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Resources for Resources: Financing Critical Minerals Supply Chains



SAFE

The Ambassador Alfred Hoffman, Jr.

**Center for
Critical Minerals
Strategy**

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This report represents the culmination of a year-long collaboration between leading minds in private-sector finance and public policy, brought together through SAFE and Appian’s Subcommittee on Opportunities and Risks in the Critical Minerals Sector (SCOR). SCOR was created to support SAFE’s MOU with the U.S. Department of State, the first goal of which was to infuse private sector advice into the U.S. critical minerals strategy. SCOR members are comprised of friendly, international investors in the Metals and Mining sector.

While this report focuses on the financing gap in the critical minerals sector, it aims to bridge a larger chasm between the private and public sector understandings of how to finance these crucial projects. We are grateful to the members of SCOR for their time and invaluable contributions to the risk section of this report. Thanks to SCOR member perspectives, SAFE endeavored to analyze the existing government funding opportunities, both coming out of Washington, DC, and from international export credit agencies and development finance institutions. We hope policymakers and investors alike read the two sections of this report with great interest, as it offers key insights into bridging the financing gap and fostering much-needed collaboration between the private and public sectors to drive the success of critical minerals projects.

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Sincerely,

Abigail Hunter
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Executive Summary

The global critical minerals supply chain faces a stark reality: decades of coordinated policy by the Chinese Communist Party (CCP) have resulted in unprecedented concentration of production, particularly in the crucial midstream processing and refining sectors. This dominance is no accident. It reflects a deliberate strategy in which CCP-backed companies systematically developed resources at home and abroad—especially for minerals where the People's Republic of China (PRC) lacks significant domestic reserves—while establishing substantial control over processing and refining operations through systemic infrastructure development and targeted acquisitions.

Reliance on a geopolitical rival for critical minerals that underpin advanced technologies, energy and transportation systems, and military readiness exposes the United States to economic and national security vulnerabilities. Control over critical mineral supply chains allows adversaries to restrict access or manipulate availability, leveraging disruptions to exert economic pressure or gain geopolitical advantages. These risks threaten immediate economic impacts, such as production shutdowns and job losses, while eroding U.S. global market share and the innovation capabilities critical to its manufacturing base over the long term.

The surging global demand for critical minerals presents a significant opportunity to build secure, diversified supply chains that could strengthen economic resilience and national security. However, a massive investment shortfall remains. By 2030, more than \$25 billion in additional investment will be needed to meet the demand for planned clean energy manufacturing in the United States and Europe.¹ This figure grows even larger when accounting for the growing demand for artificial intelligence (AI), advanced computing, and military applications.

The investment gap stems from the private sector's inability to effectively manage or accept the unique risks associated with critical minerals projects. Private capital in open-market economies gravitates toward opportunities where risks are manageable, and returns are predictable—conditions often absent in the critical minerals sector. To address this challenge, SAFE worked with leading financing experts through SCOR to ensure policymakers have a clear understanding of how investors assess projects, which risks deter investment, and where targeted government action to de-risk investments is needed.

Risks associated with critical minerals projects are evaluated across four distinct categories: technical, financial, compliance, and geopolitical. Technical risks stem from lengthy exploration timelines with a low probability of discovery, declining ore grades for certain minerals like copper and nickel, infrastructure gaps, and challenges in scaling new technologies for more cost-efficient exploration, mining, processing, and recycling. Financial risks stem from substantial upfront capital requirements—often in the billions of dollars—while a project's position on the global cost curve and its resilience to price volatility fundamentally determine its ability to attract investment and maintain operations through market cycles. Compliance risks encompass increasingly stringent environmental standards and the challenge of maintaining a social license to operate throughout a project's lifetime. Geopolitical risks further complicate critical minerals projects, as the private sector's inability to compete with state-backed competition, navigate market distortions, and adapt to an increasingly unpredictable market contributes to the critical gaps in investment. These risks do not exist in silos and often exacerbate one another.

Much of the policies and commercial-scale funding targeting critical minerals over the last four years reflected the Biden administration's focus on clean energy deployment and manufacturing. This focus led to significant attention on minerals used in batteries while creating notable policy gaps for other critical minerals essential for advanced computing, AI, and military applications. Even for battery minerals, U.S. policy has disproportionately emphasized downstream manufacturing and deployment over upstream extraction and midstream processing. For example, the Inflation Reduction Act (IRA) spurred only five cents of private-sector investment in

¹ SAFE analysis based on Bloomberg New Energy Finance (BloombergNEF) data.

critical minerals for every dollar invested in battery manufacturing.²

While downstream investment is critical to create demand and incentivize upstream development, the limited focus on upstream extraction and midstream processing of critical minerals has allowed key supply chain vulnerabilities to endure. Upstream projects require long lead times to explore, permit, and develop resources, making immediate action essential. Without greater urgency and investment in upstream production, the United States risks locking in dependencies on foreign-controlled supply chains, undermining the very clean energy and advanced technology industries it seeks to support.

To bridge the existing investment gaps in critical minerals policy, the incoming administration must build on effective measures from the past while addressing key shortcomings. By adopting a more balanced approach that prioritizes upstream and midstream investments alongside downstream development, the United States can mitigate systemic market failures, accelerate supply chain resilience, and support national security objectives. This requires targeted government interventions in areas where the private sector cannot fully address risks.

1. **Technical Risks:** While private companies excel at managing the complexities of extraction, processing, and recycling, they often face prohibitive risks in early-stage project development and the deployment of innovative technologies. Government support is critical to de-risking these activities, particularly through expanded funding for exploration, research and development (R&D) and surrounding infrastructure. These efforts will help expand the pipeline of viable projects, foster innovation, and reduce barriers to scaling cutting-edge technologies.
2. **Financial Risks:** Addressing the financial challenges of critical minerals projects requires maintaining and strengthening federal financial tools, such as low-interest loans, investment tax credits, and direct grants. These tools must be deployed strategically to target specific gaps in early-stage development, midstream processing, and co-product recovery, where private capital alone is insufficient. The government can de-risk high-priority projects, accelerate technological advancements, and build a more secure and diversified supply chain by counteracting the competitive advantage of PRC low-cost, state-backed capital.
3. **Compliance Risks:** Domestically, permitting reform is needed to improve the clarity, objectivity, and speed of the process, as well as ensure its effective execution. Improvements should include formalizing early community engagement to address environmental and social concerns proactively, build trust, and secure a social license to operate. Establishing clear guardrails is also critical to managing an ever-expanding pool of stakeholders from delaying strategically significant projects. Internationally, enhancing investor protections and providing targeted technical assistance to improve regulatory frameworks in developing nations can create more stable and predictable environments for critical minerals investment.
4. **Geopolitical Risks:** The PRC's market dominance, price manipulation, and export restrictions create supply chain vulnerabilities that private entities cannot address alone. Government action to counteract these distortions—through enhanced security cooperation, strategic stockpiling, and trade measures—can strengthen resilience and ensure market stability.

Ultimately, the private sector needs policies that provide long-term market signals to encourage sustained private sector engagement and investment. Clear articulation of government goals is essential to create predictability and align industry efforts with national priorities. Additionally, improved interagency coordination is critical to collectively pursue these goals without duplicating or undermining efforts, ensuring that federal actions are efficient, strategic, and impactful. By adopting this comprehensive approach, the incoming administration can address critical vulnerabilities, foster innovation, and secure the minerals necessary to drive clean energy, advanced technology, and national security.

² Ibid.

Introduction

Global critical minerals supply chains face unprecedented demand and concentration, creating urgent economic and national security challenges for the United States and its allies. These challenges require an estimated investment of more than \$30 billion by 2030 and innovative public-private partnerships to stand up secure critical minerals supply chains to meet the growing demand of U.S. and allied manufacturing sectors.³ Critical minerals are essential to modern society, underpinning everything from advanced technologies and defense systems to everyday consumer goods.

The demand landscape for critical minerals is dramatically transforming, driven by three key trends: the AI revolution, accelerating energy deployment, and growing military requirements for advanced technologies. The expanding use of lithium-ion batteries—containing critical minerals like cobalt, graphite, lithium, and nickel—in AI systems, robots, drones, and smart devices is a major driver of this demand growth. For instance, cobalt use in consumer electronics, a sector increasingly driven by AI capabilities, alone will increase from 59,000 metric tons in 2020 to 72,000 metric tons by 2035.⁴ This rising demand is reflected in market projections: the International Energy Agency (IEA) values the global critical minerals market at \$325 billion in 2023, expecting it to reach \$590 billion by 2040 under current energy policies.⁵

Government and industry players are responding with increased investment and policy measures. In 2023, mining investment grew by 10 percent, with the twenty-five largest mining companies investing \$50 billion in nonferrous metal production.⁶ Although the long-term critical mineral demand creates a compelling business case for private investment in new production capacity, domestic mineral producers and trusted suppliers to the United States continue to flounder. This supply-demand mismatch largely stems from insufficient capital mobilization for resilient supply chains in a highly volatile and concentrated market.

In stark contrast to growing market opportunities, U.S. dependence on critical mineral supplies controlled by foreign adversaries—predominantly the PRC—has deepened over decades, creating profound vulnerabilities that affect both civilian and military sectors. This dependency exposes the United States to economic and

national security vulnerabilities, where adversaries can leverage their control over raw and processed critical minerals to exert pressure on U.S. interests or halt U.S. commodity flows. Supply chain disruptions can trigger immediate economic impacts like production shutdowns and job losses, while long-term effects include loss of global market share and facility closures. In the critical minerals sector, this erosion extends beyond mining and refining to threaten crucial components of the U.S. manufacturing base and its associated innovation capabilities—particularly vital in emerging industries that will shape the future economy.

Dependence on foreign adversaries for critical minerals directly threatens U.S. national security by compromising the defense industrial base—the network of manufacturers, suppliers, and laboratories that produce military equipment and technology. Just as access to raw materials was crucial for U.S. industrial mobilization in World Wars I and II, control of these essential inputs by potential adversaries today puts American military readiness at risk. Modern military superiority increasingly relies on commercial technologies like AI, autonomous systems, and advanced energy systems. When domestic production declines, it triggers a cascade effect: loss of technical expertise leads to reduced innovation capacity and greater dependence on potentially hostile nations for crucial technologies.

Mitigating these vulnerabilities requires building domestic capacity across the supply chain (from exploration to recycling) while developing strategic partnerships with allies to fill remaining gaps to meet U.S. energy, economic, and national security needs. While U.S. manufacturers need access to high-quality, cost-competitive mineral resources to stay competitive, domestic sourcing alone cannot meet this need. Some critical minerals don't exist in economically viable deposits within U.S. borders, while for others, U.S. deposits vary significantly in quality—ranging from world-class resources (defined as deposits with favorable operational qualities in a stable jurisdiction) that can compete globally to marginal deposits that are vulnerable to market price fluctuations. This reality necessitates a balanced strategy combining North American resource development with strategic international partnerships to ensure supply chain security and cost competitiveness.

