Above-Ground Bottlenecks: The Real Critical Minerals Crisis

Supply chains are breaking not in the mine, but in the classroom, the waste facility, and the regulator's mandate.

Frame

When a system scales, the money moves to the input that cannot scale with it. This board names that input, the date it starts to bite, and the line that would break the call.

Area
critical minerals

Horizon
2030 to 2040

Issued
2026-06-20

Method
Wide cast, adversarial gate, public resolution criteria.

Board summary

The cross-cutting read

The board converges on a structural shift away from geology as the binding constraint on critical minerals supply, toward inelastic human capital shortages (P1, P3), regulatory waste disposal caps (P2), and unmeetable recycled content mandates (P4). These overlooked bottlenecks form a self-reinforcing choke point upstream of financing and scaling, rendering resource abundance irrelevant without the people, permits, and processing infrastructure to unlock it.

At a glance

#	Claim	Binding constraint	Case	Call	Resolves
P1	Resurgent domestic mining investment under the Defense Production Act and IRA	Number of active Qualified Persons with hard rock experience listed in the SME registry, versus the number of...	85%	60%	2032-06-30
P2	Existing rare earth processing projects with assured waste disposal permits will command massive scarcity premiums...	The approved remaining capacity in domestic NORM disposal facilities for thorium-bearing waste (in dry metric...	78%	55%	2038-06-30
P3	The rare earth processing bottleneck shifts from resource access to human capital, benefitting services companies...	The number of US graduating seniors in metallurgical/materials engineering who specialize in extractive...	75%	60%	2034-12-31
P4	By 2035, mandatory recycled content requirements in the EU and US force battery makers to source 20%+ of lithium...	The EU's mandatory recycled content requirement for cobalt (16%) and lithium (6%) becomes effective on...	65%	40%	2035-01-01

Case is the strength of the structural thesis. Call is the probability on the exact dated clause.

P1

The US critical minerals boom stalls at the drill core: a shortage of Qualified Persons freezes project financing by 2031

Domain: Mining regulation and finance

2032-06-30

Structural case	Our call, dated	Resolves
85%	60%	2032-06-30

As capital floods into critical mineral projects, the binding constraint migrates to the human capital required to sign off on resource estimates under SEC's S-K 1300; the limited pool of Qualified Persons causes a logjam, delaying IPOs and streaming deals

The boom	Resurgent domestic mining investment under the Defense Production Act and IRA
Why it is not priced yet	Unaccounted-for: analysts assume funding is the bottleneck, but the real friction is the credentialing bottleneck that blocks conversion of exploration projects into bankable assets
Where the price sits today	No direct liquid market prices this mechanism. The Manifold markets listed center on specific mine licenses, country resource control, or individual company production, not on a systemic QP bottleneck under SEC S-K 1300. Mining equity analysts may flag labor shortages generally, but the precise credentialing logjam as the binding constraint on project financing is not a consensus narrative.
The binding constraint	Number of active Qualified Persons with hard rock experience listed in the SME registry, versus the number of open project positions
What we are watching	Average time from discovery to maiden resource estimate for US critical minerals projects, as a lagging indicator
What would prove us wrong	The SEC significantly liberalizes QP requirements or a state-sponsored certification fast-track program graduates 200+ new QPs by 2028
How we tried to break it	The kill condition, SEC liberalization or a fast-track QP pipeline, is a live possibility that would directly resolve the shortage. Companies could also circumvent the bottleneck by using foreign QPs recognized under mutual recognition agreements, or by restructuring deals to avoid S-K 1300 triggers (private placements, royalty/streaming structures). The booming capital might not materialize at the scale assumed, or it might shift to jurisdictions with lighter regulatory requirements. Even if a QP crunch emerges, project delays may be absorbed as 'expected friction' rather than a headline-grabbing 'freeze' by 2031. The data layer is blind to the active QP pipeline and real-time project staffing demand, so the inelasticity of the QP supply relies on first-principle reasoning rather than measured signals.

Why we are making the call	The call identifies a specific, inelastic human-capital constraint (Qualified Persons under S-K 1300) that sits upstream of project financing, while the crowd focuses on funding availability. The data layer shows no direct signals on the QP pipeline, a genuine blind spot, but the accelerating CORDIS projects and steady Federal Register rulemaking suggest a growing pipeline of critical mineral ventures. The structural dependency is narrow: without a signed-off resource estimate, projects cannot access public capital or streaming deals. The kill condition is well-defined, bounding the timeframe. The clause_p of 60 reflects the binary risk that the SEC acts or workarounds emerge, but the vision_p remains high because the bottleneck is real and underappreciated. The market anchor reveals no pricing of this exact logjam, giving the thesis an edge.

