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A New Phase for the U.S. Battery Industry

Policy Considerations to Sustain Momentum, Bridge Gaps, and Avoid Pitfalls

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Executive Summary

Batteries are increasingly foundational to strategic sectors such as mobility, the power grid, and defense. As demand grows and competition intensifies, evolving market conditions and policy frameworks have cast uncertainty over the future of the U.S. battery manufacturing ecosystem. Drawing on extensive desk research and stakeholder interviews, this report informs policy debates through evidence-based analysis of the complex dynamics that are shaping the industry at today's critical inflection point. It focuses on three central strategic questions: where are the most critical supply chain vulnerabilities, what should be the approach to international linkages, and how can innovation be aligned with industrialization?

This report addresses these questions in four sections; the first two assess the current landscape, while the latter two chart the path forward. The opening section maps the battery value chain, reviews the U.S. manufacturing buildout, and situates it within the global context. The report next examines demand- and supply-side factors reshaping the market. It then analyzes recalibrations across the value chain in response to recent policy and market shifts, examines prospects for allied supply chain coordination, and explores the relationship between innovation leadership and industrial scaling. Finally, the report concludes by offering the following observations for policymakers:

1. Policy measures to cultivate domestic industrial capacity should be grounded in market realities across the value chain; a coordinated strategy is essential to help sustain enabling conditions.
2. De-risking strategies should manage exposure while preserving the benefits of scale, specialization, and diffusion; indiscriminate decoupling can be counterproductive.

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3. Innovation and industrialization are distinct but complementary policy domains that require careful alignment; a healthy and competitive U.S. battery ecosystem requires both.

The State of Play

Overview

Spurred by demand growth and policy incentives, the U.S. battery sector has expanded substantially in recent years. New investment has seeded manufacturing clusters across multiple regions and strengthened employment. Yet progress has been uneven across the value chain. Downstream assembly and cell manufacturing have grown faster than midstream components such as cathode/anode materials, foils, and separators. Upstream segments continue to face structural constraints: Limited domestic reserves and processing capacity for key minerals make full self-sufficiency unlikely in the near term. These gaps have reinforced reliance on global supply chains, especially as China remains dominant in most segments. At the same time, allied partners have been central to recent U.S. capacity expansion as investors, operators, suppliers, and customers, reflecting the strategic significance of international engagement.

A STRATEGIC VALUE CHAIN IN RAPID EXPANSION

The global battery industry is entering a pivotal period. Having already reached a historical high of **1 terawatt-hour (TWh)** in 2024, total demand for rechargeable chemical batteries could more than **quadruple** from 2023 levels by 2030. Much of this growth is driven by the shift away from legacy lead-acid chemistries toward lithium-ion and other more energy-dense and durable technologies, whose share of total U.S. battery production rose from around 10 percent in 2013 to nearly 90 percent by 2022. Meeting projected demand at this scale requires a complex value chain (see Table 1) that could generate over **$400 billion** in revenues by 2030.

In the United States, this buildout has already **contributed to** substantial and geographically widespread economic and employment benefits. Spurred by the bipartisan Infrastructure Investment and Jobs Act (IIJA) and the Inflation Reduction Act (IRA), battery projects have helped drive a record wave of industrial spending that has seeded new manufacturing **clusters** across the South and Midwest. With more than 180 primary component facilities commissioned since 2019, battery manufacturing sites now span 38 states. As this footprint expanded, battery-sector employment also **reached** its highest level since 1972 in 2024—even as overall U.S. manufacturing employment declined—and was projected to **create** as many as 125,000 domestic jobs by 2032.

THE U.S. BATTERY BUILDOUT: MOMENTUM AND GAPS

Driven by this rapid buildout, total U.S. battery production **increased** by nearly 140 percent between 2020 and 2025, after years of stagnation. Despite this momentum, however, the localization of battery manufacturing has advanced unevenly across the value chain. Since the 2010s, most domestic capacity additions have concentrated in final-stage pack and module assembly, while investment in cell manufacturing only **accelerated** in the early 2020s. Capacity for critical battery components—including cathode and anode active materials, foils, and separators—has **lagged** even further, though electrolytes remain a notable exception.

Table 1: The Battery Value Chain

	Mining	Refining	Active materials and components	Cell	Pack	Recycling
Description	Extraction of battery minerals (e.g., lithium, nickel, cobalt, manganese, and natural graphite)	Chemical conversion of ores/brines/ concentrates into battery-grade materials (e.g., lithium carbonate/ hydroxide, nickel and cobalt sulphates, and synthetic/ processed graphite)	Production of electrode active from refined chemicals*, electrolyte, current collector foil, separator	Manufacturing of lithium-ion cells (i.e., coating electrodes, cell assembly, formation, and testing)	Assembly of cells into modules/ packs and integration with vehicles or storage	Collection, dismantling, and processing of end-of-life batteries and production scrap to recover and resell feedstock; includes second-life applications
Projected 2030 revenue (USD billions)	34	52	110	121	74	13

Note: *The electrode active materials from refined chemicals include cathodes and graphite/silicon anodes. See Table 3 for details.

Source: McKinsey & Company.