³ Note: Required investment is only for the United States and Europe. Source: BloombergNEF analysis.

⁴ Cobalt Institute, “Cobalt 2050: Unlocking potential for a net-zero future,” October 2024, at 9.

⁵ IEA, “Global Critical Minerals Outlook 2024,” May 2024, at 7, 226.

⁶ Ibid., at 62.

If we are going to cover the volume and range of critical mineral needs industry requires, we need stronger public-private partnerships and more agile friendshoring. You have to look at the end-to-end supply chain from start to finish – from extraction to refining and increasingly through to recycling. Those two dimensions, the commercial investment and the foreign policy, need to be better integrated, otherwise U.S. and Western manufacturers are going to start feeling an even greater pinch in the next few years.”

- The Rt. Hon. Dominic Raab, Head of Global Affairs at Appian Capital Advisory

The U.S. critical mineral policy framework began taking shape in 2017 and has evolved through several administrations. The Trump administration established the foundation through Executive Order 13817, which created a federal strategy for critical minerals. Executive Order 13953 declared critical minerals supply chain vulnerabilities a national security emergency. During this period, the government created new tools like the U.S. International Development Finance Corporation (DFC) to counter the PRC Belt and Road Initiative (BRI). The Biden administration built on these efforts through legislative action, including the Creating Helpful Incentives to Produce Semiconductors (CHIPS) and Science Act, Bipartisan Infrastructure Law (BIL), and IRA, primarily focusing on clean energy supply chains. On the international front, the United States launched initiatives like the Energy Resource Governance Initiative (ERGI) under President Trump and the Minerals Security Partnership (MSP) under President Biden to coordinate with allies.

However, these domestic and international efforts have not produced adequate funding or expansion of U.S. and likeminded countries' critical minerals supply chains, in part because the United States faces a dominant nonmarket actor—the PRC—who has secured a monopoly and monopsony over the entire critical minerals supply chain.⁷ Approximately \$5 billion has been invested, leaving a more than \$25 billion gap in the required investments to meet U.S. and allied clean energy manufacturing demand.⁸ Similar shortfalls exist in critical minerals needed for AI and advanced computing. Private investment is essential to

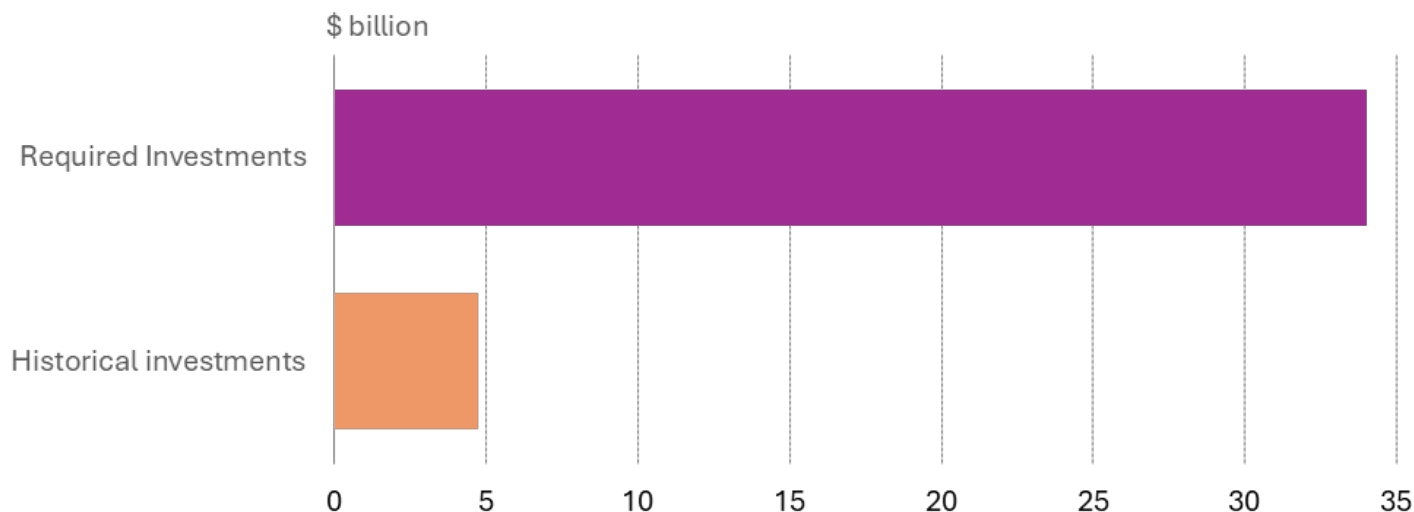
close this funding gap, but current market conditions deter capital flows to secure supply sources. Without government policies that address fundamental market barriers and reduce investment uncertainty, lower-cost PRC mineral production will continue to dominate global supply, undermining the competitiveness of domestic mineral producers and potentially eroding downstream U.S. industries—as has happened in other sectors. This report comprehensively examines the critical investment shortfall. It begins by assessing the investment barriers and risks currently deterring private capital. Then, it evaluates existing U.S. policy tools and their limitations. This analysis examines lessons from U.S. allies' approaches to critical minerals development before concluding with recommendations for the incoming administration.

The analysis draws on three primary sources. First, extensive consultations with the SAFE and Appian SCOR initiative, which brings together leading commercial experts in metals and mining investment to analyze challenges and opportunities in critical minerals development. Second, interviews with government officials, industry executives, and technical experts involved in critical minerals projects, investment, and policy development. Third, a comprehensive review of academic literature, government reports, and industry analyses on critical minerals markets, supply chains, and financing mechanisms. The report identifies primary investment barriers through this comprehensive approach and develops targeted policy solutions.

⁷ Leah Wils-Owens, “China’s Status as a Non-Market Economy,” Office of Policy, Enforcement & Compliance, October 26, 2017, at 58.

⁸ BloombergNEF analysis.

Figure 1. Critical Minerals Investment Gap in the Energy Sector



Note: Required investment is for only U.S. and EU clean energy manufacturing sectors. Historical investment shows publicly announced capital investments.

Source: BloombergNEF.

Investment Barriers and Risk Analysis

The 2008 financial crisis fundamentally reshaped how financial institutions evaluate and fund projects dependent on project finance and those with high upfront capital requirements—precisely the profile of most critical minerals developments.⁹ The crisis led to a severe tightening of credit conditions. Energy companies saw their cost of borrowing increase by 2.5 percentage points despite plummeting interest rates.¹⁰ This rise in the cost of capital created an enduring shift in how financial institutions evaluate capital-intensive, long-timeline projects.¹¹ The effects continue to influence critical minerals project financing in 2025.

Today's critical minerals sector faces many of the same structural challenges that hampered energy investment after 2008: institutional investors remain wary of complex, large-scale industrial projects, especially those in emerging markets; lenders continue to demand higher risk premiums for projects with long development horizons; and smaller developers struggle to access commercial debt markets.¹² As companies face higher financing expenses and risk premiums, they often respond by compromising margins and extending development timelines; the ultimate result is

the lower attractiveness of critical mineral projects to potential investors.

Moreover, the financial crisis led to a greater focus on short-term performance among investors, making it harder for mining companies to maintain a long-term perspective during market downturns. While the management of top mining companies typically maintains a long-term investment focus, many shareholders struggle to overcome a "spot mentality" and prioritize short-term performance.¹³ This misalignment can constrain capital allocation during market downturns, limiting investment in exploration and development projects that are necessary to ensure adequate supply for future demand. Ultimately, this dynamic exacerbates the industry's cyclicity, as constrained supply sets the stage for the next upcycle.

These challenges were starkly evident from 2011 to 2016, the first significant commodity downturn following the 2008 financial crisis. Although mining projects inherently require a long-term investment horizon, investors outside the sector struggled to maintain this perspective during the downturn. As a result, the global mining industry experienced a staggering 90 percent reduction in market capitalization,

⁹ Gabriel Collins, "Critical Mineral Futures Markets: A Brief Introduction," *Commodity Insights Digest*, June 2024, at 4.

¹⁰ IEA, "The Impact of the Financial and Economic Crisis on Global Energy Investment," May 2009, at 46.

¹¹ *Ibid.*, at 4.

¹² SAFE findings from consultation with SCOR members.

¹³ See e.g., Paul Mitchell et al., "How Do Miners Confidently Share Opportunities to Create Value?: Top 10 Business Risks and Opportunities for Mining and Metals in 2025," EY, October 2024, at 4; and PWC, "Mine 2016: Slower, Lower, Weaker...but not defeated," June 2016, at 7.

wiping out an estimated US\$1.5 trillion.¹⁴ While such dramatic downturns typically lead to significant growth during recovery periods, structural changes in investor sentiment following the 2008 crisis have dampened this traditional rebound effect.