If the call is right

Who is exposed

U.S. Department of Energy Loan Programs Office (LPO) credit analysts, the desk that conditions Title 17 loans to critical mineral projects on S-K 1300 resource estimates.

Action now

Pre-commit to accepting resource estimates signed by Qualified Persons recognized under the 2012 CRIRSCO Mutual Recognition Agreement (e.g., Canadian NI 43-101 QPs) to insulate the DOE loan pipeline from domestic QP scarcity.

Decision it changes

Shift LPO provisional financing from pre-resource exploration-stage juniors to development-stage projects that have already filed S-K 1300 compliant technical reports, prioritizing the few with signed estimates.

ROI / risk logic

Early reallocation avoids a 12-24 month delay and 15-30% project cost escalation from the bottleneck, preserving the LPO's capital deployment schedule and capturing a timing edge before competing lenders bid up advanced assets.

Value concentrates in U.S.-domiciled mining consultancies holding dense QP benches, and in the specific projects whose compliant resource is already on file with the SEC: SRK Consulting's Denver and Reno offices, Tetra Tech's Golden office, and the Thacker Pass lithium resource held by Lithium Americas.

Who gains

SRK Consulting (U.S.) Inc.: Its staff of 40+ SME-registered QPs commands premium billing rates as demand outpaces supply.

Lithium Americas Corp. (LAC): Its Thacker Pass project's fully signed-off S-K 1300 resource becomes a scarce bankable asset, lowering its cost of equity and debt.

Perpetua Resources Corp. (PPTA): Its Stibnite Gold-Antimony project already has a compliant resource and advances into permitting while peers stall.

Who loses

U.S. Gold Corp. (USAU): Early-stage Nevada exploration assets lack a QP-signed resource, blocking access to the capital needed to advance.

Piedmont Lithium Inc. (PLL): Its Tennessee project faces a financing freeze unless it secures an in-state QP, an increasingly scarce commodity.

American Battery Technology Company (ABAT): Its lithium claystone project has no compliant resource, rendering it unbankable until a QP is contracted.

What reprices

No clean instrument directly prices the QP bottleneck; proxy: implied volatility on out-of-the-money call options on junior U.S. critical mineral names widens as the first financing delays are disclosed in SEC filings.

The next constraint it creates

Once the QP pipeline clears, the binding constraint shifts to NEPA permitting review capacity at the U.S. Forest Service and Bureau of Land Management, as a wave of advanced projects now needs environmental impact statements.

Earliest sign it has begun

First public withdrawal of a S-1 registration for a U.S. critical mineral IPO citing inability to obtain a QP opinion on its resource, expected in company filings by Q2 2026.

P2

Rare earth oxide processing outside China will be capped by 2038 due to insolvable radioactive waste disposal permitting.

Domain: Critical minerals, processing waste infrastructure

2038-06-30

Structural case	Our call, dated	Resolves
78%	55%	2038-06-30

Monazite-based rare earth processing generates thorium and uranium-bearing waste streams classified as NORM. Disposal requires specially licensed facilities, and in the US there is only one operating NORM disposal site. The EU has even stricter regulations. The data shows EU CORDIS projects scaling at 20% CAGR in total cost, but no accompanying waste disposal projects. Federal Register policy documents are steady, but rulemaking documents are zero, indicating no new waste rules easing the path. With production scaling ambitions, waste volumes will outstrip disposal capacity by 2035. The dependency on rare-earth imports will persist not because mines are absent, but because no one can get rid of the radioactive byproducts.

The boom	Existing rare earth processing projects with assured waste disposal permits will command massive scarcity premiums, while new entrants without a waste pathway become stranded assets. The value of disposal capacity as a moat will be realized.
Why it is not priced yet	Markets trade lithium mine licenses, copper production targets, and even US control over cobalt resources, but there is no financial instrument tracking NORM disposal capacity. It is an invisible infrastructure crisis. The edge is the inelasticity of permitting: a new disposal site can take 10-15 years to permit, while processing plants can be built in 3-5 years. No planned large NORM site in the West is under construction.
Where the price sits today	No liquid market tracks rare earth NORM disposal capacity. Manifold markets cover only extraction and production (lithium, copper, cobalt), not waste infrastructure bottlenecks. The thesis is unpriced in these venues, and equity coverage rarely isolates disposal capacity as a standalone moat.
The binding constraint	The approved remaining capacity in domestic NORM disposal facilities for thorium-bearing waste (in dry metric tons per year).
What we are watching	Track annual volumes of thorium-bearing waste generated by rare earth processors vs remaining licensed capacity; a ratio exceeding 0.8 by 2030 indicates an inevitable bottleneck.
What would prove us wrong	If the US or EU licenses a new, large-scale NORM disposal facility by 2032 that adds at least 10,000 metric tons/year of capacity.

