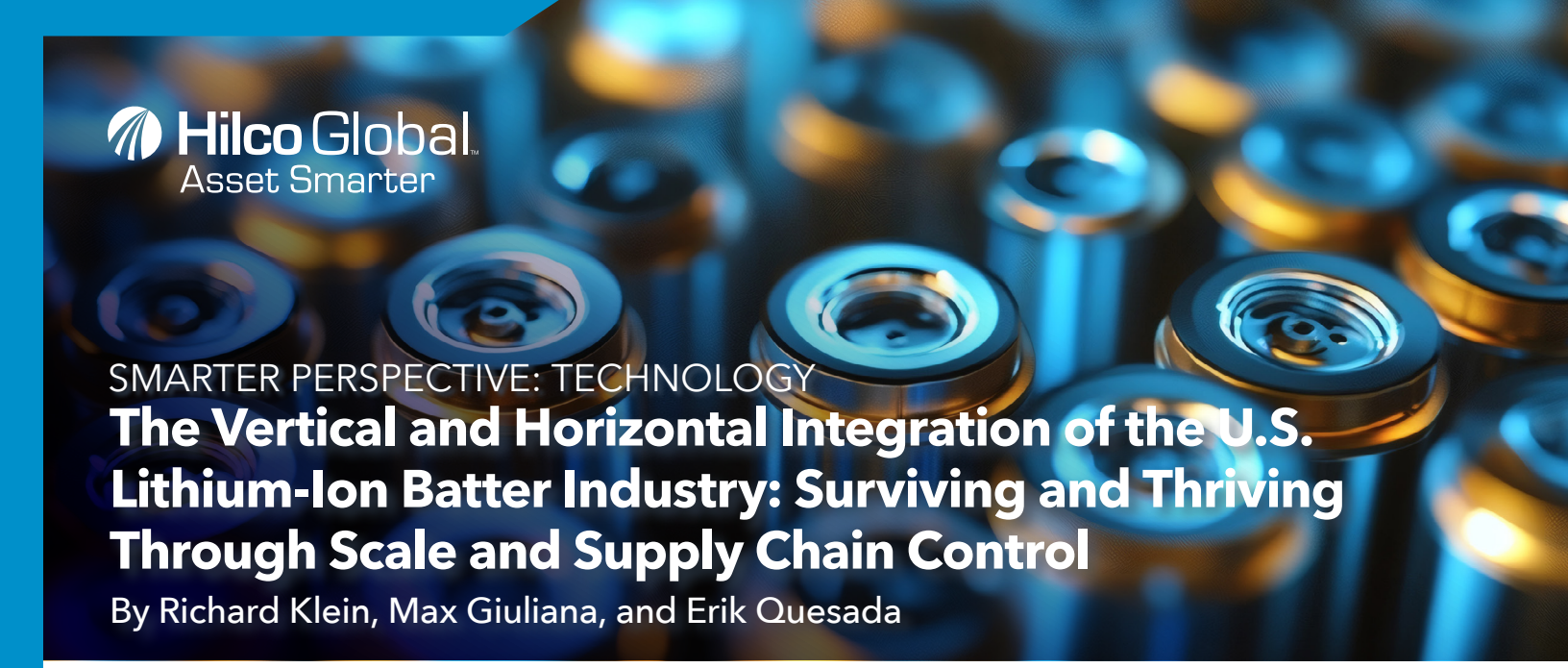

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SMARTER PERSPECTIVE: TECHNOLOGY

The Vertical and Horizontal Integration of the U.S. Lithium-Ion Batter Industry: Surviving and Thriving Through Scale and Supply Chain Control

By Richard Klein, Max Giuliana, and Erik Quesada

September 2025 Lithium-ion batteries power the modern world's most transformative technologies. From electric vehicles and grid-scale storage to drones and defense systems, they are an indispensable component of both consumer and national-security supply chains. Yet as demand rises, the industry's economics are being squeezed by two forces:

1. **Cost Pressures** driven by raw material volatility, regional expertise disparities, and downstream price compression.
2. **Geopolitical Concentration Risk**, as supply and production is heavily controlled by China and regional champions.

Unless American players consolidate both vertically and horizontally to aggregate demand, secure non-Chinese minerals, and scale to beyond 40 GWh, profitability will remain out of reach.

Overview - Evidence of the Squeeze

Global demand for lithium-ion batteries reached 1 TWh in 2024 – an increase of over 25% year-over-year - and is projected to more than triple by 2030 under the International Energy Agency's (IEA) Stated Policies Scenario. Despite this surge in demand, capacity is growing faster: announced and operating plant capacity is between 3 and 3.3 TWh, creating a structural oversupply.