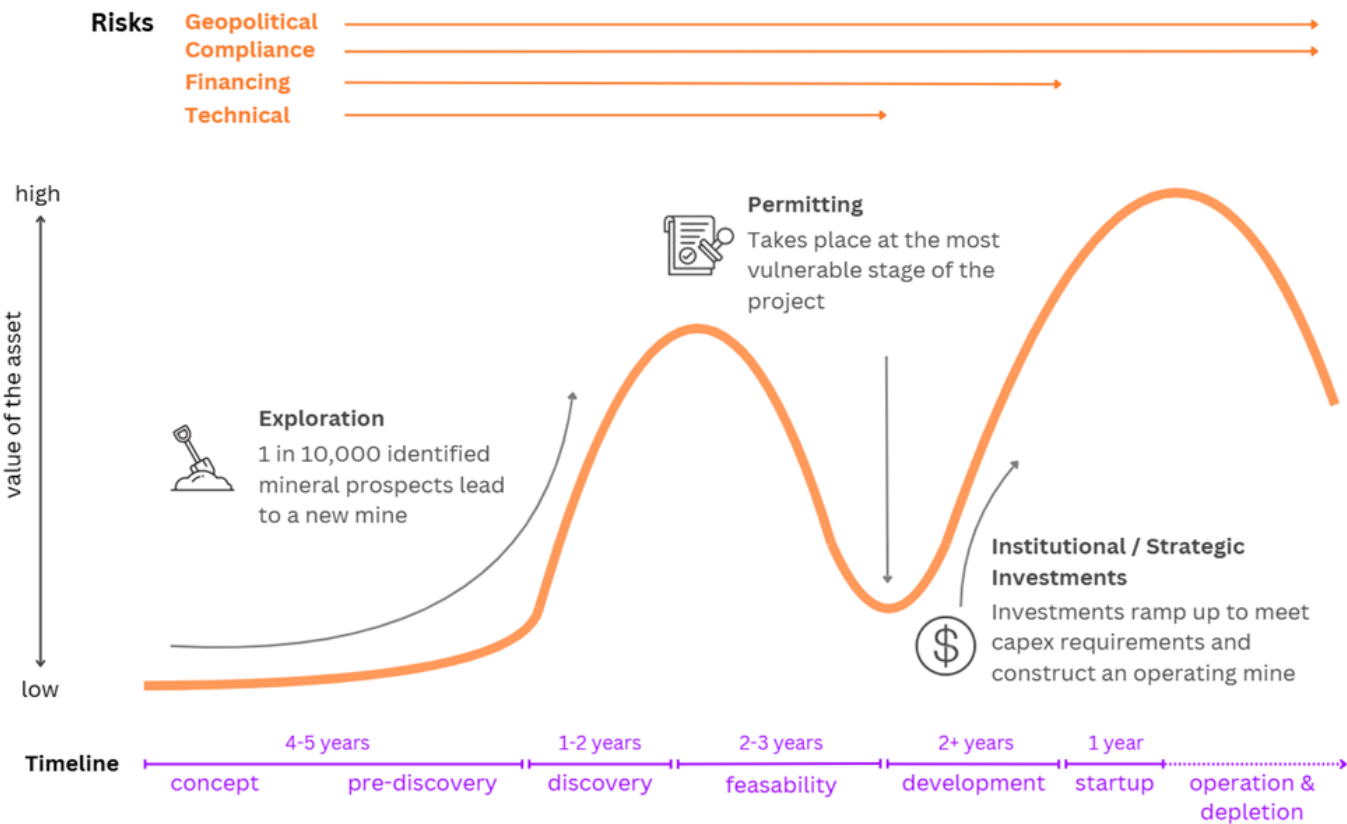
The combination of heightened investor risk aversion due to the 2008 crisis and depressed commodity prices severely limited mining companies' access to capital, forcing many to sell assets, often to Chinese buyers, at fire-sale prices. This pattern has persisted into the present day, particularly when developers face investment gaps or financing delays, as Western markets remain reluctant to accept the inherent risks of long-term mining projects.

Understanding how investors evaluate projects becomes critical to mobilizing private sector capital in this environment. Investors examine several key risk categories when evaluating projects in the critical minerals sector, from technical feasibility to financial structure, compliance with regulations and voluntary standards, and geopolitical concerns.

Risks operate at multiple levels. Individual projects face unique challenges based on location and characteristics. Different supply chain stages—mining, processing, and recycling—present distinct operational and technical hurdles. Each critical mineral market has its competitive dynamics. While the specific risks vary across projects and minerals, common patterns emerge across the industry.

It is imperative to understand the two distinct types of market risks: the inherent industry risks that exist even in well-functioning markets (which made projects more challenging to finance under the post-2008 climate and contributed to market concentration toward actors better equipped to manage them), and second, the geopolitical risks that now stem from PRC's dominant market position. Government policies must address both types of risks—enabling broad sector-wide support through measures like permitting reform and infrastructure development, alongside targeted interventions such as strategic stockpiling and offtake agreements where national security interests are at stake—to mobilize private sector investment effectively.

Figure 2. Life Cycle of a Mine



Source: SAFE interpretation of the Lassonde curve graphic from Visual Capitalist.

¹⁴ Anthony G. Nolan, "Mining Collapse Echoes Subprime Mortgage Crisis," *Australian Financial Review*, January 27, 2016.

Technical and Financial Risks

Critical mineral projects present unique investment challenges due to an exceptional combination of risks not typically found in other sectors. These projects require substantial upfront capital expenditures and prolonged development timelines, which can last 20 to 30 years. These timelines create significant barriers to entry that exceed those found in other industrial and technology sectors.¹⁵ The upstream segments of the supply chain—mining, processing, and recycling—face severe technical and financial risks, making them far more challenging to develop than downstream manufacturing operations.

Investment decisions in this sector must account for both project-specific technical challenges and broader country-level risks, particularly those related to regulation and infrastructure. These factors heavily influence where capital flows in the critical minerals sector. While these risks are inherent to critical minerals development, their severity, and

appropriate mitigation strategies vary significantly by project, jurisdiction, and country context.

This challenging risk profile has created a systematic bias against private investment in crucial upstream and midstream projects. The resulting funding gap threatens the development of projects essential for meeting future energy needs, supplying the industrial base, and supporting the rapidly growing technology sector.

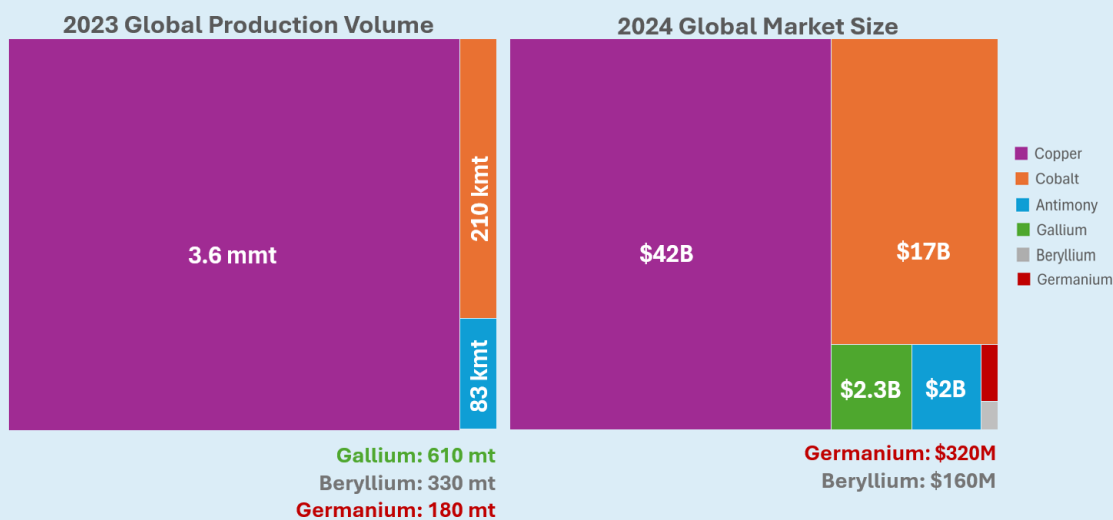
Project Development: Mining

The path from initial exploration to an operating mine for critical minerals is lengthy and complex. Developing a mine can take more than ten years, even under the most optimal conditions. All mineral projects start as prospects that require surface exploration and initial drilling to identify potential deposits. When early tests indicate there might be valuable minerals in the ground, companies undertake extensive drilling campaigns to define and validate the

Co- and By-Products

Not all critical minerals have the grades, volumes, or market size that justify investment in dedicated mining operations. This is particularly true for the more esoteric minerals with niche defense applications, where annual demand may only be in the hundreds of tons. Instead of driving mine development, these minerals are recovered as co-products and by-products that sometimes enhance the economics of projects targeting other metals.

Figure 3. Production Volume and Market Size Comparison of Select Critical Minerals



Note: mmt = million metric tons; kmt = thousand metric tons; mt = metric tons; B = billion; M = million.

Source: SAFE analysis based on data from U.S. Geological Survey and news reports.

For example, cobalt production is predominantly tied to copper mining in the Democratic Republic of Congo (DRC) and increasingly to Indonesia's expanding nickel industry.^a Gallium, which naturally occurs with bauxite, is produced as a by-

¹⁵ See e.g., Mohsen Bonakdarpour, Frank Hoffman and Keerti Rajan, "Mine Development Times: The U.S. in Perspective," S&P Global, June 2024, at 6.

product of aluminum smelting. The PRC made the recovery of gallium as a co-product mandatory at its aluminum facilities.^b With shifting market dynamics in response to PRC's export controls on gallium, Rio Tinto aims to recover gallium from its Saguenay–Lac-Saint-Jean facility in Quebec.^c Germanium is often produced as a by-product of zinc. In North America, Alaska's Red Dog zinc mine stands as the region's only germanium supplier and could expand production.^d Finally, antimony is typically recovered as a by-product of lead and other metals. In response to PRC antimony export restrictions, the U.S. government provided a key permit to Perpetua Resources' primary gold project in Idaho, which also happened to be a key gold-antimony project in the pipeline.

The co- and by-product nature of certain critical minerals presents both challenges and opportunities for supply development. On the one hand, production is inherently tied to the project's economics and development decisions of primary metal operations, adding complexity to investment decisions. Co-products share mine development and production costs with the primary metal.^e How producers distribute costs between primary and co-product metals varies, making cost comparison and standardized cost curve creation more challenging.^f

On the other hand, many of these primary products—such as copper, nickel, and aluminum—are strategic or critical materials facing significant demand growth due to their applications in critical infrastructure and advanced technologies.^g While gold is not a critical mineral, it is a precious metal that consistently attracts substantial investment interest.^h As such, there are opportunities to strategically expand the production of co- and by-product critical minerals alongside the primary metals, which are also experiencing strong demand growth.

Additionally, tailings in operational mines, legacy assets, and abandoned mines can offer readily extracted sources for critical minerals produced as co- and by-products while simultaneously removing waste material from those sites. Mine tailings, especially those from operating mines, could provide a fast pathway to production for critical minerals facing or at risk of facing export bans from the PRC.ⁱ Some unconventional sources, however, yield lower returns than the greenfield mines they compete with for capital—making it challenging for them to attract investment despite their potential strategic importance and environmental benefits.^j

Depending on the market volume and prices, materials traditionally mined as co-products may also be mined as primary products. The best example is cobalt. However, by-product metals often have lower costs due to shared extraction and beneficiation expenses attributed to the primary metals. This dynamic challenges primary cobalt producers at the higher end of the cost curve and requires higher cobalt prices to operate at a profit. An example is a primary cobalt mine in Idaho. The mine was idled weeks before it was set to start operations after an influx of Indonesian cobalt produced as a by-product of nickel mining and processing brought cobalt prices down.^k

resource, resulting in a discovery.¹⁶ This exploration stage alone typically spans five to seven years.¹⁷

The process of exploration, discovery, advanced exploration, and early-stage development is lengthy and highly risky. Of the minerals prospects, only one in 10,000 leads to a new mine.¹⁸ Historical data suggests that about

one in 1,000 advanced exploration projects become producing mines.¹⁹ The odds are even steeper for world-class resources, at one in 3,333.²⁰

Resource evaluation continues post-discovery as companies conduct detailed feasibility studies and economic assessments. During this phase, companies

¹⁶ Nicholas LePan, "Visualizing the Life Cycle of a Mineral Discovery," *Elements*, December 12, 2020.

¹⁷ Ibid.