How we tried to break it

1. Data blind spot: The grounding pack has no measured signal on remaining NORM disposal capacity, so the bottleneck timing is speculative. 2. Policy acceleration: National security emergency could fast-track a disposal site, undermining the 10-15-year timeline and killing the call by 2032. 3. Alternative geographies: Countries like Australia or Canada might permit disposal more easily, easing the constraint. 4. Waste minimization: New processing technologies (e.g., direct thorium extraction, in-situ leaching) could reduce waste volumes below capacity thresholds. 5. On-site storage: Temporary storage may delay the cap beyond 2038 without constituting a permanent solution. These counter-arguments temper clause_p but do not fully negate the structural inelasticity shown by zero rulemaking and project growth outpacing waste planning.

Why we are making the call

The ground data: spine layer gaps hide actual waste capacity, but policy signals (zero rulemaking) and project growth (CORDIS +20% CAGR) show scaling production without waste solutions. The market anchor only covers extraction bets, not waste infrastructure, so the specific 'waste cap' thesis is unpriced. The structural dependency (monazite → NORM → single US disposal site) forms a genuinely inelastic input with a 10-15 year response lag. However, clause_p is constrained by unknown remaining capacity and potential policy shifts. The call survives refute because no liquid market contradicts it and the policy vacuum is measurable, making it a pre-consensus edge with moderate resolution odds.

If the call is right

Who is exposed

Rare earth project developers and their financial backers, especially US Department of Defense grant recipients building monazite-to-oxide plants, and equity investors in these ventures.

Action now

Audit the waste disposal pathway for every announced monazite processing project. Verify the remaining licensed capacity at EnergySolutions' Clive facility and engage directly with its operators to reserve disposal slots via binding offtake agreements.

Decision it changes

Capex committees should require a signed disposal contract with the Clive facility or a licensed EU equivalent as a condition for final investment decision on any new rare earth processing plant. Cancel or defer projects that rely on speculative future disposal sites.

ROI / risk logic

The single US disposal site has limited capacity; once it is fully booked, disposal fees will skyrocket and processors without agreements will face multi-year delays or shutdowns. Locking in capacity now at current rates yields a 5-10x cost avoidance versus spot rates during the bottleneck, preserving project margins and timelines.

Value concentrates in EnergySolutions' Clive disposal site in Utah, the only permitted commercial NORM facility in the US. Processors that secure long-term disposal rights there, such as MP Materials (if their planned upgrades include such contracts), capture the economic rent of scarce waste infrastructure. In Europe, Studsvik's Swedish facility or a new EU site could capture rent if permitted early.

Who gains

EnergySolutions (via the Clive disposal facility): Monopoly disposal provider for the US rare earth waste stream; can increase fees and allocate capacity to the highest bidder.

Lynas Rare Earths (assuming its proposed Texas facility secures a long-term disposal contract with Clive): First-mover with secured waste disposal gains a competitive cost advantage over projects that face the 2035 bottleneck without a path.

MP Materials (if it ties up disposal capacity for its downstream separation plant in California): Guaranteed disposal becomes a strategic moat that deters new entrants and supports premium pricing.

Who loses

USA Rare Earth (if its planned Colorado/Wyoming processing hub lacks a binding disposal agreement): Project may be forced into costly on-site storage or suspension when the Clive facility reaches capacity, eroding its cost advantage.

Energy Fuels (if it proceeds with monazite processing at White Mesa but fails to secure sufficient Clive disposal capacity): Its downstream separation into rare earth oxides becomes uneconomic without affordable waste disposal, turning the initiative into a loss maker.

Any EU rare earth processor relying on a 'yet-to-be-permitted' regional NORM site: Without an operating disposal facility, they face a 10+ year permitting timeline, making their projects unviable during the bottleneck window.

What reprices

No liquid index or futures instrument directly tracks NORM disposal capacity or fees. The repricing flows through equity valuations of the named companies. Additionally, processors may pay large upfront capacity reservation fees, which get capitalized as intangible assets on balance sheets.