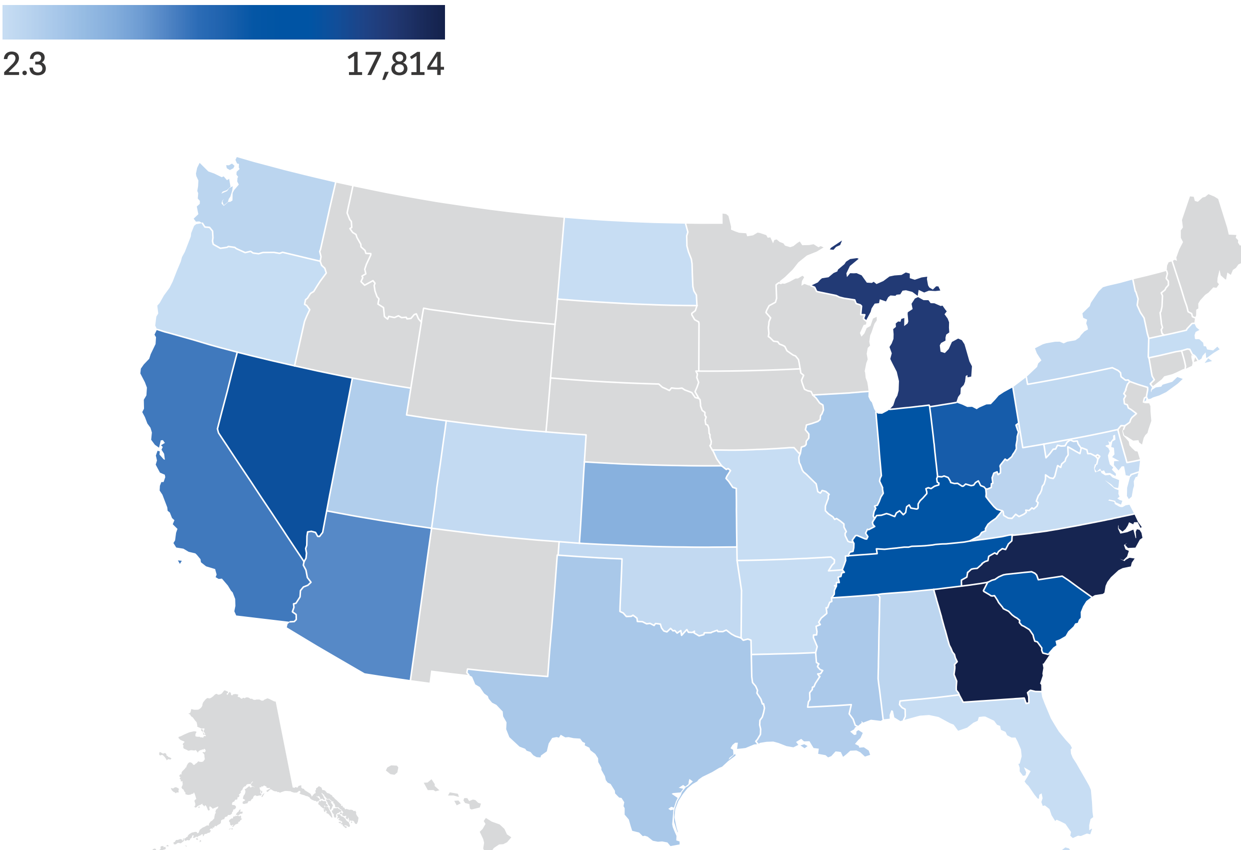
These trends highlight the structural constraints that make complete decoupling across the value chain unlikely. Most forecasts now suggest the cell and pack capacity in the pipeline as of year-end 2025 could meet—or even exceed—projected U.S. demand by 2030. In contrast, significant shortfalls are still **expected** for midstream components, even if all domestic capacity announced as of 2025 comes online by 2030. The upstream picture is even more **constrained**: With less than 1 percent of global **processing** capacity for lithium, less than 3 percent for nickel, and less than 1 percent of global **reserves** of nickel, cobalt, and natural graphite, the United States is deemed unlikely by industry **assessments** to meet the entirety of its minerals or refining needs with domestic capacity alone by 2030.

GLOBAL LINKAGES AND MARKET CONTEXT

Combined with the rapid expansion of downstream demand growth, these domestic capacity constraints have deepened U.S. reliance on global supply chains. U.S. lithium-ion battery imports **grew** almost sevenfold between 2018 and 2023. By 2024, lithium-ion batteries **accounted** for nearly 85 percent of all energy storage battery imports, compared to 17 percent in 2009. China is the main source of non-lead-acid energy storage battery imports, **supplying** nearly 70 percent of finished products and about 33 percent of parts in 2024. By absolute value, Chinese imports have increased more than tenfold from pre-pandemic levels.

Figure 1: Cumulative Announced Investment in Battery Projects Since 2018

USD millions invested



Source: Rhodium Group.

China's Market Gravity

U.S. import reliance reflects China's market leadership. Over past decades, China has **built up** domestic industrial and innovation capabilities that allow it to now command around **70-90 percent** of segments across the global lithium-ion value chain and produce packs at prices more than 40 percent **below** U.S. levels. Upstream, China produces around 80 percent of **mined** and **synthetic** graphite and possesses **over two-thirds** of global processing capacity for lithium, cobalt, and graphite. Midstream, China accounts for about **85-90 percent** of all global cathode and anode active material manufacturing capacity. Downstream, China possesses about **75-85 percent** of the world's total cell manufacturing capacity, compared to around 5 percent each for the United States and the European Union.

That said, China's competitive position is not wholly immovable. Factors such as a market correction in domestic **overcapacity** and the introduction of alternative supply could erode China's market preeminence; if all global projects announced prior to 2025 come fully online by 2030, for instance, China's share of total cell manufacturing capacity could be reduced by more than **15 percent**. Still, building the scale and sophistication needed to meaningfully displace

China's comparative advantages—particularly in resource-constrained segments—requires time, capital, and expertise; the recent collapses of **Northvolt** (EU) and **Powin** (U.S) prove this to be no easy feat. As things stand, Chinese incumbents will likely **retain** their global technical and cost leadership in the near-to-medium term.

China is not the only node in U.S. global linkages. Even as China's share of U.S. downstream cell and module imports rose from **44 percent to 71 percent** between 2020 and 2023, sourcing in upstream and midstream segments has diversified. Germany, for instance, has become the top supplier of anodes and cathode active materials. International partners have also been crucial—as direct investors or joint-venture operators—to recent U.S. manufacturing capacity expansions. Almost all major domestic cell plants currently in operation or under development have a non-U.S. partner; four leading Korean and Japanese incumbents alone are estimated to be **supporting** over half of all U.S. cell production capacity in 2026.