¹⁸ See e.g., Angeline Shi, "How global copper, nickel markets will drive the outlook for cobalt in 2025," *Fastmarkets*, November 26, 2024.

¹⁹ Matthew Funaiolo, Brian Hart, and Aidan Powers-Riggs, "Mineral Monopoly: China's Control over Gallium Is a National Security Threat," *Center for Strategic and International Studies*, July 18, 2023.

²⁰ "Rio Tinto progresses the development of a gallium extraction process in Quebec," *Business Wire*, December 13, 2024.

²¹ Shane Lasley, "Germanium: the OG Digital Age metalloid," *North of 60 Mining News*, September 16, 2024.

²² Prospectors & Developers Association of Canada, "Access to Capital," Webpage.

²³ Lisa McDonald, "Standing Committee on Natural Resources (RNNR), 43rd Parliament, 2nd Session, Meeting 12," February 19, 2021.

²⁴ Jeff Desjardins, "The Mineral Exploration Roadmap," *Visual Capitalist*, March 5, 2018.

undertake comprehensive analyses to determine key project parameters: they define the size and grade of the deposit through additional drilling and identify engineering requirements to optimize critical minerals recovery and operational efficiency.²¹ These studies are crucial as they determine whether a deposit qualifies as a Tier 1 asset—also referred to as a world-class resource—or requires higher commodity prices to achieve profitability.²²

Before commercial operations begin, the final project development stage is where non-technical risks become more evident. Financial risks are particularly significant due to the substantial upfront investment needed to construct a mine. The capital expenditure (CAPEX) needs, which include investments in equipment and infrastructure such as power generators, roads, and desalination plants, are essential to determining the project's financial viability.²³ High CAPEX can place a project in a higher position on the cost curve, as these upfront investments must be recouped. However, higher CAPEX can indicate more advanced technology or larger-scale operations, which may lead to lower production costs in the long run.²⁴

Once the mine begins operations, operational expenses (OPEX), which cover ongoing costs like labor, energy, and supplies, are another crucial consideration for investors.²⁵ OPEX is an important factor in determining a mine's position on the cost curve in the long run. A position at the higher end of the global cost curve means the mine will need higher commodity prices to remain profitable.²⁶

A project's cost position and expectations of future commodity prices factor in assessing financial risks and influence project developers' ability to raise capital. World-class deposits and Tier 1 assets can secure financing more efficiently, while projects in the second or third quartile of cost competitiveness will face more significant challenges.²⁷ The financial considerations of investors often do not account for political goals like diversifying supply or reducing import reliance. Projects deemed strategically

important from a U.S. policy perspective may fall under the higher end of the cost curve and find it challenging to raise capital if they cannot demonstrate profitability under conservative price assumptions, especially during periods of market uncertainty. In these cases, targeted government support may be required to unlock potential and align private investment with broader supply chain goals.

Finally, declining ore grades for certain critical minerals and metals like copper and nickel are rendering the discovery of new world-class resources for these materials progressively rarer. As the average grade of remaining deposits decreases, mining operations are increasingly required to process larger volumes of material, dig deeper, or turn to deposits in more difficult-to-reach locations. These factors contribute to rising production costs, presenting technical and financial challenges. Furthermore, extracting and processing lower-grade material or digging deeper poses environmental challenges, including increased waste generation and energy consumption. Extracting and refining materials at the lowest possible cost is necessary to remain competitive and ensure that downstream industries can access them at affordable prices. This requires adopting more advanced and efficient technologies to access materials, reduce costs, mitigate environmental impact, and explore innovative business models, such as full-value mining that maximizes recovery of all economically viable minerals while minimizing waste generation, to recover more material and maximize resource utilization.

Project Development: Processing and Recycling

Once extracted, critical minerals cannot directly enter manufacturing supply chains. They must first be transformed into precise specifications for industrial applications. An alternative pathway to critical mineral recovery is recycling. Although it relies on end-of-life products rather than mined ores as feedstock, the metallurgical processes involved in material recovery from recycled goods are fundamentally similar to processing

²¹ Brian Goss, "Why is a feasibility study important in mining?," Rangefront, July 7, 2022.

²² Ibid.

²³ See e.g., Rafael Rilo et al., "Eight Key Levers for Effective Large Capex-Project Management," Boston Consulting Group, October 30, 2012.

²⁴ See e.g., Marc Humphries, "Critical Minerals and U.S. Public Policy," *Congressional Research Service*, June 28, 2019, at 13.

²⁵ See e.g., "Accounting Practices for the Mining Industry: A Comprehensive Guide," Accounting Insights, June 28, 2024.

²⁶ See e.g., IEA, "Global Critical Minerals Outlook 2024," May 2024, at 8.

²⁷ See e.g., Paul Mitchell et al., "How Do Miners Confidently Share Opportunities to Create Value?: Top 10 Business Risks and Opportunities for Mining and Metals in 2025," EY, October 2024, at 11.

¹ SAFE findings from consultation with SCOR members.

² See e.g., U.S. Government Accountability Office, "Critical Minerals: Status, Challenges, and Policy Options for Recovery from Nontraditional Sources," July 2024, at 27; and SAFE, "WEBINAR: Yesterday's Mines, Tomorrow's Minerals," August 29, 2024.

³ Ernest Scheyder and Pratima Desai, "Insight: Western miners push for higher metals prices to ward off Chinese rivals," *Reuters*, July 22, 2024.

⁴ See e.g., Eduardo Mencarini et al., "The Capex Crystal Ball: Beating the Odds in Mining Project Delivery," McKinsey & Company, November 27, 2024; and Rafael Rilo et al., "Eight Key Levers for Effective Large Capex-Project Management," Boston Consulting Group, October 30, 2012.

⁵ See e.g., Gary Poxleitner Peng, "Operating Costs for Miners," SRK Consulting, presentation prepared for MeMO 2016 – Reducing Mining Costs and Value Optimization, 2016, at 3.

⁶ See e.g., John Mackey, "Minerals Economics 101: How Mining Investors Get Rich," Minestarters, Webpage.

⁷ SAFE findings from consultation with SCOR members.

virgin materials. The two approaches represent different sides of the same coin, with processes tailored to their respective feedstock characteristics.²⁸

Project development for processing and recycling has similar routes to mining but with distinct characteristics. Processing facilities have historically emerged through two routes: miners investing in downstream integration based on market opportunities or end-users developing upstream capacity to secure feedstock requirements. More recently, technology developers are entering the space with their innovative processes, but they are also choosing to partner with miners or develop integrated supply chains. Similarly, players in recycling are mainly companies with innovative techniques, pursuing strategic partnerships with offtakers or moving down the supply chain themselves to scale operations. These more integrated models are crucial to ensure the security of supply, project viability, and profitability.

Once a processing or recycling project is conceptualized, feasibility studies are required to evaluate technical and economic viability through detailed engineering design, operational planning, and comprehensive cost estimation. Unlike mining, where resource quality is paramount, technical considerations for processing and recycling focus on metallurgical process efficiency and feedstock specifications.²⁹ These studies must determine optimal process parameters, equipment requirements, and material flow designs that consistently deliver products meeting strict industry specifications.

For a company looking to deploy a new processing technology, such as improved rare earth element (REE) separation techniques or novel lithium extraction methods, at a commercial scale for the first time, additional technical risks come into play when going from pilot-scale to full-scale production. What works well during the pilot scale may not work as efficiently when produced on a larger scale. Adjustments are needed to improve the process for more significant production volumes. These changes might involve tweaking the process, upgrading equipment, or refining how materials move through the system. It's essential to carefully consider these adjustments during the planning phase to minimize the risks of production inefficiencies, technical failures, and delays, all to ensure the technology works effectively when scaled up for commercial use.

The financial viability of a processing or recycling operation depends on three key factors: cost competitiveness, scale, and offtake.³⁰ Production costs encompass CAPEX and OPEX and are influenced by feedstock considerations. The feedstock type dictates processing costs, technology requirements, and operational complexity. For instance, lower-grade raw materials often require additional processing steps to remove impurities, increasing costs and technical challenges. Ore characteristics also determine metallurgical route selection; in nickel processing, sulfide ores typically undergo concentration and pyrometallurgical smelting, while laterite ores require either energy-intensive pyrometallurgical treatment (e.g., ferronickel or nickel pig iron) or acid-intensive hydrometallurgical processing (e.g., high pressure acid leach (HPAL)), each with distinct capital and operating cost structures.³¹ Similarly, in recycling, the composition of the end-of-life materials, quality (or grade) of recycling intermediates like black mass, and the specific products being targeted for recovery significantly influences the design and complexity of the processing flowsheet.

The United States faces disadvantages on CAPEX and OPEX. Compared to other regions, processing and recycling projects in the United States can be at least two to three times more expensive, primarily due to higher construction and capital costs. U.S. processors and recyclers also face higher labor, energy, and material costs. For example, Chinese REE processors benefit from industrial policy advantages like subsidized or free hydrochloric acid due to regional overproduction—a practice documented in industry reports—while U.S. refiners must purchase it at market rates exceeding \$200 per ton, which can represent over 30 percent of their total production costs.³² To overcome these cost challenges, successful U.S. operations typically rely on three advantages: secure access to high-quality feedstock that reduces processing complexity, advanced technologies that improve operational efficiency, and strategic partnerships that help distribute capital costs. These factors are especially critical given the significant cost disadvantages U.S. facilities face compared to nonmarket competitors.

Offtake agreements are vital to project viability by providing guaranteed revenue streams and mitigating market risks. Such arrangements, particularly when binding and including pricing structures that guarantee producers can cover all costs and secure a predetermined profit margin, help projects secure more favorable financing terms.

²⁸ Note: When discussing recycling, this report will exclusively focus on the physical (ex. shredding, crushing) and metallurgical processes used to recover critical minerals and transform them into forms and purity levels suitable for industrial applications.

²⁹ George C. Marshall, "Specification for Control and Qualification of Laser Powder Bed Fusion Metallurgical Processes (MSFC-SPEC-3717,") NASA, " October 2017.

³⁰ SAFE findings from consultation with SCOR members.

³¹ IEA, "Global Critical Minerals Outlook 2024," May 2024, at 162.

³² SAFE findings from interviews with industry leaders; and Business Analytiq, "Hydrochloric Acid price December 2024 and outlook (see chart below)," Webpage.