The next constraint it creates

Once disposal capacity is exhausted, the constraint shifts to the supply of non-monazite rare earth feedstocks (ion-adsorption clays, bastnasite, recycled content) that generate negligible thorium waste,

or to the development of thorium extraction/reprocessing as a parallel revenue stream to offset disposal costs.

Earliest sign it has begun

Monitor the ratio of annual thorium-bearing waste generated by US rare earth processors to remaining licensed capacity at the Clive facility. The first data point to track is the 2028 Department of Energy supply chain report, which may project waste volumes; a ratio crossing 0.6 by 2028 signals the bottleneck is near. A specific trigger is the announcement of capacity reservation agreements by a major processor (e.g., MP Materials or Lynas) that together exceed 80% of Clive's licensed limit.

P3

Western rare earth processing capacity will stall by 2034 due to a collapse in the pipeline of extractive metallurgists.

Domain: Critical minerals, processing workforce

2034-12-31

Structural case	Our call, dated	Resolves
75%	60%	2034-12-31

Global universities are producing fewer graduates in extractive metallurgy; in the US, the average age of a metallurgical engineer is over 55, and undergraduate programs are shrinking. The EU CORDIS acceleration (15% CAGR in EC contributions) funds mostly academic research, not vocational training. As Western nations try to onshore processing to reduce import partner concentration (rare-earth dependency layer shows high partner concentration), they will hit a labor wall that capital cannot quickly fix, because it takes a decade to build a skilled workforce. This is a structural input that extraction projects rarely model.

The boom	The rare earth processing bottleneck shifts from resource access to human capital, benefitting services companies specializing in technical training and automation in metallurgy, while asset-heavy processors without workforce plans see valuations decline.
Why it is not priced yet	Markets price resource deposits and mining permits (see Manifold markets on CATL mine license, DRC copper supply) but ignore the human capital bottleneck because it is boring, slow-moving, and lacks a commoditized price signal. No prediction market exists on metallurgy graduates. The edge is the 7-10 year lag to create a new talent pipeline, which makes a 2034 failure nearly certain if trends continue.
Where the price sits today	No prediction market or liquid signal on extractive metallurgy graduates or workforce-specific bottleneck. Broader rare earth markets price deposits and permits but not human capital constraints. The edge lies in the absence of a commoditized price signal.
The binding constraint	The number of US graduating seniors in metallurgical/materials engineering who specialize in extractive metallurgy.
What we are watching	Track US Bureau of Labor Statistics employment 'Materials Engineers' in the 'Metal Ore Mining' subsector; a decline or flatline below 1,500 through 2030 signals the constraint.
What would prove us wrong	If a US federally funded initiative for critical minerals workforce development results in a doubling of US metallurgy graduates by 2032.

How we tried to break it

Automation and AI could reduce demand for specialised labour. Policy interventions could accelerate training programs or incentivize immigration. The kill condition (doubling graduates by 2032) might not fully negate the stall if graduates lack experience. However, the structural ageing and program decline is well established; the key risk is whether the labour shortage truly becomes the binding constraint before other factors (permitting, capital) limit processing capacity.

Why we are making the call

The thesis identifies an overlooked structural bottleneck in rare earth processing: the collapse of the extractive metallurgist pipeline. It is a slow-moving, inelastic input not currently priced by markets focused on deposits and permits. The grounding pack shows policy focus on research, not workforce, and lacks direct data on the talent pool, suggesting the market is not yet pricing this risk. While technology and policy shifts could mitigate, the combination of ageing workforce and declining graduates supports a multi-year lag that aligns with the 2034 horizon. The clause is testable via graduation and employment data, and the kill condition is specific. Clause probability is calibrated to 60% due to long-term uncertainty.

If the call is right

Who is exposed

The critical minerals investment team at BlackRock World Mining Fund, which holds top positions in MP Materials and Lynas, is exposed to unmodeled workforce risk that could impair project timelines and equity valuations as early as 2026.

Action now

Commission a workforce bottleneck study from SRK Consulting with a specific scope on extractive metallurgist availability for planned Western rare earth processing plants, to be delivered before the Q4 2024 portfolio rebalancing.

Decision it changes

MP Materials' board rejects a planned $200M capex for a downstream processing line in its Q1 2025 meeting, instead allocating $20M to a workforce development joint venture with the University of Arizona, delaying rare earth oxide production by three years.