A Shifting Policy Environment

Overview

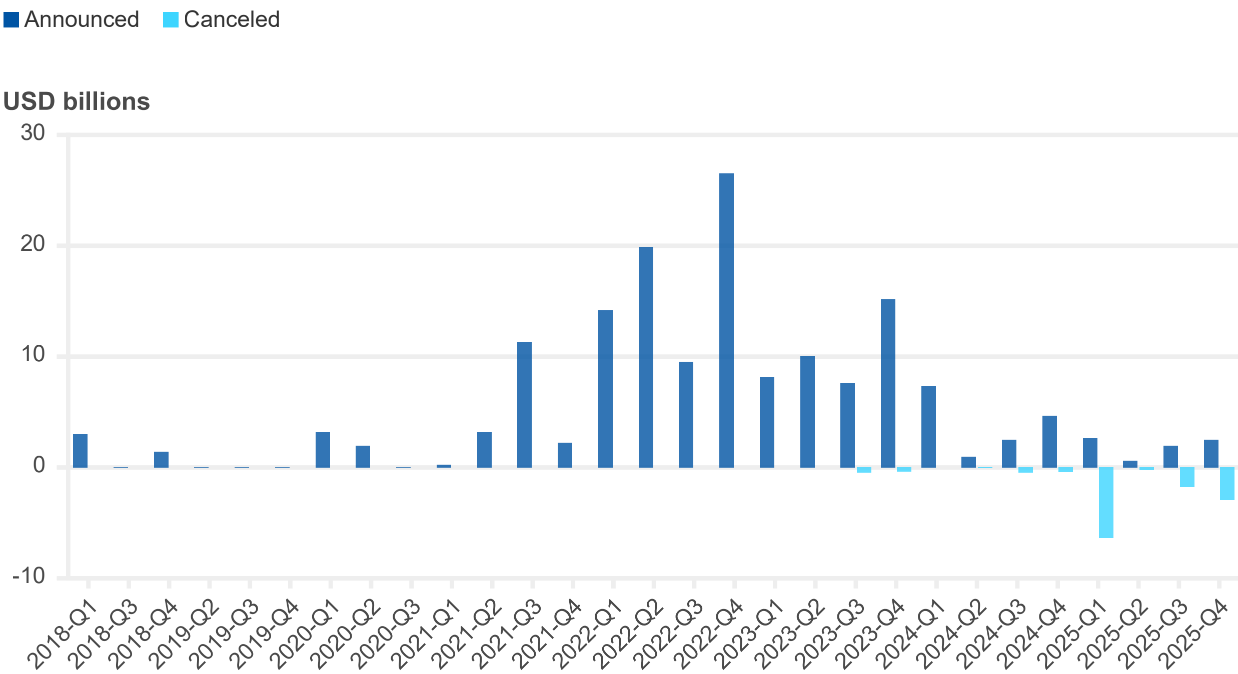
The U.S. battery sector now faces a more uncertain market environment, visible in its two biggest end-use segments. Transportation remains the primary demand anchor for batteries, but recent changes to policy incentives and regulatory frameworks have weakened the demand signal and increased downside risk for domestic capacity utilization. Grid-scale storage is an increasingly important growth market driven by reliability needs and improving economics, but its trajectory is sensitive to evolving constraints that include market rules, interconnection and permitting processes, and policy frameworks. At the same time, cross-cutting policy uncertainty is rising and affecting the entire sector. Sourcing restrictions and trade barriers have increased compliance cost and uncertainty, with implications for domestic capacity building. Together, these shifts highlight the need for coherent, predictable policy design.

The first section of this paper outlined a battery ecosystem marked by rapid growth, uneven capacity buildout across the value chain, and continued reliance on globally integrated supply chains. The focus now shifts to the forces reshaping that landscape: evolving market and policy dynamics that are that are redefining the outlook for transportation and grid-scale storage—the two segments set to dominate U.S. battery demand—along with broader cross-cutting uncertainties set to affect the entire manufacturing value chain.

TRANSPORTATION: STILL DOMINANT, BUT POLICY HEADWINDS MOUNT

As is the case in much of the world, transportation has historically been the primary driver of battery demand in the United States. Mobility sectors are expected to **remain** the dominant end market and to continue to account for roughly **75–90 percent** of total U.S. battery demand through 2035; about **40 percent** of operating and planned U.S. battery manufacturing capacity was tied to partnerships with automakers in 2025. Given this reliance, recent policy and regulatory shifts that risk weakening what had been a relatively clear demand signal in the auto sector could have outsized implications on the entire domestic battery value chain.

Figure 2: Battery Sector Investment Announcements and Cancellations



Source: Rhodium Group.

The One Big Beautiful Bill Act (OBBBA), signed into law in July 2025, presents immediate challenges. On the demand side, OBBBA eliminated key federal incentives provided by the IRA. The $7,500 new electric vehicle (EV) credit (Section 30D), $4,000 used EV credit (25E), and commercial EV fleet credit (45W) all terminated on September 30, 2025. Additionally, the home charging infrastructure (30C) credit will not apply to property placed in service after June 2026. The market response has been swift: U.S. EV sales declined by about **36 percent** between Q4 2024 and Q4 2025, after the tax credits expired in September. On the supply side, OBBBA also rescinds federal lending authorities that were crucial in **supporting** higher-risk projects across the battery value chain, including an estimated **$1.6 billion** in unobligated credit subsidy for the Advanced Technology Vehicle Manufacturing (ATVM) loan program.

Beyond direct incentives, recent regulatory changes also threaten two key compliance mechanisms that had been positioned to sustain high-volume demand for EVs and batteries. The first is the U.S. Environmental Protection Agency (EPA) 2024 Corporate Average Fuel Economy (CAFE) **standards** for model years 2027-2032, which **sets** fleet-wide average tailpipe emissions standards that automakers broadly **agree** can only be met if roughly two-thirds of new light-duty vehicles sold by 2032 are electric. OBBBA, however, eliminated monetary penalties for CAFE noncompliance while legal actions by **states** and **federal** agencies have further weakened the standards. At the same time, the EPA has also begun systematically challenging the legal foundation of broader federal emissions rules, including by moving to **repeal** its 2009 Endangerment Finding.

The second mechanism is California's Advanced Clean Cars II (ACC II) program, which **mandates** that 100 percent of new passenger vehicle sales by 2035 must be zero-emission vehicles and plug-in hybrids. The current administration has attempted to use the Congressional Review Act to **nullify** California's Clean Air Act waivers, which allowed the state to set its own–often stricter–standards such as the ACC

II. As of 2025, 17 states and the District of Columbia—together **accounting for** over 40 percent of new light-duty and 25 percent of new heavy-duty vehicle registrations in 2023—had adopted some subsets of California's standards.

Collectively, the attempted rollback of federal incentives and the erosion of federal- and state-level compliance regimes—along with associated litigation—have created legal uncertainties and economic headwinds that could slow EV adoption and, in turn, dampen domestic battery demand. U.S. EV sales in 2030 are projected by various industry **forecasts** to be as much as 44 percent (or about 14 million units) lower than pre-OBBBA expectations; a recent study estimates that the repeal of IRA clean vehicle tax credits and the EPA CAFE standards could result in the potential closure of **29–72 percent** of current cell manufacturing capacity, as well as all planned facilities.

POWER SECTOR: POISED FOR GROWTH AMID LINGERING UNCERTAINTY

Although mobility is expected to remain the primary demand driver, grid-scale storage is **emerging** as a dynamic growth segment. As electricity load rises while generation and transmission additions lag, flexible resources that can absorb surplus power and discharge during shortages are increasingly valuable for grid reliability and price stability. Battery energy storage systems (BESS) are uniquely positioned to **fill** this role while also being among the fastest assets to **deploy** in the United States. BESS deployment has increased **25-fold** between 2019 and 2025, making the United States **second** only to China in total installed storage capacity.