Furthermore, they can help strengthen the overall financial position of processing companies, enhancing their ability to raise capital for other projects in their development pipeline. One example is Panasonic's binding offtake agreement with NOVONIX, a synthetic graphite anode material producer in Tennessee.³³

Offtake agreements can also be integrated with equity investments, further aligning the interests of producers and buyers while providing the capital necessary to advance projects. For instance, General Motors' \$625 million investment in Lithium Americas came with a 20-year offtake agreement for up to 100 percent of the battery-grade lithium produced in the first phase of Thacker Pass and an additional 20-year offtake agreement for up to 38 percent of the material produced under the second phase.³⁴

Relationships with buyers also inform product specifications for specialized metals and chemicals. Some refining and processing products are like commodities, which can be sold in multiple markets without requiring such close alignment between producer and end-user. However, when producing more specialized metals and chemical forms with precise industry specifications, such as battery-grade materials, early relationships with buyers become essential to not only understand exact product requirements but also justify the investment needed to achieve these specifications.

Finally, scale is important in determining a project's financial viability. Some critical minerals have small markets where the demanded volume is insufficient to justify large-scale competition. In extreme cases, the inability to scale commercial production due to small production volumes can eliminate any economic incentive for companies to undertake processing or recycling activities without support from a single, large end-user. However, not all end-users in the commercial market may be willing or able to support financing. This is where government interventions become crucial. The government can step in as the end-user, particularly for defense-critical materials, where national security considerations create a strong incentive for maintaining a stable supply of specialized minerals. Government support through procurement, tax incentives, and strategic investments can ensure the long-term viability of projects.

Infrastructure Gaps

The availability and quality of infrastructure in a host country can significantly impact the economic viability of critical

minerals projects. Mining and processing operations require reliable access to power, water, and transportation networks to function efficiently and deliver their products to market.

Insufficient access to power supply can disrupt operations and increase costs, whether due to limited generation capacity or unreliable distribution networks. Similarly, the lack of access to clean water sources or the inability to effectively manage water resources can hinder production and raise environmental concerns. Transportation infrastructure, such as roads, railways, and ports, is essential for timely and cost-effective delivery of equipment and supplies to the mine site, processing plant, or recycling facility and transporting extracted or processed minerals to consumers.

Inadequate or underdeveloped infrastructure poses a significant challenge to project development in developing

"The critical minerals industry needs lower operating costs and investments that will survive price drops. This goal can be achieved through lower cost of capital, utilizing economic zones, permitting reform, and increasing ports and supporting infrastructure."

- Andrew Trahar, Co-Founder of Vision Blue Resources

countries. However, the infrastructure challenge is not exclusive to developing nations. Projects in remote areas with poor transportation links, regardless of a country's development level, will face higher capital and operating costs and longer lead times for construction and delivery. A recent survey found that Canada's second-largest inhibitor to critical minerals investment was the lack of infrastructure for remote projects.³⁵

³³ NOVONIX, "Panasonic Energy and NOVONIX Sign Binding Off-Take Agreement," February 8, 2024.

³⁴ Lithium Americas, "View all news Unlocking Thacker Pass: General Motors to Contribute Combined \$625 Million in Cash and Letters of Credit to New Joint Venture with Lithium Americas," October 16, 2024.

³⁵ Ariane Bourassa and Jonathan Arnold, "What is holding back investment in Canadian critical minerals?," Canadian Climate Institute, October 3, 2024.

Compliance Risks

Investors require three elements from government regulatory frameworks: transparent and predictable rules of law and processes, an objective and standardized legal framework for project evaluation, and consistent implementation of stated regulations. In the United States, the permitting regime is particularly challenging due to its fragmentation across federal, state, and private land regulations, coupled with frequent environmental litigation that creates significant uncertainty for project development. It takes an average of seven to ten years to permit a mine in the United States—reflecting both robust technical requirements and opportunities for administrative and legal challenges throughout the process.³⁶ This contrasts with peer jurisdictions like certain Canadian provinces and Australian states that maintain high standards while providing more predictable approval pathways.³⁷ These regulatory hurdles often drive investors toward foreign opportunities, though growing resource nationalism and political and judicial instability in many mineral-rich nations present their own risks.

When operating abroad, companies often rely on investor-state dispute settlement (ISDS) mechanisms as one of their only legal recourses to protect investments against adverse government actions—see the callout box on the next page for more details on these critical protection mechanisms.

The regulatory burden is particularly challenging given limited government support for upstream mineral development compared to downstream manufacturing—while battery and electric vehicle facilities receive substantial incentives, mining projects face extensive permitting requirements with minimal offsetting assistance. Misalignment between industrial policy goals and regulatory frameworks impacts the ability to develop secure supply chains. Compliance risks manifest in different forms at the processing and recycling stages. Each country maintains distinct environmental standards, and specific technologies' pollution profiles and waste management strategies can quickly derail a project if not carefully evaluated. Some processing technologies may generate emissions or byproducts that fall short of a country's stringent regulatory requirements, making permitting impossible without waivers. Moreover, these regulatory constraints can substantially impact facility design and scale, effectively limiting the project's upside potential by restricting the maximum operational capacity or requiring costly emissions mitigation technologies.

Regulatory Uncertainties

Regulatory risks encompass uncertainties arising from changes to mining laws, regulations, and administrative frameworks governing mining operations. These changes can significantly impact project viability through shifts in mining codes, environmental standards, fiscal regimes, and permitting requirements. The permitting process often introduces significant uncertainty, with timelines varying widely across jurisdictions and frequent delays due to administrative bottlenecks, changing requirements, or stakeholder objections.³⁸

Projects can face challenges when multiple agencies have overlapping authority, leading to complex approval processes with uncertain outcomes. Such risks are particularly challenging to predict and control as they depend on evolving political, social, and economic factors within host countries. Regulatory uncertainties can pose a significant barrier to investment in the critical minerals sector, as high upfront capital investments and extended development timelines for mining and processing make projects especially vulnerable to regulatory changes throughout their long payback periods. The predictability and stability of a host country's rules and regulations are crucial in attracting and sustaining investment in critical minerals projects. Investors seek jurisdictions with clear, consistent, and transparent regulatory frameworks that provide a level playing field for all participants. Resource nationalism, however, often emerges in developing and emerging economies where mining dominates gross domestic product (GDP), tax revenue, and export earnings. These nations, typically dependent on foreign investment for mine development, tend to increase state intervention during commodity boom cycles through higher taxes, mandatory local ownership, or outright nationalization.³⁹

³⁶ SNL Metals & Mining, "Permitting, Economic Value and Mining in the United States," July 2015, at 25.

³⁷ SAFE findings from consultation with SCOR members.

³⁸ Womble Bond Dickinson, "Striking the Balance: Permitting Reforms for Mining and the Energy Transition," June 2024.

³⁹ Rick Mills, "A vicious cycle of rising resource nationalism," Mining.com, August 11, 2023.

Resource Nationalism: A Source of Regulatory Risk

Resource nationalism represents a key regulatory risk in resource-rich countries seeking greater economic benefits from mineral wealth. This pattern typically emerges in developing economies where mining dominates GDP, tax revenue, and export earnings. During commodity boom cycles, governments often increase state intervention through higher taxes, mandatory local ownership, or nationalization.

Zambia's Mining Experience: Zambia's mining history demonstrates the cyclical nature of resource nationalism:

- Late 1960s-early 1970s: Nationalized mining sector during copper price boom to redirect profits toward national development
- Early 1970s-1995: State ownership period led to production decline and widespread mismanagement as commodity prices fell
- 1996: Began re-privatizing mines with tax breaks to attract foreign investment
- 2000-2017: Frequent tax regime changes (approximately every 18 months):
 - During price booms: Increased taxes and royalties to capture a greater revenue share
 - During downturns: Offered concessions to attract investment
- Result: Long-term planning became difficult, deterring potential investors

Modern Export Restrictions:

Between 2009-2022, export restrictions increased fivefold globally, with bans becoming increasingly common.¹ Indonesia's 2014 nickel export ban exemplifies this trend:

- Attracted \$30 billion in processing facility investments
- Increased Indonesia's share of global nickel refining to 37 percent
- Limited Western investment (\$2 billion from the United States, Canada, and Australia combined)

Nations following suit include:

- Zimbabwe: banned unprocessed lithium exports (2022)
- Namibia: restricted lithium, cobalt, manganese, graphite, rare-earths exports (2023)
- Ghana: banned exports of unprocessed lithium, bauxite, cobalt, copper (2024)

Investment Implications:

- May incentivize downstream investment from established producers
- Often deters new investment through increased uncertainty
- Requires substantial infrastructure investment for processing facilities

Frequent changes to mining laws, tax regimes, or other regulations can create uncertainty and deter investment, making it difficult for companies and investors to plan and execute long-term strategies. The risk of expropriation, unilateral contract adjustment, and sudden changes to royalty regimes can drive away potential investors or prematurely terminate existing projects.

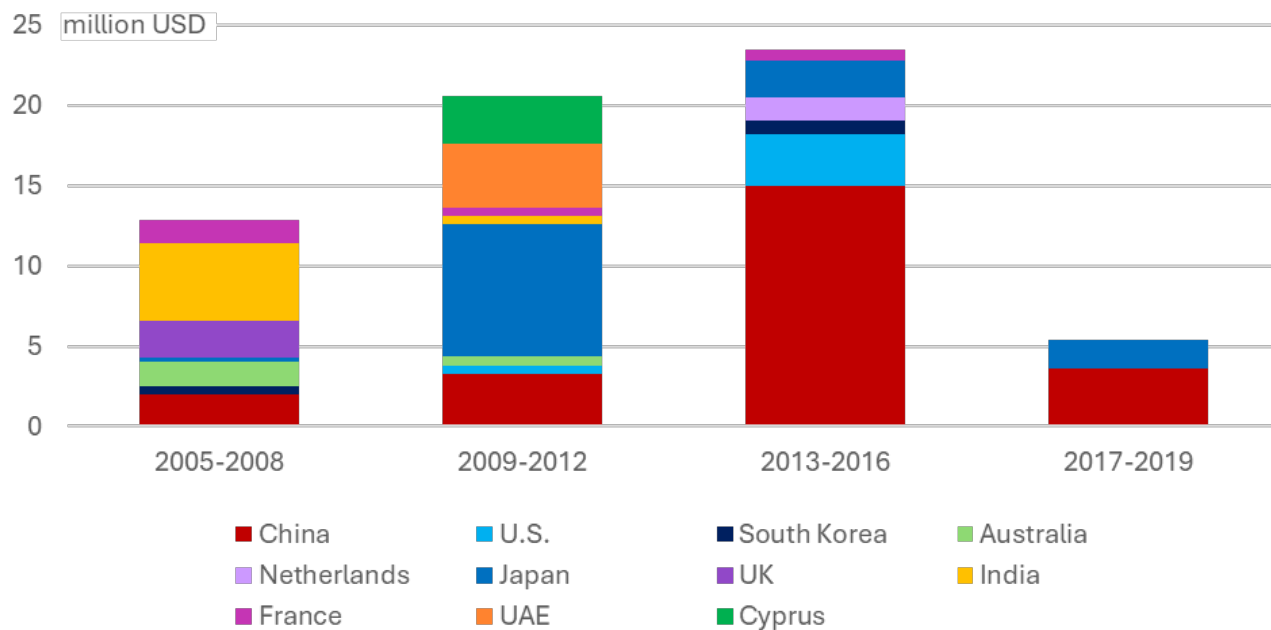
Export bans may successfully incentivize mid- or downstream investment from established producers who have already recovered their initial capital expenditure and operate world-class assets, as these companies may opt to invest in processing facilities rather than abandon valuable operations. However, for prospective investors, such

restrictive policies or their potential implementation introduce additional regulatory uncertainties that may deter new investment in the country. This is particularly true when export restrictions require rapid development of domestic processing capacity, significantly increasing overall project costs and capital requirements in developing nations. Indonesia's experience illustrates these dynamics: Western capital constituted a tiny part of the billions of dollars invested in Indonesia for nickel production, with combined investments from the United States, Canada, and Australia totaling less than \$2 billion between 2014 and 2022.⁴⁰

¹OECD, "Raw materials critical for the green transition," April 11, 2023, at 6.