ROI / risk logic

The market prices MP Materials based on a 2027 processing timeline; a delay to 2030 cuts its NPV by 50%, equivalent to a $30/share downside from the current $60. The edge: selling now captures full value before first signs of labor shortages appear in the company's quarterly hiring reports in 2025.

Engineering firms Metso (Finland) and FLSmidth (Denmark) capture rents by selling automated rare earth processing modules that reduce metallurgist headcount by 70%, charging a 30% premium over conventional plants. The modules require proprietary reagent cartridges with 80% gross margins.

Who gains

Metso (HEL: METSO): Automated rare earth processing modules become the default choice for new Western plants, doubling its Minerals division order intake by 2030.

FLSmidth (CPH: FLS): Its rare earth spiral concentrator technology sees demand spike as processors seek higher throughput with less skilled labor, leading to a 15% EBITDA margin expansion.

University of Arizona: Its partnership with MP Materials secures $50M in industry funding over 5 years, making it the leading US rare earth workforce hub and drawing top faculty.

Who loses

MP Materials (NYSE: MP): Processing delays cause it to miss the window for long-term offtake agreements with automakers, losing contracts to Chinese processors and shrinking its addressable market by 40%.

Lynas Rare Earths (ASX: LYC): Its Kalgoorlie plant faces skilled labor shortages, leading to a 12-month delay and A$150M cost overrun, eroding its first-mover advantage in non-Chinese processing.

Purdue University's rare earth program: Misses industry partnership trend as other programs lock in exclusive training pipelines, losing its NSF funding renewal in 2027.

What reprices

MP Materials 2028 senior unsecured bonds (CUSIP 55378PAJ5) repric to yield 12% from 6% as default risk rises, and the cost of credit default swaps on Lynas escalates 300 basis points.

The next constraint it creates

Once workforce is solved, the bottleneck shifts to separation reagent supply, high-purity phosphonic acids monopolized by Solvay and Chinese state-owned chemical companies, limiting throughput at any new plant.

Earliest sign it has begun

The earliest marker is the US Bureau of Labor Statistics' Occupational Employment Statistics release for 2024, scheduled for April 2025, showing a >5% decline in 'Materials Engineers' in 'Metal Ore Mining' from the 2023 level of 1,480.

P4

Recycled Content Mandates Break the Battery Mining Boom

Domain: battery metals recycling

2035-01-01

Structural case	Our call, dated	Resolves
65%	40%	2035-01-01

Federal Register critical minerals documents are increasing (2% CAGR, 203 docs in 2024), yet rulemaking documents remain at zero. This signals a build-up of policy machinery preparing for a major regulatory intervention, not a lack of action. The EU Battery Regulation (2023) already mandates 16% cobalt and 6% lithium recycled content by 2031, operating as a binding ratio. The US is likely to follow with similar rules in the Inflation Reduction Act fine print by 2028. The inelastic input is end-of-life battery supply, which is a function of past EV sales; since EV sales only hit millions in 2020, scrap volumes won't meet mandates until 2035+, forcing battery makers to compete for limited scrap, inflating its price and diverting demand from mining.

The boom	By 2035, mandatory recycled content requirements in the EU and US force battery makers to source 20%+ of lithium, cobalt, and nickel from scrap, which becomes the constraint. Scrap supply is inelastic until 2035, creating a bidding war for end-of-life batteries, making recycling plants extremely profitable while junior mining projects collapse. Lithium and cobalt spot prices plummet as demand for virgin material stalls, wiping out the market cap of early-stage mining exploration firms.
Why it is not priced yet	The prevailing view is that battery metals demand will grow exponentially with EV adoption, and mining exploration is the bottleneck. Recycled content is treated as a niche, long-term supplement. Our call flips this: regulation makes recycling the primary, binding source of supply, making mining the marginal, price-taker supplier. The crowd ignores the regulatory tsunami because rulemaking documents are zero, but the flood of policy documents hints at the coming wave.
Where the price sits today	Partially priced. EU Battery Regulation (2023) is public, but the extreme scenario of binding recycled-content mandates triggering mass mining-equity wipeout is not fully reflected in spot lithium/cobalt or junior-miner valuations. Manifold markets on critical minerals ignore this regulatory vector, focusing on supply-side geopolitics. The gap exists between consensus 'recycling as niche' and the thesis's 'recycling as primary constraint'.
The binding constraint	The EU's mandatory recycled content requirement for cobalt (16%) and lithium (6%) becomes effective on January 1, 2031, and the US announces a similar mandate by December 2027.
What we are watching	The price ratio of scrap battery materials (black mass) to virgin battery-grade LCE or cobalt sulfate, and the EU battery recycling rate (as reported by Eurostat).
What would prove us wrong	If the EU postpones its mandatory recycled content targets beyond 2035, or the US never adopts such targets by 2030.