Still, the outlook for U.S. BESS deployment is far from certain. Renewables, which have historically enabled storage by creating colocation opportunities and favorable market conditions, face an immediate challenge from OBBBA's accelerated phase-out of solar and wind tax credits. Combined with broader policy **rollback** and regulatory **interference** targeting renewables, these policy headwinds could indirectly slow BESS deployment—even though OBBBA largely preserves incentives for storage, including the Section 48E technology-neutral investment tax credit (ITC) and the transferability mechanism, which **allows** developers to sell tax credits directly to third parties.

In the near term, renewable deployment may continue **rising** on the momentum of remaining IRA tax credits and demand related to load growth and reliability concerns. Roughly 76 percent of solar and 86 percent of wind projects slated to come online by 2029—or about 33 gigawatts (GW) of capacity—are **estimated** to be safe-harbored and will retain their tax credit eligibility. Over the longer term, however, the durability of this growth remains to be seen. As policy support recedes, projects will become more **sensitive** to underlying price signals. Markets with weaker pricing dynamics or slower interconnection processes, for instance, may be disproportionately affected.

Table 2: Remaining IRA Credits Directly Applicable to Batteries

Advanced Manufacturing Credit (Section 45X)	
Items	*Terms*
Cathode and anode active materials, electrolyte, battery-grade lithium and graphite processing	10 percent of production costs
Cell	$35 per kilowatt-hour (kWh)
Module	$10/kWh in addition to cell credit, or $45/kWh for modules that do not use cells
Tech-Neutral Investment Credit (Section 48E)	
Items	*Terms*
▪ Standalone battery storage projects ▪ Storage components of hybrid projects	▪ 6 percent of qualified investment, up to 30 percent if wage and apprenticeship requirements are met ▪ 10 percent bonuses each for energy community or domestic content

Source: Author analysis of the IRA.

Power Market Mechanisms as Enablers of Battery Deployment

As of 2025, roughly **890 GW** of storage capacity sat in interconnection queues, underscoring both developer interest and grid bottlenecks. Capacity payments and power market rules that govern how storage assets can **monetize** a stack of revenue streams—from capabilities such as energy arbitrage, ancillary services, and resource adequacy—will help determine whether these projects achieve commercial viability. The Federal Energy Regulatory Commission (FERC) has directed system operators to better integrate storage projects, but implementation remains **uneven** while revenue prospects **vary** across U.S. markets.

To improve project economics, power market mechanisms need to work in concert with underlying system characteristics including generation mix, load dynamics, cost-recovery frameworks, interconnection and permitting timelines, procurement mandates, and even local safety standards. Systems with high existing baseload and peaking capacity, for instance, may offer fewer recurring arbitrage opportunities for storage. At the same time, California and Texas—neither of which operates a forward capacity market—have nevertheless led the nation in battery deployment due to a variety of other **factors**.

Grid-scale storage deployment will directly affect demand volumes and utilization rates for domestic battery manufacturers. Previous forecasts **projected** storage's share of total battery demand to peak around 2030; more recent industry estimates suggest deployment could **exceed** expectations. Whether storage becomes a durable second growth driver alongside transportation, however, will depend on how developers and investors navigate evolving policy support, market rules, and revenue models—including how they balance merchant exposure and stable cash flow from tolling or power purchase agreements (PPAs) and ancillary service contracts.

CROSS-CUTTING SOURCES OF UNCERTAINTY

Sourcing Restrictions Introduce Added Complexity

Sourcing requirements are reshaping investment and deployment across the U.S. battery value chain. OBBBA introduces new restrictions on cross-border ties through the Prohibited Foreign Entity (PFE) criteria, which limits eligibility for the IRA's remaining Sections 45Y, 48E, and 45X tax credits. The PFE rule set expands on the Foreign Entities of Concern (FEOC) provisions that previously **governed** eligibility for benefits under the 2021 National Defense Authorization Act, IIJA, CHIPS and Science Act (CHIPs), and IRA. The new framework applies to most of the remaining IRA tax credits and restricts foreign entities' involvement in U.S. projects and firms across three categories: ownership, payments, and "**material assistance**." Violation of any of these categories could result in the U.S. taxpayer losing the ability to claim or transfer tax incentives.

Specifically, OBBBA prohibits corporate taxpayers deemed to be PFEs—either a specified foreign entity (SFE) or a foreign influence entity (FIE)—from receiving credits. Eligibility is similarly **denied** if a PFE is "involved in aspects of [a given] facility's development or ownership." Taxpayers may also face **recapture** of up to 100 percent of credits received within the last 10 years if they enter into arrangements that confer "**effective control**" to an SFE or FIE. In addition, projects are subject to the material assistance cost ratio (MACR) test, which **caps** the percentage of the supplies used to build a facility that can come from PFEs.

PFE Guidance for Battery Manufacturing Thus Far

As of 2026, U.S. battery manufacturers must **satisfy** three PFE screens at the firm, contract, and product levels to qualify for the 45X credit. At the entity level, battery manufacturers cannot claim 45X credits in any year in which they qualify as an SFE or FIE. SFE designation is triggered if a manufacturer is majority owned by governments, firms, or nationals of China, Russia, Iran, or North Korea; FIE status may apply if SFEs hold certain levels of equity, debt, or governance rights. Although the U.S. Department of the Treasury has **outlined** the framework, it has not yet finalized rules governing how foreign ownership and influence are calculated. At the contractual level, battery manufacturers must ensure that their commercial agreements are not deemed to **cede control** to a PFE. Contracts that grant authority over production volumes, customer selection, sourcing practices, operational practices, royalty payments, or licensing restrictions may jeopardize eligibility.

At the product level, battery components must **meet** a minimum MACR of 60 percent for components sold in 2026, rising to 85 percent for components sold after 2029. MACR measures the share of direct material costs attributable to non-PFE sources but excludes the cost of any constituent materials sourced from PFEs. Manufacturers may focus on a defined set of relevant inputs, primarily those identified in Internal Revenue Service (IRS) **safe harbor tables**—though there are currently no such guidelines for cells or electrode active materials. The Treasury Department **allows** flexibility in cost accounting through individual input tracking, de minimis assignment for low-value components, or averaging over specified periods. For tolling or contractual arrangements, direct material costs apply to those incurred by the producer but may also include costs borne by the 45X claimant if the producer did not assume the full cost. Manufacturers may use supplier certifications—either simple attestations or more detailed cost breakdowns—to prove compliance.[1]

Industry stakeholders broadly agree that the battery sector is especially exposed to sourcing restrictions due to its extensive international linkages. Although firms have begun **reconfiguring** supply chain strategies to comply with these requirements, substantial uncertainty remains regarding how the Treasury Department will define and enforce key standards, including those related to ownership, effective control, and supply chain tracing. Forthcoming Treasury Department **rulemaking**—with final guidance and updated safe harbor tables set for release by December 31, 2026—is therefore seen as essential to restoring clarity for long-term planning.