⁴⁰ Eliot Chen, "The Nickel Pickle," *The Wire China*, May 7, 2023.

Figure 4. Foreign Direct Investment in Indonesia's Mineral Sector



Source: Carnegie Endowment for National Peace.

Permitting and License to Operate

Uncertainties related to the permitting process pose a significant hurdle at the most vulnerable stage of a mine project. When permitting timelines become unpredictable, it creates a cascade of complications: construction schedules cannot be reliably established, operational cash flow projections become uncertain, and financial models lose validity. Unexpected delays in the permitting process alone reduce a typical mining project's value by more than one-third.⁴¹ Regardless of a project's commercial viability, the inability to reasonably predict timelines makes it impossible for investors to price risk accurately and can ultimately drive investment away from otherwise viable projects.⁴² The problem is particularly acute in the mining sector, where projects face intense scrutiny of their environmental and social impacts. Processing facilities risk facing "not in my backyard" (NIMBY) opposition from local communities concerned about pollution and industrial activity, while permitting typically presents fewer challenges than mining projects.⁴³

The permitting landscape in the United States and Europe is particularly challenging. It is characterized by complex social opposition and bureaucratic inefficiencies that often

lack objectivity and speed. While these regions benefit from stable regulatory frameworks that minimize uncertainties such as expropriation risks or changes in tax policies once a mine is built and operating, they face significant challenges in permitting new projects.

Politics inevitably play a role in permitting decisions. Still, the issue is particularly exacerbated in the United States, where political considerations often overtake a regulatory

"There are three primary components of a successful permitting regime: clarity of process, objectivity of process, and ability and speed to execute process."

- Michael Barton, Deputy Group CEO of Orion Resource Partners

⁴¹ SNL Metals & Mining, "Permitting, Economic Value and Mining in the United States," June 2015, at 7.

⁴² SAFE findings from consultation with SCOR members.

⁴³ Allyn West, "It's hard to breathe with a concrete plant in your backyard," Urban Edge, August 19, 2020.

process that should be grounded in technical criteria and clear timeframes. Opposition to mining projects is frequently cause-driven, aiming to block permit applications outright rather than addressing specific technical objections or seeking resolution on individual issues. Political pressures from special interest groups influence permitting decisions, leading to a lack of objectivity and inconsistent outcomes. Projects become mired in political debates, with local and national policymakers weighing in, further slowing down the process.

In addition to the political challenges, the legal challenges that mining projects face are equally problematic, which can often put them on hold for years after permits are secured, as evidenced by the Arizona Resolution Copper project, despite it completing environmental reviews. The project faced several lawsuits, including a seven-year battle resolved in 2024 over water rights related to its permit renewals at the state level and a lawsuit filed in 2021 challenging a land exchange agreement the project has with the U.S. government.⁴⁴ After 29 years since its discovery and 11 years since the company started its U.S. permitting process at the federal level, these legal hurdles continue to cause substantial delays in the development of Resolution Copper.⁴⁵

Historical mining practices have contributed to an erosion of public trust in the sector, which fuels opposition and litigation against projects at every stage. For example, Silver Bull Resources, which was conducting exploration activities in Mexico, could not access the exploration site for over four years due to a blockade organized by members of a local cooperative.⁴⁶ In Panama, protests erupted after the government quickly approved a 20-year concession for First Quantum Minerals' Cobre Panama copper mine, sparking outrage over the lack of public consultation and perceived political favoritism.⁴⁷ In Peru, protests and political upheaval in 2022 and 2023 imperiled more than 30 percent of the country's copper output after protestors attacked mines and implemented blockades that forced temporary closures.⁴⁸

Early and consistent engagement with local and indigenous populations to address environmental and social concerns is key to acquiring a license to operate and reducing the likelihood of prolonged legal challenges or disruptions in operations.⁴⁹ While they may add additional financial and

"We must deploy capital in the responsible and right way, which means we need all-stakeholder discussions. These can change the narrative, which in turn will increase the comfort we need for the capital to flow through."

- SCOR Member

logistical requirements at the pre-revenue stage when funding is more constrained, adopting responsible practices is crucial to re-establishing public trust and ensuring a stable supply chain. By demonstrating a commitment to responsible practices that address the interests and concerns of all stakeholders, companies can create the conditions necessary to attract and mobilize private capital.

Geopolitical Risks

PRC market control creates systematic market distortions that fundamentally alter critical minerals project economics, perpetuated by PRC policies that create artificially low prices, encourage price volatility, and control essential chokepoints, rendering it impossible for ex-China companies to compete. These factors allow state-owned enterprises (SOEs) to operate, often at a loss, in high-risk areas and offer artificially low prices for raw and processed critical minerals through employing low labor, environmental, and human rights standards. Low or no-cost capital provided by the PRC to strategic sectors allows Chinese companies to shift their business model from one that prioritizes profits to one that prioritizes national strategy. These practices enable Chinese companies to effectively box out market competitors.

Beyond the market distortions caused by PRC intervention, the ongoing tit-for-tat responses between the U.S. and PRC and allied government trade policies heighten geopolitical risks in the critical minerals sector. The United States is implementing increasingly stringent regulations on Chinese companies, imposing tariffs, and restricting access to

⁴⁴ David Abbott, "Arizona Supreme Court gives Resolution Copper a win in wastewater discharge appeal," *AZ Mirror*, June 28, 2024; and Debra Utacia Krol, "Oak Flat copper mine lawsuit is headed to the Supreme Court after 9th Circuit ruling," *AZ Central*, May 14, 2024.

⁴⁵ Mohsen Bonakdarpour, Frank Hoffman, and Keerti Rajan, "Mine development times: The US in perspective," S&P Global, June 2024, at 18; and "Project Overview," Resolution Copper, Webpage.

⁴⁶ Silver Bull Resources, "Silver Bull Files Memorial In Claim Against Mexico," June 18, 2024.

⁴⁷ James Bosworth, "Latin America's Mining Backlash Has Global Implications," *World Politics Review*, November 13, 2023.

⁴⁸ James Attwood, "Peru's Violent Protests Imperil 30% of Its Copper Output," *Bloomberg*, January 27, 2023.

⁴⁹ IEA, "Sustainable and Responsible Critical Mineral Supply Chains," December 2023, at 7.

advanced technologies.⁵⁰ In response, the CCP is introducing measures to restrict the flow of critical minerals and the technologies needed to transform them.⁵¹ Moreover, the CCP has implemented increased reporting requirements for both exporters and Chinese miners operating abroad, signaling heightened monitoring and intervention in global supply chains.⁵² These actions create uncertainties in the global supply chain, drive costs up, and complicate international trade dynamics in this critical sector. While this report will not dive deep into these trade risks, it is important to acknowledge how they impact investors since they are rapidly changing and unpredictable.

Strategic Non-Market Actions

The PRC has spent decades shaping its defense, diplomatic, and development policies to achieve and promote 1) territorial integrity and sovereignty, 2) internal security and stability, and 3) domain protection.⁵³ Building and maintaining advanced and robust industrial networks with a technological edge in dual-use sectors to feed into its defense industrial base is a crucial pillar of the CCP security agenda. The CCP resorts to illegal subsidies and opaque and predatory market practices to acquire strategic foreign assets and promote domestic value addition.

Guiding the PRC's ambitions is Made in China 2025, a strategy that seeks to raise the country's global standing by taking commanding leadership positions in various emerging industries of economic and strategic significance.⁵⁴ This strategy outlines 10 priority sectors, with five sectors requiring critical minerals as primary inputs—oceanographic engineering equipment, advanced rail transportation equipment, new energy vehicles and equipment, power equipment, and new materials—while the other five sectors use critical minerals as supporting components in their supply chains.⁵⁵ SOEs and private companies operating under significant government influence are strategically deployed to pursue the national agenda.

Many other nations support their domestic industries and emerging industrial players. The PRC's approach, however, is distinctive and highly distortive in scale and scope. First, the PRC provides comprehensive financial support to its

"The mid and downstream processing areas are typically the biggest challenges the resources sector faces in competing head-on with China's very low cost of capital. Western projects are now burdened with a significant capital intensity disadvantage. China now has cost, scale, and technology advantages right across the mining value chain."

- Stephen McIntosh, Senior Advisor at EMR Capital

domestic critical minerals sector, offering established market leaders grants, low-cost loans, energy subsidies, access to cheap land, and tax benefits. Examples of industry leaders benefiting from such subsidies include Tianqi Lithium, which reported \$24 million; Ganfeng Lithium, which reported \$217 million; and China Northern Rare Earths Group, which reported \$29 million in subsidies in 2023.⁵⁶ Experts estimate that PRC's subsidies cover 20 to 40 percent of the total project cost for critical mineral mining and processing, ensuring that Chinese companies can outcompete foreign competitors.⁵⁷

Second, the PRC deploys several tools that are considered illegal under World Trade Organization (WTO) terms. Under the WTO Subsidies Agreement, two types of subsidies are prohibited: export subsidies and import substitution subsidies.⁵⁸ Export subsidies are those that require companies to meet export targets to receive government support. Import substitution subsidies are those that require companies to use domestic rather than imported goods to receive government support. These subsidies are classified as specific under WTO terminology and illegal under WTO

⁵⁰ See e.g., David Bond et al., "United States Finalizes Section 301 Tariff Increases on Imports from China," White & Case, September 17, 2024; and Reuters, "U.S. Announced New Export Controls on China's Chip Industry," December 3, 2024.

⁵¹ See e.g., Gracelin Baskaran and Meredith Schwartz, "China Imposes Its Most Stringent Critical Minerals Export Restrictions Yet Amidst Escalating U.S.-China Tech War," Center for Strategic and International Studies, December 4, 2024.

