Without the volatile liquid component, solid-state batteries are inherently safer, eliminating the risk of fires or explosions.

[3] Jiangsu Highstar Battery Manufacutring Co Ltd, 20 Jun 2025.

Exhibit 6



Lithium-ion battery **Solid-state battery**

Source: Thermo Fisher Scientific.

Technology resilience across diverse climates: Solid-state batteries can operate across a broader temperature range, from -40°C to over 100°C, compared to LFP's narrower -20°C to 55°C window. This could lead to more consistent performance in harsher climates where current batteries suffer significant capacity drops.

There are still significant uncertainties in the development of solid-state technology. This is partly related to the unproven technology, and partly to high costs. Solid state batteries will require significant upfront capex in new production lines as solid electrolyte manufacturing is much more complex than lithium-ion battery production.

Nonetheless, China has been an active player in the development of solid-state technology. As of May 2025, China accounted for over one-third of patent applications worldwide.[4] And as is common with new technologies, the Chinese government has provided significant funding for solid-state research and development and is coordinating collaboration between research institutions and manufacturers.

Over time, the application of solid-state batteries is likely to extend beyond passenger EVs to other areas such as electric vertical take-off and landing (eVTOL) aircraft, a key component of China's "low-altitude economy" initiative, as well as civil aviation, and long-range trucks, where energy density, stability and safety are critical.

However, achieving these performance gains requires more critical minerals. High-performance solid-state designs often rely on lithium metal anodes and high-nickel cathodes to maximise energy density and charging speed. Due to their more material-intensive design, solid-state batteries currently face cost-related challenges. Their path to commercialisation will depend heavily on reducing manufacturing costs and developing reliable supply chains for these critical materials.

[4] Gelonghui Finance, 8 Sep 2025.

Exhibit 7: EV battery types

Batteries	LFP	NMC	Sodium-ion	Solid-state
Core materials	Lithium, iron and phosphate (abundant)	Lithium, nickel, cobalt, manganese	Sodium (abundant)	Lithium, high content nickel, specialised solid electrolyte materials
Key pros	• Lower cost • High safety • Long cycle life	• Higher energy density • Longe range capability • Better cold weather performance	• Lowest cost • High safety • No critical materials required • Compatible with existing LFP production lines	• Highest energy density • Longest range capability • Wide operational temperature range • Faster charging potential
key cons	• Lower energy density • Poor cold weather performance	• Higher cost • Safety concerns • Short cycle life • Requires critical materials	• Lowest energy density • Limited range capability	• Highest cost • Requires the most critical materials • Manufacturing challenges • Requires new production infrastructure
Primary applications	• Standard range EVs • Commercial vehicles • Consumer electronics • Energy storage (ESS)	• Long range premium EVs • Performance-based vehicles	• Affordable EVs • Electric motor bikes • Consumer electronics • Energy storage (ESS)	• Long range premium EVs • Performance-based vehicles • Long range trucks • Low-altitude vehicles (eVTOL) • Civil aviation
Commercialisation status	Widely adopted – gaining share	Widely adopted – losing share	Early commercial deployment	R&D / pilot production

Source: Allianz Global Investors.

Conclusion

China's leadership in batteries rests on a foundation built over more than a decade of strategic investment and industrial coordination. As the full potential of LFP technology is being realised through innovations in battery design, Chinese battery companies are establishing LFP as a global standard, reinforcing their control over the battery supply chain.

This same strategic planning is now being applied to next-generation batteries. The development of solid-state and sodium-ion batteries will likely result in complementary solutions designed to serve different market opportunities. Together, these two next-generation battery technologies are poised to broaden the appeal of EVs as well as enabling new applications in energy storage, consumer electronics, and industrial sectors.

In this environment, we see innovative companies with proven R&D capabilities and a clear ability to capture and expand market share are well positioned to deliver sustained growth and create compelling opportunities for long-term investors.

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