Beyond creating immediate sourcing bottlenecks, proposed restrictions on **licensing agreements** and other forms of technological transfer could intensify longer-term competitive challenges—particularly given China's growing share of global battery intellectual property and its leadership in the rapidly expanding lithium iron phosphate (LFP) market, where the country **accounts** for 98 percent of output. As lower-cost, higher-performance LFP batteries gain traction across both mobility and stationary storage applications, tightening licensing control could hamper U.S. manufacturers' ability to pivot away from legacy chemistries and respond to evolving demand.

Tariffs Compound Cost and Volatility

The U.S. battery industry finds itself in the crosshairs of escalating trade disputes. "Liberation Day" tariffs, for instance, imposed a **64.5 percent** composite import duty on Chinese lithium-ion batteries. At their peak, combined tariffs on Chinese lithium-ion batteries and components briefly reached a historic high of nearly **156 percent** in April 2025. Additional barriers in 2025 affecting battery manufacturing included 50 percent tariffs on **steel** and **copper**, a **93.5 percent** tariff on Chinese graphite, a **30 percent** baseline tariff on all Chinese goods, and **25 percent** Section 301 tariffs. Broader measures on other trade partners, such as **25 percent** reciprocal tariffs on South Korea, further increased import costs for battery products. Although the Supreme Court struck down tariffs imposed under the International Emergency Economic Powers Act (IEEPA) in February 2026, the administration has continued to **pursue** battery-related trade barriers through other authorities—such as Section 232 investigations—while maintaining existing ones, including a **10 percent** import surcharge under Section 122.

All else equal, tariffs on finished products may appear to increase the relative price competitiveness of U.S. outputs, but extensive reliance on imported inputs across the U.S. battery value chain means

1. Note: CSIS offers policy analysis, not legal advice. Interpretations reflect information and interim Treasury Department guidance released to date. Conclusions are subject to change.

that trade barriers can impose significant burdens on project developers and manufacturers alike. Recent industry analysis finds that high tariffs could increase the cost of BESS projects by **up to 50 percent**. For some segments, there are currently no adequate capacity pipelines or **feasible** commercial pathways by which domestic production could fully replace imports. Moreover, frequent and unpredictable changes to tariffs—as well as the attendant legal **uncertainties**—further increase investment risk. As the permitting and development cycles of battery capacity can take years to complete, tariff volatility directly translates to costs and delays that impair the financial viability of projects. In the near term, therefore, tariffs are more likely to catalyze higher costs than to drive immediate localization of the entire ecosystem.

The Strategic Outlook: Policy-Market Feedback Loops

Overview

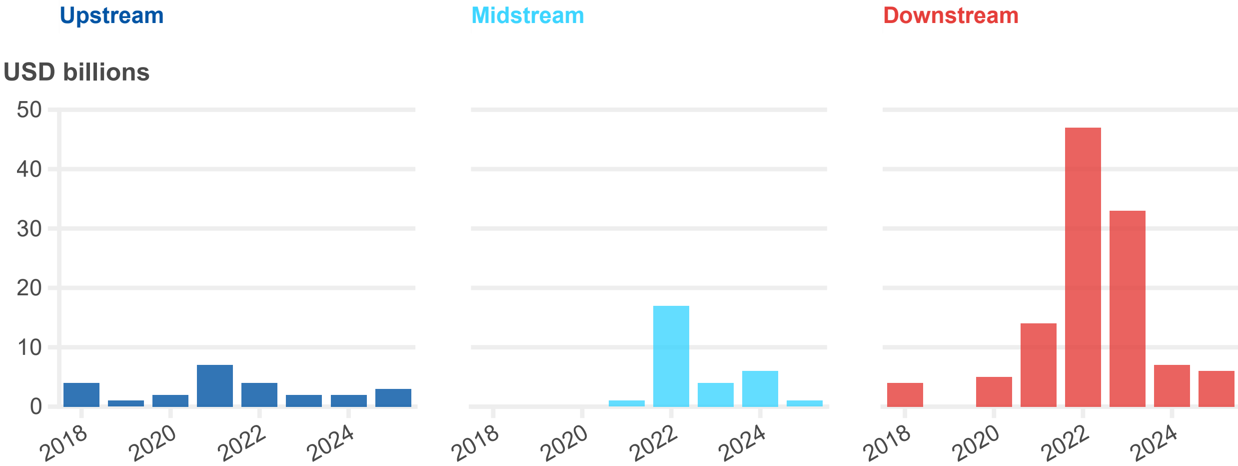
Policy and market shifts are prompting firms across the value chain to recalibrate. The adjustment is likely to be uneven. Downstream segments need to sustain utilization amid demand uncertainty; midstream segments remain difficult to finance without market coordination; upstream efforts must contend with resource constraints and commodity price exposure. Supply chain security is a central policy challenge that requires tailored intervention; complete decoupling is impractical, and carefully managed international linkages will remain crucial. Different segments present distinct risk profiles and cost tradeoffs, requiring calibrated approaches that balance domestic capacity-building, friendshoring, and diversification. Finally, this strategic outlook underscores that innovation leadership is inseparable from industrial capacity. Durable competitiveness depends on positive policy-market feedback loops that create an enabling ecosystem that allows technologies to commercialize at scale.

Recent developments are reshaping crucial feedback loops between public policy, technology change, and market behavior. This recalibration is already visible in investment and deployment activities: After a surge of announcements in 2022 and 2023, U.S. battery manufacturing investment has fallen **roughly 38 percent** from its late-2024 peak. In total, $8 billion in battery projects were announced and $11 billion were **cancelled** in 2025, marking the first time in recent years that cancellations have exceeded new announcements. Several major battery manufacturers have also announced plans to **pivot** capacity away from mobility and toward grid storage, even though the segment can have lower margins. Looking ahead, three interconnected dynamics will bear outsized implications for the trajectory of the U.S. battery value chain: (1) how shifting demand and policy signals reshuffle the domestic industrial base, (2) whether supply chain security objectives can be advanced without undermining deployment, and (3) how innovation pathways evolve under new opportunities and constraints.

INDUSTRIAL BASE RECALIBRATION

Rather than a uniform slowdown or expansion, the U.S. battery ecosystem is likely to see asymmetric adjustment, with different segments responding differently to changing demand expectations, cost structures, and regulatory exposure. Understanding these uneven effects will be essential for policymakers to design—or revamp—strategies for specific segments.

Figure 3: Announced Investment Across Value Chain Segments



Note: For the purposes of this analysis, upstream segments include mining and extraction of minerals and materials; midstream segments include refining and processing for battery-grade materials, cathode and anode active materials, separators, foils, and electrolytes; downstream segments include cell and pack manufacturing.