⁵² See e.g., Benchmark Source, "China Tightens Graphite Export Controls to the United States," December 5, 2024; and Mia Nulimaimaiti, "Beijing Orders Chinese Miners to Report More of Their Overseas Reserves," South China Morning Post, January 9, 2025.

⁵³ Ministry of National Defense, "Defense Policy," Webpage.

⁵⁴ Ben Murphy, "Notice of the State Council on the Publication of Made in China 2025," Center for Security and Emerging Technology, March 8, 2022, Translation, at 1.

⁵⁵ Scott Kennedy, "Made in China 2025," Center for Strategic and International Studies, June 1, 2015.

⁵⁶ "China: Government subsidies for listed company Ganfeng Lithium Group Co., Ltd. in year 2023," Global Trade Alert, Webpage; "China: Government subsidies for listed company China Northern Rare Earth (Group) High-Tech Co. Ltd in year 2023," Global Trade Alert, Webpage; and "China: Government subsidies for listed company Tianqi Lithium Corporation in year 2023," Global Trade Alert, Webpage.

⁵⁷ John Coyne, "Critical Minerals Security Partnership may not be enough for Australia," *The Strategist*, September 25, 2024.

⁵⁸ International Trade Administration, "Trade Guide: WTO Subsidies Agreement," Webpage.

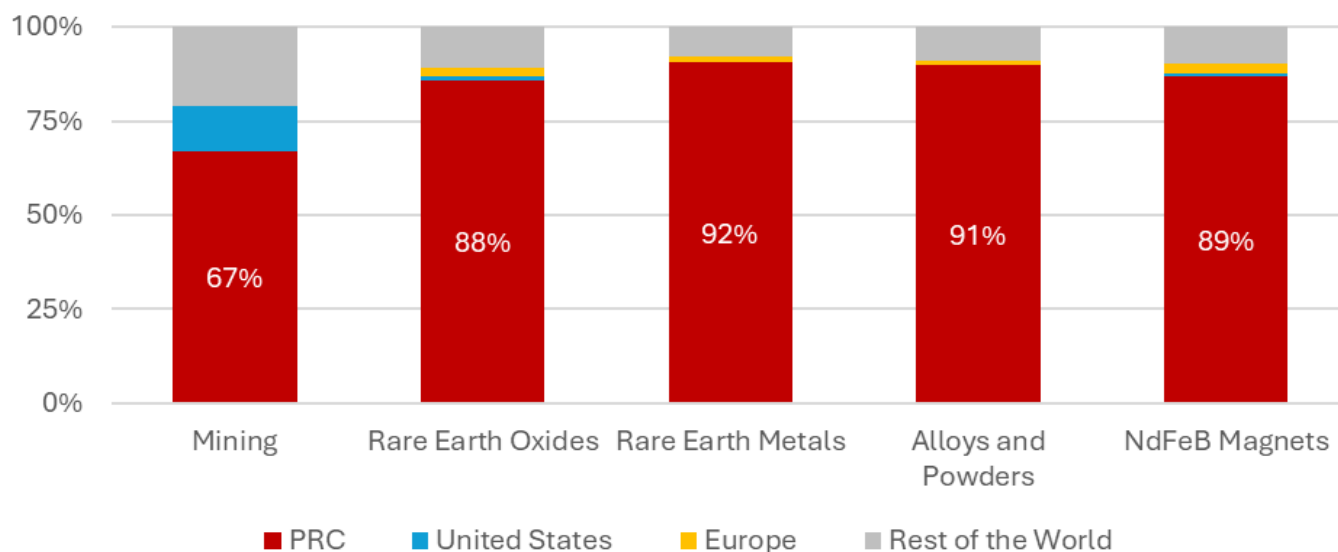
rules and U.S. law because they are considered particularly damaging to international trade.⁵⁹

The REE sector provides a notable example of how the PRC offers illegal subsidies through its tax regime. All REE products in the PRC, including oxides, metals, and magnets, are subject to a 13 percent value-added tax (VAT).⁶⁰ When domestic producers buy raw rare earth oxides and metals in the PRC, they pay the international market price, including the 13 percent VAT. The VAT is not refunded if these materials are exported as raw REE. However, when exported as value-added products like rare earth magnets, the Chinese companies receive a VAT refund. The refund automatically creates a 13 percent cost advantage for Chinese rare earth magnet producers over their foreign competitors.⁶¹ The system is created to discourage the export of REEs so that they can be retained within the PRC for further processing and exported as greater value-added products while providing cost advantages for Chinese rare earth magnet producers compared to their foreign competitors.

Although not a subsidy, taxes, and tariffs are also structured to incentivize sourcing from domestic players at the strategic processing steps. Imports of rare earth

concentrates, the main product of REE extraction, are not subject to VAT by the PRC and import duties.⁶² This is because extraction is bound by geology, and it does not make sense to restrict the Chinese industry's access to raw materials. However, imports of rare earth oxides, carbonates, and metals face a five percent tariff and 13 percent VAT.⁶³ The PRC remains the primary buyer of processed REE because of its dominance at every step of the supply chain. The tax system ensures the PRC controls the critical midstream processing steps. Meanwhile, foreign REE producers are discouraged from building value-added processing capabilities since their products would face uncompetitive pricing in the Chinese market.

Figure 5. PRC's Global Market Share of Rare Earths Supply Chain, 2023



Source: Adamas Market Intelligence.

⁵⁹ International Trade Administration, "An Introduction to U.S. Trade Remedies," Webpage.

⁶⁰ Mary Hui, "How China uses tax policies to defend its rare earths monopoly," *Quartz*, February 22, 2022.

⁶¹ Ibid.

⁶² Ibid.

⁶³ "The History of Sumitomo Metal Mining," Sumitomo Metal Mining, Webpage.

⁶⁴ See e.g., Nick Evans, "Australian operations put serious dent in MCC's reputation," *Papua New Guinea Mine Watch*, February 7, 2012.

⁶⁵ Jon Emont, "China Harnesses a Technology That Vexed the West, Unlocking a Treasure Chest," *The Wall Street Journal*, September 9, 2024; and Earl Cotton, "China Harnesses a Technology That Vexed the West, Unlocking a Treasure Chest," *Medium*, September 9, 2024.

⁶⁶ Rick Mills, "Indonesia and China killed the nickel market," *Mining.com*, March 4, 2024.

⁶⁷ Ibid.; and Fransiska Nangoy and Fathin Ungku, "Exclusive: Facing green pressure, Indonesia halts deep-sea mining disposal," *Reuters*, February 5, 2021.

⁶⁸ Joseph Rachman, "Indonesia: US Department of Labor adds nickel to forced labour list, citing poor working conditions in Chinese-Indonesian industrial parks," *Business & Human Rights Resource Centre*, September 10, 2024.

⁶⁹ Ibid.

For critical mineral mining and processing projects overseas, support comes through the BRI, launched in 2013 to boost trade and connectivity across Africa, Asia, and Europe through infrastructure development. A decade since its launch, BRI investment has surpassed \$1 trillion in total engagement, including \$634 billion in construction contracts and \$419 billion in non-financial investments.⁶⁴ In 2023, BRI investments in energy-related engagement were just under \$8 billion—a record high.⁶⁵ Within this period, projects in the technology and mining sectors saw remarkable growth of 1,046 percent and 158 percent investment rates, respectively.⁶⁶ The lion's share of these mining investments comprises critical minerals and metals projects essential for the energy transition and advanced technologies, including cobalt, lithium, and nickel mines. Researchers anticipate that 2024 financial reports will demonstrate further BRI engagement and growth, with investment targeting renewable energy, mining, and related technologies.⁶⁷

Financing offered by state-owned banks under the BRI has been crucial in providing the low-cost capital needed to close infrastructure gaps and facilitate access to mineral resources abroad. For example, in the early 2010s, Tsingshan had previously attempted to build nickel smelters in Indonesia, where it purchased raw ore, as transporting refined material back to the PRC was more cost-effective than transporting raw.⁶⁸ However, these efforts stalled due to insufficient infrastructure. Once BRI was operationalized, Tsingshan could tap into low-cost financing from state-owned banks to enable the construction of essential infrastructure such as roads, ports, and captive coal power plants, opening its first nickel industrial park in 2015.⁶⁹

Today, Chinese companies control 90 percent of Indonesia's nickel smelters.⁷⁰ Their emissions-intensive processing facilities skirt environmental regulations by dumping toxic tailings in the ocean while taking advantage of weakened labor protections.⁷¹ This combination of state backing and lowered standards has allowed Chinese

The Nickel HPAL Case Study

High-Pressure Acid Leaching (HPAL) is a processing method used to extract battery-grade nickel and cobalt from laterite ores, Indonesia's predominant nickel ore type. HPAL produces a material called Mixed Hydroxide Precipitate (MHP), an intermediate product that is further refined into nickel sulfate and cobalt sulfate for advanced battery production. While HPAL is not a new technology—Japan's Sumitomo Metal Mining initially commercialized it—it has historically been considered expensive and technically challenging due to the use of sulfuric acid, high-pressure reactors, and significant corrosion risks, all of which drive up operational and maintenance costs.^m Additionally, the process generates acidic waste, which is costly to manage and requires strict containment measures to prevent environmental damage.

With access to low-cost capital from state-owned banks, Chinese companies could overcome these barriers by refining and adapting HPAL technology. Early projects, such as the Ramu Nickel plant in Papua New Guinea developed by the state-owned Metallurgical Corporation of China (MCC), faced significant cost overruns and delays. Still, the ability to absorb financial losses allowed Chinese firms to experiment, build expertise, and gradually reduce production costs.ⁿ By iterating through multiple projects and leveraging state backing, Chinese companies improved the efficiency of HPAL facilities, eventually scaling the process for commercial use at competitive costs.^o

Today, Chinese firms backed by the CCP are deploying HPAL at scale in Indonesia. In addition to expertise and continued state support, these companies benefit from Indonesia's relaxed environmental and regulatory standards. Although a deep-sea tailings disposal ban was announced in 2021, the practice likely continues.^p At least four HPAL plants were under construction before the ban was announced, and at least one of them is reported not to have sufficient dry stack storage capacity.^q Indonesia's nickel sector is also fraught with concerning labor conditions that have been categorized as forced labor by the U.S. Department of Labor.^r This combination of state-backed financing, lenient oversight, and exploitative practices has enabled Chinese firms to position Indonesia as a global leader in low-cost nickel production, even as the environmental and social costs remain unaddressed.

⁶⁴ Christoph Nedopil, "China Belt and Road Initiative (BRI) Investment Report 2023," Griffith Asia Institute, February 2024, at 8.

⁶⁵ *Ibid.*, at 6.

⁶⁶ *Ibid.*, at 12.

⁶⁷ *Ibid.*, at 7.