This imbalance is driving down prices. BloombergNEF's survey put pack costs at $115 kWh, a 14% drop year-over-year. While cheaper packs accelerate adoption, they compress producers whose fixed costs decline far more slowly than selling prices. Oversupply hands pricing power to the largest, most vertically integrated firms (nearly all of which are based in China), further underscoring the need for U.S. consolidation.

Raw materials account for over 70% of a cell's variable cost, and those markets remain highly volatile:
Despite falling input prices, pricing pressure is intensifying due to:

- **Price-war Economics:** Chinese EV and battery makers leverage their supply-chain control and manufacturing capacity to create an oversupply and aggressive cut prices, forcing suppliers to accept reductions.
- **The Policy Premium:** The new One Big Beautiful Bill has strict restrictions on supply from Prohibited Foreign Entities.
- **Tech & R&D Churn:** The rapid shift from NCM to LFP and emerging sodium-ion chemistries strands some capex before they are fully depreciated keeping unit costs elevated.

These forces make scale, enabled by vertical and horizontal integration, the only durable path to margin recovery. Furthermore, the industry is concentrated abroad: the top size cell manufacturers control over 80% of global output, with most based in China or South Korea. This dynamic sets up the "China dilemma" addressed in the following sections, highlighting

Input	2022-2025 Price Trend	Supply Picture	Implications
Lithium	Down 85% from Nov. 2022 peaks	Oversupply driven by expansion in China, Australia, and Chile	Short-term relief for cell manufacturers
Nickel	Prices halved since 2022; 2025 surplus project at 109 kt	Indonesia high pressure acid leaching wave sustains market glut amid weaker EV demand	Push toward lithium, iron, and phosphate (LFP) & sodium-ion chemistries
Cobalt	Multi-year slide amid shift to LFP	Democratic Republic of the Congo (DRC) output steady; recycling on the rise	Margins are thin for legacy nickel, cobalt, and manganese (NCM) producers
Graphite	China controls >80% of processing	Democratic Republic of the Congo (DRC) output steady; recycling on the rise	Drives onshoring & synthetic graphite R&D

Source: Hilco Global

the geopolitical risks the industry poses to consumers, companies, and governments alike.

Relevant trends & context for the industry include:

- **Chemistry Shifts:** LFP batteries obtained 50% of the EV market in 2024.
- **Downstream Pull Amid the Capacity Glut:** While demand is rising, gigafactories are outpacing it, leading to expected cancellations, joint-venture rationalizations, and distressed M&A activity.
- **Defense & Data-center Applications:** LFP gaining traction for drones, submarines, and grid-stability services, highlighting the importance of secure supply chains.
- **Policy Bifurcation:** U.S and EU tariffs are accelerating decoupling between Western and Eastern industries; premium local supply and expertise costs in America and the EU contrast with Asia's mass-market exports competing primarily on price.

Mineral Bottlenecks

Five minerals dominate lithium-ion battery chemistry: lithium, nickel, cobalt, manganese, and graphite. However, their extraction and processing are geographically concentrated and highly volatile:

- **Price volatility:** Lithium carbonate prices surged over 500% in 2022, before plunging 40% through 2024. On the other hand, oversupply from new Indonesian capacity has kept prices depressed since late-2023. Such large swings in mineral costs compress margins for all industry players.
- **Chokepoints:** Beijing's export-license regime for graphite, gallium, and germanium exhibit how, in its current state, a single policy can change to disrupt the entire supply chain.
- **Insufficient Diversification:** Although new projects, joint ventures, and agreements are emerging online in Africa, South America, and Eastern Europe, but the scale and complexity of these deals limit meaningful diversification of mineral inputs in the near future.

Region	2024 Share of EV-Cell Installations	Strategic Position	Key Companies
China	66% of global market; 85% of LFP cells	Cost leader with full value-chain control; export-oriented	CATL, BYD, CALB, Gotion
South Korea	23-24%	Pivot to U.S./EU plants to avoid tariffs; regional benefit	LG Energy Solution, SK On, Samsung SDI
United States	13% of global demand; <10% cell capacity	IRA subsidies in place; supply-chain gaps persist	Tesla/Panasonic, GM-Samsung SDI, Ford-CATL licensing
Japan & Europe	Single-digit share	Focus on next-gen chemistries & premium segments	Drives onshoring & Panasonic, Toyota, Northvolt

Source: Hilco Global

The China Dilemma

China refines 70% of the world's lithium chemicals and is projected to overtake Australia as the largest miner by 2026. BloombergNEF's Global Lithium-ion Battery Supply Chain ranked China first due to its unmatched cathode and anode capacity, as well as state-backed financing.