Source: Rhodium Group.

Downstream: Utilization as the Binding Constraint

Downstream manufacturing–cells, modules, and packs–had been the primary beneficiary of policy efforts prior to 2025. Projects currently in the pipeline could **increase** U.S. cell and module manufacturing capacity fourfold and fivefold, respectively. Under scenarios in which EV demand weakens significantly and storage growth does not fully compensate, however, this buildout could result in overcapacity by 2030–especially in cells, where planned capacity is already sufficient to meet even high-demand projections. Even if surplus domestic output finds export markets, U.S. producers in these segments are unlikely to achieve **price parity** with Chinese competitors.

Firms' recent pivots toward stationary storage reflect relative resilience of BESS demand under current policy conditions. But if producers converge on the same–and potentially smaller–set of bankable offtake opportunities, competitive pressure may intensify and raise the likelihood of bankruptcies and consolidation; this potential "**bullwhip effect**" is **compounded** by long lead times in the battery supply chain. The policy challenge for downstream segments, therefore, lies in whether demand-side levers can support sustained utilization. Without demand anchors, capacity additions may fail to translate into a durable industrial base.

Midstream: A Market Coordination Challenge

Despite recent activity, projected domestic midstream capacity additions–including for the processing of precursor materials and the manufacturing of components such as cathode and anode active materials, foils, and separators–still lag the planned cell and module buildout. A difficult **mix** of upstream supply volatility, downstream demand uncertainty, intense global competition, and regulatory hurdles have suppressed domestic investment. As policy incentives contract and trade arrangements shift, future capacity additions are likely to prioritize cost competitiveness, potentially further weakening incentives for friendshoring or localization; about 450 kilotons per year of cathode and anode capacity had already been **canceled** between Q3 2024 and the same period in 2025.

Midstream segments could benefit from clearer statutory treatment and a more targeted policy approach. For example, the two-year delay in IRS guidance for the treatment of midstream components under the IIJA was **viewed** as partially responsible for underinvestment. Policy interventions should focus on improving the bankability of strategic capacity through market-making and coordination—either domestically or with allied partners. Tools such as procurement anchors, price guarantees, warehousing, and risk-sharing mechanisms can help underwrite early investment until scale and ecosystem effects improve commercial viability. Such targeted support may be particularly warranted in segments that deliver crucial system-level benefits but face persistent project-economic challenges, such as refining.

Upstream: Structural Bottlenecks and Strategic Interventions

Supply-side policy efforts have lent momentum to U.S. critical minerals projects, but structural **constraints** remain. Limited resource endowments, high capital intensity, long lead times, environmental concerns, and technical complexity all mean the U.S. battery industry will rely on imports for key upstream inputs in the near term. Alongside retaining incentives for domestic investment where feasible, the strategic priority should be to diversify supply and strengthen resilience without sharply increasing costs. This requires granular analysis to identify which specific minerals and upstream capabilities constitute binding bottlenecks. Domestic lithium projects, for instance, have proven attractive to investors, in contrast to muted commercial interest in graphite.

Beyond project-level support, policymakers have proposed market-based instruments such as strategic resource reserves or a government-backed clearinghouse for price benchmarking to help mitigate volatility and reduce vulnerability to supply shocks. Strengthening credible midstream and downstream demand signals (see above) and easing regulatory burdens—especially permitting—could also create broad-based benefits. Ultimately, policy effectiveness will hinge on tailoring interventions to the specific characteristics and market structures of each mineral or input; ad hoc measures that distort incentives or privilege a narrow set of players can be counterproductive.

SUPPLY CHAIN SECURITY: A BALANCED APPROACH

Adjustments across the battery industry are increasingly shaped by efforts to manage supply chain exposure. As firms reassess procurement relationships, the central policy challenge is to strengthen resilience without eroding deployment economics or undermining the scale and learning effects needed to build a durable domestic industrial base. Critically, supply chain security is not synonymous with complete onshoring or uniform localization across the value chain. Different segments present different risk profiles, cost structures, and strategic sensitivities. In some segments, acute vulnerabilities or market failures may justify reshoring; in others, friendshoring among trusted partners or diversified global sourcing may provide sufficient resilience at lower cost.

Batteries for Defense

Defense applications for batteries account for a minor but noteworthy portion of the U.S. market. Between 2010 and 2022, the U.S. Department of Defense (DOD) procured at least **7 gigawatt hours (GWh)** of rechargeable batteries for about $1.8 billion; yearly demand during this period was estimated to be between 500 and 700 megawatt hours, compared to around 100 GWh in **total** U.S. demand in 2023.

Lead acid chemistries account for most military batteries in demand today, and specialty designs will continue to be necessary for many bespoke applications. However, lithium-ion batteries–mostly nickel manganese cobalt (NMC), and increasingly, LFP–are projected to meet the bulk of defense battery demand by 2050. Under its 2024 aggressive electrification scenarios, DOD lithium-ion demand could reach **1 GWh** per year by 2053.

Existing DOD efforts have identified measures such as interservice standardization and coordination to help meet this demand. While specialized manufacturing capacity exists to meet certain military-specific form factors and performance profiles, the defense segment remains a fraction of the total lithium-ion batteries market. As a result, proactive and sustained linkages with the broader consumer-oriented industrial base will remain crucial for defense needs.

U.S. priorities in the battery sector span multiple–and potentially competing–objectives: reliability of supply, integrity of equipment and software, long-run manufacturing competitiveness, and sovereignty for sensitive applications. Each implies different risk tolerance and requires different policy approaches. Upstream capacity critical to defense applications, for example, may still require commercial demand from broader consumer markets. Effective de-risking therefore requires clarity about what is being secured, for which end uses, and at what cost, while also accounting for ecosystem interdependencies. Absent this discipline, policy can drift toward blunt localization mandates that weaken the very industrial base they aim to protect.

Global Linkages as an Asset

Even with aggressive reshoring strategies, international commercial partnerships and allied sourcing are likely to remain integral to the U.S. battery ecosystem. Canadian projects, for instance, were broadly counted on to support U.S. need for nickel, cobalt, and graphite for the near term as of 2025. Although U.S. mineral production may expand, the country still **lacks** sufficient reserves for key inputs; mining alone also does not solve the more binding constraint of limited domestic refining and processing capabilities. Conversely, the U.S. market has proven to be a crucial demand anchor that enables the necessary upstream projects to get built in partner countries. As a result, supply chain security will depend as much on sustained international diplomatic and commercial engagement as on domestic initiatives.