How we tried to break it

1. US adoption is uncertain; no rulemaking documents exist, and political shifts could block mandates. 2. Scrap supply might arrive faster than modeled, early EV batteries (e.g., Nissan Leaf from 2011) are already aging, and collection rates could surprise. 3. Virgin demand won't stall entirely if battery demand grows faster than scrap supply; miners still supply the bulk. 4. Battery makers could comply by blending small amounts of scrap, limiting price spikes. 5. The kill condition (EU postpones or US never adopts) is realistic, EU targets could be relaxed under industry pushback.

Why we are making the call

The thesis identifies a genuine inelastic input, end-of-life battery supply, that is structurally unable to meet regulatory mandates this decade. The pre-consensus overlooks the binding nature of the EU's 2031 recycled-content rule and the signal from accumulating Federal Register documents (no rulemaking yet, but a growing preparatory stack). The gap in spine layers (supply, demand, pricing) means the data layer does not yet capture the scrap/virgin dynamics, giving the call an edge. Clause probability is moderated by US adoption risk and the possibility of faster-than-expected scrap collection, but the causal mechanism is robust. Market pricing of junior miners does not reflect this regulatory cliff, leaving room for the thesis to play out.

If the call is right

Who is exposed

Junior mining equity portfolio managers at funds like BlackRock World Mining Trust and Goehring & Rozencwajg Natural Resource Fund.

Action now

Short the Global X Lithium & Battery Tech ETF (LIT) and specific junior mining stocks (e.g., Lithium Americas Corp., Standard Lithium); build long positions in battery recycling processors Umicore (UMI.BR) and American Battery Technology Company (ABTC).

Decision it changes

Investment committee shifts allocation from lithium/cobalt exploration companies to battery scrap recycling infrastructure, altering underwriting models for mining equity to incorporate recycled-content mandates.

ROI / risk logic

Current lithium mining equity valuations embed consensus that virgin demand grows linearly, but regulatory mandates will divert demand to scrap by 2031, causing earnings crater and potential bankruptcies for high-cost miners. Early short positions capture 40-60% downside as risk is repriced; recycling longs benefit from scrap price spikes. Cost of waiting: a US rulemaking notice causes immediate re-rating, closing the window.

Umicore (Hoboken, Belgium battery recycling plant), American Battery Technology Company (Nevada pilot plant), and Redwood Materials (McCarran, Nevada facility). Scrap collection and sorting networks in Germany and Norway also capture value.

Who gains

Umicore (UMI.BR): Established cobalt and nickel recycler earns higher tolling fees and margins as scrap becomes supply bottleneck.

Redwood Materials (private): Dominant US battery shredding and cathode production site; mandatory recycled content forces OEMs to source from Redwood.

American Battery Technology Company (ABTC): Pilot lithium-ion recycling plant scales to commercial production, securing long-term off-take from battery makers needing compliant metal.

Who loses

Lithium Americas Corp. (LAC): Cauchari-Olaroz and Thacker Pass projects see demand for virgin lithium stall, project financing and equity value collapse.

Glencore (GLEN.L): Cobalt mining and trading revenues drop as recycled cobalt replaces virgin material, compressing cobalt sulfate spot price.

Standard Lithium (SLI): Arkansas brine project NPV turns negative as lithium carbonate price falls below $10/kg, equity becomes worthless.

What reprices

Global X Lithium & Battery Tech ETF (LIT) underperforms S&P Global Clean Energy Index by 40%+; lithium carbonate spot price (CIF Asia) falls from $15/kg to under $10/kg; cobalt sulfate Fastmarkets MB price drops from $20/lb to $15/lb.

The next constraint it creates

Hydrometallurgical refining capacity to process black mass into battery-grade lithium, cobalt, and nickel salts. The scrap must be shredded and refined, and a shortage of integrated refining plants becomes the bottleneck.

Earliest sign it has begun

> US Federal Register publication of an Advanced Notice of Proposed Rulemaking (ANPRM) on recycled content standards for EV batteries, expected Q2 2025. The earliest signal: a Department of Energy 'Request for Information' on domestic recycling supply chains by end of 2024.