As a result, China holds significant leverage:

- **Strategic Export Curbs** on graphite and gallium demonstrate Beijing's willingness to weaponize supply chains for diplomatic gain.
- **Market-share Price Pressure** as Chinese producers routinely operate at a loss to maintain market share, undercutting Western competitors and deterring new entrants.
- **Policy Risks** include the IRA's "foreign entity of concern" provisions, as well as tariffs and EV tax credit cuts implemented during the current administration.

South Korea's Competitive Edge

Korean battery giants such as LG Energy Solution, Samsung SDI, and SK On operate within the East Asian production hub, drawing heavily on Chinese suppliers while adding their own supply-chain expertise. These geographic and partnership advantages create a structural cost advantage when selling into the United States and competing with U.S. firms.

U.S. Industry Consolidation - The Only Path to Durable Profitability

U.S. cell makers and firms across the broader lithium-ion battery supply chain face a steep cost curve, shaped by Chinese and Korean giants that quote LFP cells at $53 per kWh, roughly half the U.S. average. These low prices are enabled by factories producing over 40 GWh annually, combined with deep manufacturing expertise and input-cost control. In this competitive landscape, fragmented plants operating at 5 to 10 GWh struggle to amortize equipment, fund R&D, or secure raw materials at scale, leaving them unable to remain profitable or competitive. The industry's short history shows that fixed costs fall sharply once a site facility surpasses the 30-to-40 GWh threshold, bringing pack costs into the sub-$100 zone, now considered the minimum entry point by automakers.

The market is already beginning to recognize this reality. In April 2025, LG Energy Solutions agreed to pay $2 billion for General Motors' underutilized joint-venture plant in Michigan. Just three months earlier, Ford and SK On secured a $9.63 billion Department of Energy (DOE) loan to build 120 GWh of fresh

Cost Lever	Evidence	Impact on U.S. Buyers
Cheap Chinese logistics	$700 vs. > $2,300: Guangzhou to Busan vs. U.S. West Coast shipping costs	>$30/kWh raw-material freight savings that U.S. firms must either absorb or pass on to consumers
Use of low-priced Chinese processing	Korea sourced 84% of its lithium hydroxide and 94% of its natural graphite from China in 2023	Korean cathode and anode input costs closely track China's—maintaining a lower cost basis than U.S. firms
Joint R&D with Chinese cathode leaders	LG Energy Solution is negotiating JV cathode plants with three Chinese suppliers to match Chinese LFP battery costs	Enables Korean firms to quote LFP packs to U.S. automakers at near-China pricing while avoiding direct Chinese cell imports and associated restrictions
Assembly footprint flexibility	Finished cells can ship tariff-free under KORUS (pending tariff negotiations) when final assembly occurs in Korea	Lowers effective cost to U.S. consumers, even when Chinese raw materials are embedded in the supply chain

Source: Hilco Global

capacity across Kentucky and Tennessee, explicitly to match Chinese cost curves. Vertical consolidation is accelerating just as quickly: Redwood Materials has a conditional $2 billion DOE loan to scale its Nevada campus, which will recycle feedstock and convert it directly into 100 GWh of new anode and cathode material annually.

Vertical and horizontal consolidation in the domestic lithium-ion battery industry deliver scale and integration advantages across multiple fronts. First, at gigafactory volumes, unit costs, along with depreciation and overhead, fall to just 15-25% of today's U.S. pack cost gap with China. Second, scale enables procurement leverage; an 80 GWh buyer can secure multi-year offtake agreements for lithium, nickel, and graphite that track commodity indices. Third, integration provides tax certainty, as a unified player can ensure each critical mineral qualifies as a "non-foreign-entity-of-concern"—a factor that will prove increasingly crucial during the current administration. Lastly, integration reduces the cost of capital by roughly two to three percentage points. More specifically, Washington is demonstrating that it is inclined to supply low-cost debt to domestically significant and vertically integrated projects.

In practice, consolidation will involve rolling up fragmented Mid-western and Southeastern plants into 40+ GWh hubs. These plants would work alongside U.S. facilities producing their own cathode and anode materials while the parent company invests in American lithium and graphite projects. This approach delivers economies of scale, mitigates currency volatility, and reduces geopolitical supply chain risk. In parallel, partnerships with DOE research labs and automakers help distribute the risks of experimentation while keeping intellectual property domestic. Lastly, these firms will be One Big Beautiful Bill tax incentive compliant, providing a healthy margin boost until the plants' scale alone allows them to reach profitability.

Fragmentation is a luxury the U.S. battery sector can no longer afford. Horizontal aggregation to gigafactory scale, combined with vertical control of minerals, recycling and pack integration, is the strongest route to cost parity with Asia, full margin capture, and the capital required to bring the next generation of cell technology from the lab to the production line.

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