Beyond access to inputs and capital, U.S. battery manufacturing also benefits from the technical and operational know-how of the country's international partners. Battery manufacturing requires a variety of skills, from engineering and process optimization to assembly. In particular, specialized personnel such as assemblers, fabricators, and metal and plastic workers **require** extensive technical programs or on-the-job training; foreign battery manufacturers have played an **outsized role** in providing this assistance and could continue to support domestic **workforce development** efforts. U.S. battery manufacturers' international operations have likewise benefited from cross-border market integration; about **57 percent** of Mexico's lithium-ion imports, for instance, came from the United States and supplied U.S. EV plants in the country.

Acknowledging Market Realities

Despite recent momentum, the U.S. battery sector continues to lag global industry incumbents in scale and cost competitiveness. If sourcing restrictions and compliance rules become overly rigid, complex, or unpredictable, they risk raising the cost or constraining the performance of compliant batteries. In this case, firms may instead favor imported alternatives, whose cost or quality advantages could partially or fully offset the opportunity costs of policy incentives and avoided tariffs. For instance, recent industry analysis **indicates** that even with an estimated 58 percent tariff in place as of January 2026, U.S.-produced LFP battery cells still require the 30 percent ITC to match Chinese imports on cost.

Evaluating National Security Risks from Imports

Inverters—essential components that enable BESS to convert direct current into alternating current and vice versa—are increasingly equipped with communications capabilities that enable remote monitoring, diagnostics, and operational adjustments. While these features improve performance and maintenance efficiency, they also create potential cybersecurity vulnerabilities; compromised components could allow unauthorized actors—domestic or foreign—to disrupt battery operations at scale, potentially destabilizing and damaging U.S. grid infrastructure.

Although such risk had previously been recognized in principle, scrutiny intensified following a May 2025 Reuters article **alleging** the discovery of undocumented communication devices in batteries from Chinese suppliers. In mid-November the same year, some 50 members of Congress **asked** the Commerce Department to ban the import of Chinese battery inverters and related equipment, **citing** "unacceptable national security, economic, and supply chain risks." In February 2026, however, Reuters **reported** that "DOE assessments [had] found no definitive evidence of intentionally introduced malicious wireless functionality" when the agency inspected about 30 inverters from China. It remains to be seen if or how the Commerce Department responds to the congressional request.

As the U.S.-China relationship remains in flux, debate over what constitutes an acceptable level of reliance on Chinese technologies is likely to persist. At its core, the issue is about how risk should be defined and prioritized. Clarifying what is at stake is the first step: is it a particular sector, broader industrial competitiveness, or military self-reliance? Equally important is understanding if the risk is immediate and material, or more latent and hypothetical. Moreover, are these risks unique to Chinese-origin components, or inherent to digitally networked energy systems? Framing the debate around these distinctions can foster a calibrated approach that addresses genuine security vulnerabilities without defaulting to unnecessarily disruptive measures that could slow deployment, deter investment, or hinder innovation.

The potential tradeoff between cost and compliance will shape procurement decisions, influence technology pathways, and affect market composition. With global battery prices expected to continue **declining** in 2026, localization requirements and compliance burdens that raise near-term costs too sharply can slow deployment and undercut the learning-by-doing and transfers needed to make domestic production competitive over time; they may also **decrease** the impact and fiscal efficiency of existing incentives. Successful capacity-building strategies should therefore prioritize establishing demand and de-risking investment first through clear rules and predictable interventions.

Allied Industrial Strategy and Realignment

The structure of the global battery value chain—and the U.S. position within it—will be shaped as much by allied strategy as by domestic policy. As the global market and geopolitical environment shift, some U.S. allies may pursue alternative arrangements to advance national strategic goals. Recent developments illustrate this dynamic: In **Canada** and **Europe**, for instance, resistance to partnerships with Chinese firms has begun to soften in early 2026. Upstream producers, such as Argentina and Australia, may likewise seek alternative offtake markets as uncertainty grows in U.S. end-use segments. Such realignments can have lasting **consequences** for the global distribution of capacity and expertise.

For U.S. policymakers, this underscores that supply chain de-risking requires sustained diplomacy attuned to where allied incentives align and where comparative advantages are complementary. Rather than relying on unilateral measures or insisting on uniform alignment, a pragmatic allied industrial strategy can reduce concentration risk while preserving economies of scale through targeted cooperation and a deliberate division of roles across capital, materials, and manufacturing capacity. Well-designed international partnerships can secure access to critical inputs while facilitating the transfer of expertise needed to build durable domestic capability. Operationally, international engagement is also essential to harmonizing complex technical and regulatory **frameworks**.

MANAGING THE INNOVATION-INDUSTRIALIZATION NEXUS

Patent trends **illustrate** both existing strengths and emerging constraints in innovation: The United States is a qualitative leader in advanced LFP and NMC technologies, while China leads in overall patent volume across both mature lithium-ion chemistries and emerging alternatives such as solid-state and lithium-sulfur batteries. Although technical progress remains essential, innovation leadership is increasingly **inseparable** from the ability to commercialize and manufacture at scale under evolving market and policy conditions.

Understanding Technology Pathways

For lithium-ion technologies, electrode chemistry accounts for roughly 70 percent of cell costs and about 25 percent of total pack costs and is the central determinant of cost, performance, and raw material requirements; shifts in chemistry therefore carry significant competitive implications. Historically, U.S. battery technology choice was shaped by "range anxiety" in the EV market, which favored energy-dense chemistries such as NMC. As stationary storage begins to account for a larger share of demand, less **energy-dense** but cheaper chemistries—namely LFPs— have gained **momentum**, mirroring a global **shift**. In total, the United States now has an estimated 200 GWh of LFP capacity in the pipeline by 2030.

U.S. manufacturers report that switching production between EV and grid storage batteries is financially and operationally feasible, though not without friction. Retooling lines and retraining workers for different electrode chemistries is also achievable, as reflected by announced plans to retrofit **existing** plants, but **variations** in casing and form factor requirements can introduce complications or prevent manufacturers from capitalizing on existing process expertise and cost advantages. In practice, U.S. manufacturers may be able to adapt to shifting demand—but which technology pathways ultimately prevail will depend on how markets respond to relative costs, performance requirements, and policy incentives.

Table 3: Predominant Battery Technologies

Chemistry/ attributes	Lithium nickel manganese cobalt (NMC)	Lithium nickel cobalt aluminum (NCA)	Lithium iron phosphate (LFP)	Lithium-titanate (LTO)	Vanadium flow (VFB)	Sodium-ion (NIB)	Solid-state (SSB)
Maturity	Fully commercial	Fully commercial	Fully commercial	Niche commercial	Niche commercial	Early commercial	Pre-commercial
Energy density	High	Very high	Medium	Low	Very low	Low-medium	Very high
Anode	Graphite	Graphite	Graphite	Lithium titanate	Liquid vanadium electrolyte	Hard carbon	Lithium-metal
Cycle life	Medium	Medium	High	Very high	Extremely high	Medium	High
Thermal safety	Moderate	Moderate	Excellent	Excellent	Excellent	High	Excellent
Cost	Medium-high	High	Low	High	Medium-high	Very low	High
EV suitability	Excellent (long-range)	High-performance	Fleets and mid-range	Limited	Not suitable	Early adoption (low-range)	Future long-range
BESS suitability	Good	Limited	Excellent	Niche (fast-charge)	Excellent (long-duration)	Strong potential	Future

Source: Alabama Mobility and Power Center.

In the near term, commercially mature lithium-ion chemistries are likely to remain dominant, as continued innovation and manufacturing scale drive down costs. Globally, NMC, NCA, and LFP together represented **over 90 percent** of total EV sales in 2024, effectively setting the direction of the broader battery market. Although emerging alternatives—such as sodium-ion and solid-state batteries—have made meaningful technical and commercial progress in recent years, in the absence of major breakthroughs they are still likely to only play a complementary role; their combined market share is generally expected to remain **below 10 percent** in the near-to-medium term.

Innovation and Industrialization in Tandem

Looking ahead, the United States may still find opportunities to reposition itself in technological domains where leadership is not yet consolidated as the next **wave** of innovation takes shape. These opportunities span novel battery chemistries and alternative technology categories, such as **long-duration energy storage** (LDES). Similarly, emerging value chain segments such as recycling could create new commercial opportunities while easing U.S. resource constraints. In addition, although U.S. firms face structural disadvantages including higher energy and labor costs and a lack of vertical integration, they may be able to narrow cost gaps through operational means. AI could offer a potentially crucial lever: Predictive algorithms, for instance, could **compress** development cycles by accelerating new battery chemistry discovery and experimental validation through rapid iteration, while AI tools on the factory floor could help firms flatten the learning curve by improving yields and detecting defects.

Whether these opportunities translate into defendable competitive strengths, however, will depend on more than just first-mover R&D advantage. Even technically promising innovations will struggle to scale without an **enabling ecosystem**—capital access, workforce availability, regulatory clarity, industrial clustering, demand signals, and credible revenue models. These needs may become more acute if continued cost and performance improvements in lithium-ion technologies further raise the barrier of entry for emerging alternatives, which must compete within markets increasingly optimized for lithium-ion deployment. As a result, policy may need to play a bridge role by reducing early-stage commercialization risk long enough for learning effects to take hold, or by helping to build out the necessary infrastructure. History offers a useful **precedent**: Targeted tax incentives in the U.S. shale sector helped de-risk early investment and crowd in private capital, which sustained technological improvements in drilling and completion that eventually underpinned U.S. global leadership in the decades since.

Key Policy Observations

Recent market shifts underscore a recurring theme in industrial capacity-building: While policy incentives can catalyze investment, long-term competitiveness ultimately depends on enabling conditions that sustain commercial viability over time. Capital-intensive industries with thin margins and intense competition—such as the battery sector—are especially sensitive to policy-induced changes in both demand anchors and supply-side enablers. As such, the U.S. battery manufacturing ecosystem offers a revealing case study in how public policy and private capital can converge to strengthen industrial resilience.

With cost and performance competitiveness closely linked to scale, systemic inertia, and supply chain maturity, the central policy challenge is less about picking technological winners than about fostering commercialization environments that allow innovative solutions to grow organically. For batteries, this may include power market structures that reward flexibility and firm capacity, procurement frameworks that solidify demand signals, policy incentives that lower financing costs, favorable interconnection and permitting treatments that reduce completion risk, as well as compliance regimes that reinforce learning and aggregation across the value chain.

The following observations translate this report's findings into actionable policy insights, organized around three central challenges: (1) building capacity where constraints are most binding, (2) de-risking without sacrificing the benefits of scale and diffusion, and (3) aligning innovation policy with industrial strategy.

1. **Policy measures to cultivate domestic industrial capacity should be grounded in market realities across the value chain; a coordinated strategy is essential to a durable enabling ecosystem.** Rigorous market analysis is critical to identifying the interdependent supply- and demand-side dynamics at play—and to understanding how policy interventions can align incentives across segments and stakeholders. Although access to cost-competitive inputs, leading technologies, and efficient production practices matters across the battery value chain, these factors may weigh more heavily on downstream segments that compete on scale and cost. Upstream and midstream projects, by contrast, may be more sensitive to demand certainty and commodity price volatility. These needs are heterogeneous but interlinked: Misalignment between segments or stakeholders can stall or distort development across the entire ecosystem, while policy uncertainty can have similar ripple effects. Achieving strategic goals therefore requires policymakers to reinforce intended market signals through coherent fiscal, trade, and regulatory measures that are deliberately sequenced and consistently executed.
2. **De-risking strategies should manage exposure while preserving the benefits of scale, specialization, and diffusion; indiscriminate decoupling can be counterproductive.**

International partnerships have played an essential role in enabling the recent wave of battery manufacturing in the United States. Sweeping, abrupt decoupling that ignores market realities can backfire by undercutting deployment economics and learning curves. Efforts to reduce U.S. supply chain vulnerabilities should instead be guided by clear priorities, consistent policy signals, and disciplined deliberation over the appropriate scope and depth of de-risking. Certain sensitive battery applications or components may justify more thorough decoupling, but they often still rely on adjacent consumer-oriented industrial bases. Frequently, selective linkages are unavoidable—or even advantageous—particularly when resources, capabilities, or comparative advantages are geographically dispersed or prohibitively costly and time-consuming to localize. Where linkages remain appropriate, well-designed cross-border arrangements can still advance strategic objectives by sustaining capital formation, economies of scale, and technology and knowledge transfer.

3. **Innovation and industrialization are distinct but complementary policy domains that require careful alignment; a healthy and competitive U.S. battery ecosystem requires both.** Each of these two domains may prioritize different objectives over different scopes and timelines: Innovation efforts target long-term global competitiveness and differentiation, while industrialization focuses on scaling domestic capacity within existing market constraints. But innovation and industrialization should not be pursued in isolation, as neither can substitute for the other—innovation must reflect commercialization realities, and industrialization must remain adaptive to technological change. For batteries, ambitions to pivot to next-generation pathways must contend with the infrastructure, supply chain, and end use inertia of incumbent technologies. Through calibrated interventions, policymakers can harmonize innovation leadership and industrial capacity, which can be mutually reinforcing when effectively coordinated. ■

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