⁶⁸ Angela Tritto, "How Indonesia Used Chinese Industrial Investments to Turn Nickel into the New Gold," Carnegie Endowment for International Peace, April 2023.

⁶⁹ *Ibid.*, at 7.

⁷⁰ Gracelin Baskaran, "Diversifying Investment in Indonesia's Mining Sector," Center for Strategic and International Studies, July 11, 2024.

⁷¹ Rick Mills, "Indonesia and China killed the nickel market," *Mining.com*, March 4, 2024; and Joseph Rachman, "Indonesia: US Department of Labor adds nickel to forced labour list, citing poor working conditions in Chinese-Indonesian industrial parks," Business & Human Rights Resource Centre, September 10, 2024.

producers to flood the market with cheap nickel, driving global prices down and forcing Western producers like BHP to write down billions in assets and consider closing their Australian operations that operate with higher environmental and social standards, including the prohibition of deep-sea tailings disposal.⁷²

A key distinction between the PRC's state-driven economic model and the market-driven systems of Organization for Economic Cooperation and Development (OECD) nations like the United States is the high concentration and dominance of SOEs in strategic industries, including critical minerals.⁷³ Since the early 2010s, the CCP has positioned SOEs at the core of its industrial policy, a trend often described as "state advance, private retreat."⁷⁴ In the critical minerals sector, SOEs play a pivotal role in securing access to strategic, world-class resources and building overcapacity in mining and processing across five continents—all to consolidate the PRC's dominance across global supply chains.⁷⁵

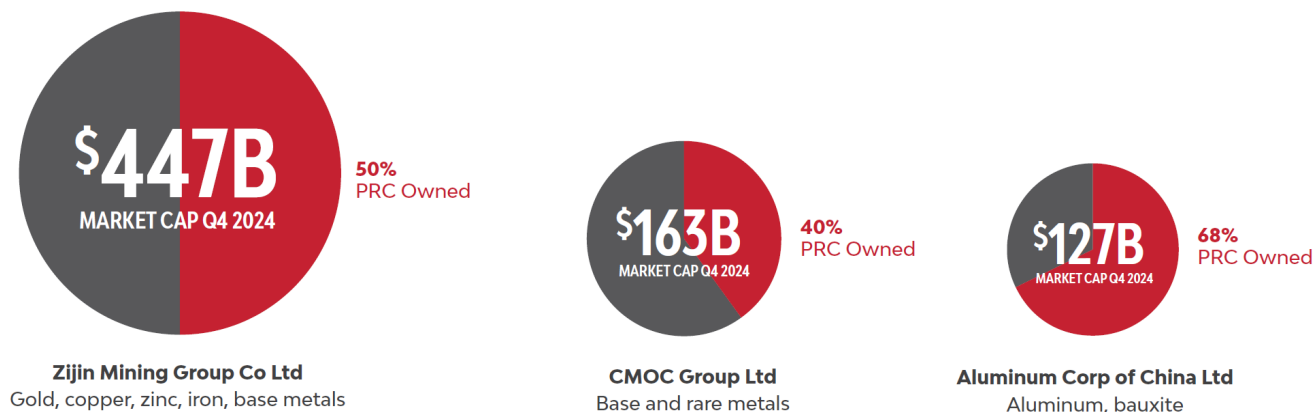
Quantifying the exact market share controlled by SOEs in the PRC is challenging. Official definitions and data often fail to capture situations where the state holds a minority but controlling share and the growing partnerships between SOEs and private firms.⁷⁶ In many cases, SOEs and private entities operate together, with private companies leveraging state-backed resources and support.⁷⁷ Nonetheless,

illustrative examples provide insight into these enterprises' dominant role in the global market for critical minerals.

The PRC owns controlling stakes in the country's top three mining and metals companies by market capitalization.⁷⁸ In the REEs sector, the state-owned China Rare Earth Group controls nearly 70 percent of PRC domestic mine production quotas.⁷⁹ It is responsible for approximately one-quarter of global REE output.⁸⁰ The mega-conglomerate was created in 2021 by merging six state-owned companies, including three of the "Big 6" rare earths SOEs.⁸¹ Jinchuan Group, owned by the Gansu province, is the third-largest nickel, fourth-largest cobalt, and third-largest copper producer in the PRC.⁸² It is also the largest platinum group metals manufacturer in Asia.⁸³ SOEs also play a key role in improving extraction and processing technologies. Perhaps the most notable example is MCC's role in advancing HPAL technology, as discussed previously.

SOEs do not operate with the same profit-driven motivations as Western companies and investors. They are instruments to achieve the policy goals of the CCP. The investments and strategies employed by PRC SOEs are designed to consolidate market control and maintain long-term dominance in critical sectors. Supported by the Chinese government's low-cost capital, SOEs build overcapacity in mining and processing, flooding the market with supply even

Figure 6. State Ownership in Top Three PRC Mining and Metal Companies



⁷² Rhiannon Hoyle, "BHP Signals \$5.7 Billion of Write-Downs From Nickel Crash, Dam Failure Fallout," *The Wall Street Journal*, February 14, 2024; and Anna Baxter, "CAP puts an end to years of marine pollution: disposal of tailings into the sea is terminated," *Oceana*, March 28, 2019.

⁷³ Ilaria Mazzocco, "Unpacking Linkages Between the Chinese State and Private Firms," Center for Strategic and International Studies, March 21, 2024.

⁷⁴ Ibid.

⁷⁵ Edward Burrier and Thomas Sheehy, "Challenging China's Grip on Critical Minerals Can Be a Boon for Africa's Future," United States Institute of Peace, June 7, 2023.

⁷⁶ Ilaria Mazzocco, "Unpacking Linkages Between the Chinese State and Private Firms," Center for Strategic and International Studies, March 21, 2024.

⁷⁷ Ibid.

⁷⁸ Market capitalization, or market cap, is the total value of a publicly traded company, calculated by multiplying the total number of outstanding shares by the current share price. It represents the market's view of a company's value and prospects. Source: Fidelity, "What is market cap?," Webpage.

⁷⁹ Sulgiye Park, Cameron L. Tracy, Rodney C. Ewing, "Reimagining U.S. rare earth production: Domestic failures and the decline of US rare earth production dominance – Lessons learned and recommendations," *Science Direct*, August 2023.

⁸⁰ Michelle Michot Foss and Jacob Koelsch, "Of Chinese Behemoths: What China's Rare Earths Dominance Means for the U.S.," Baker Institute, December 19, 2022.

⁸¹ Qian Zhou and Sofia Brooke, "China Merges Three Rare Earths State-Owned Entities to Increase Pricing Power and Efficiency," China Briefing, January 12, 2022.

⁸² Jinchuan Group International Resources Co. Ltd, "Major Shareholders," Webpage.

⁸³ Ibid.

when it leads to operating losses.⁸⁴ The firms can continue investments even during market downturns or periods of low profitability.⁸⁵

“China is not looking for internal rate of return (profitability), they are seeking broader strategic goals, making China and Western investors pursuing different goals on an uneven playing field.”

- SCOR Member

While they can bring more production capacity online, Chinese SOEs are unreliable partners in the global minerals market. The minerals extracted and processed by SOEs are primarily intended for domestic use. Overseas SOE subsidiaries are tasked with exporting strategically important materials back to the PRC for further processing and manufacturing. For example, Metorex, Jinchuan Group’s subsidiary producing copper and cobalt in the DRC and Zambia is under an agreement to sell its cobalt products exclusively to its parent company in the PRC.⁸⁶

Market Control and Price Manipulation

State support for the PRC’s critical minerals sector encompasses the entire value chain, from raw material sourcing to advanced manufacturing. In addition to their dominance in critical minerals production, this holistic approach ensures that Chinese entities are also the primary consumers of mineral inputs.

A substantial portion, if not most, of the critical minerals mined globally ultimately ends up in the PRC due to its dominant role in processing. The PRC maintains market control by processing 99 percent of battery-grade graphite, over 60 percent of lithium chemicals, 40 percent of refined copper, over 80 percent of refined magnet REEs, and 70 percent of refined cobalt.⁸⁷ Additionally, the PRC processes around 90 percent of cathode-active materials (CAM) and

97 percent of anode-active materials, and it is the leading producer of permanent magnets, producing more than 90 percent of the global supply.⁸⁸ The PRC pursued dominance in these midstream steps in part because it is the leading producer of advanced batteries and permanent magnets. The scale of the PRC’s buying power, combined with its state-backed policies, enables it to exert significant influence over global supply chains, securing favorable terms and prices for the minerals necessary to fuel its technological ambitions.

Chinese companies, heavily influenced by state policies, also follow a vertical integration model that spans multiple stages of production. Figure 6 illustrates the scale of vertical integration in lithium and REE markets as opposed to their Western counterparts. The same is true for other critical minerals. For example, the Contemporary Amperex Technology Co., Limited (CATL) vertical integration strategy applies to all of its cathode materials—including a 25 percent stake in the DRC Kisanfu copper-cobalt mine to a \$5.8 billion investment in Indonesian nickel processing, culminating in its position as the world’s largest EV battery manufacturer with a 36.8 percent global market share.⁸⁹ CATL’s investments are facilitated by substantial government support, including over \$800 million in subsidies in 2023, preferential financing, and special access to state-backed funding for overseas acquisitions.⁹⁰

The vertical integration model allows Chinese firms to integrate upstream and downstream activities, from resource extraction to final product. One significant advantage of this structure is the ability to shift value along the supply chain.⁹¹ Chinese entities can intentionally flood the global market with low-priced critical minerals—sometimes following directions from the CCP—to undercut competitors, often below-market value. For example, following direction from the PRC Ministry of Industry and Information Technology, REE spot prices started to fall from a high of \$180/kg in 2022 to less than \$60/kg for most of 2024—a level where even the three largest, integrated REE producers in the PRC operated at a loss.⁹²

It is widely recognized in the mining sector that the benefits provided to these downstream industries—through access

⁸⁴ Note: Chinese government policy has deliberately supported the creation of overcapacity in mining and processing industries, particularly for minerals and metals that China is heavily dependent on for imports. This strategy ensures access to low-cost materials for its downstream industries, which are integral to China’s broader industrial goals. Source: SAFE findings from interviews with mining industry leaders.

⁸⁵ See e.g., William Clowes and Godfrey Marawanyika, “China Mining Firms Partner with Zimbabwe on Lithium Mine,” Bloomberg, September 23, 2024.

⁸⁶ Jinchuan Group International Resources Co. Ltd, “Business Overview,” Webpage.

⁸⁷ Kris Cooper, “A deep dive into China’s role as ‘critical mineral monolith,’” Mining Technology, September 10, 2024.

⁸⁸ Fabian Villalobos, et al., “Time for Resilient Critical Material Supply Chain Policies,” RAND, December 2022.

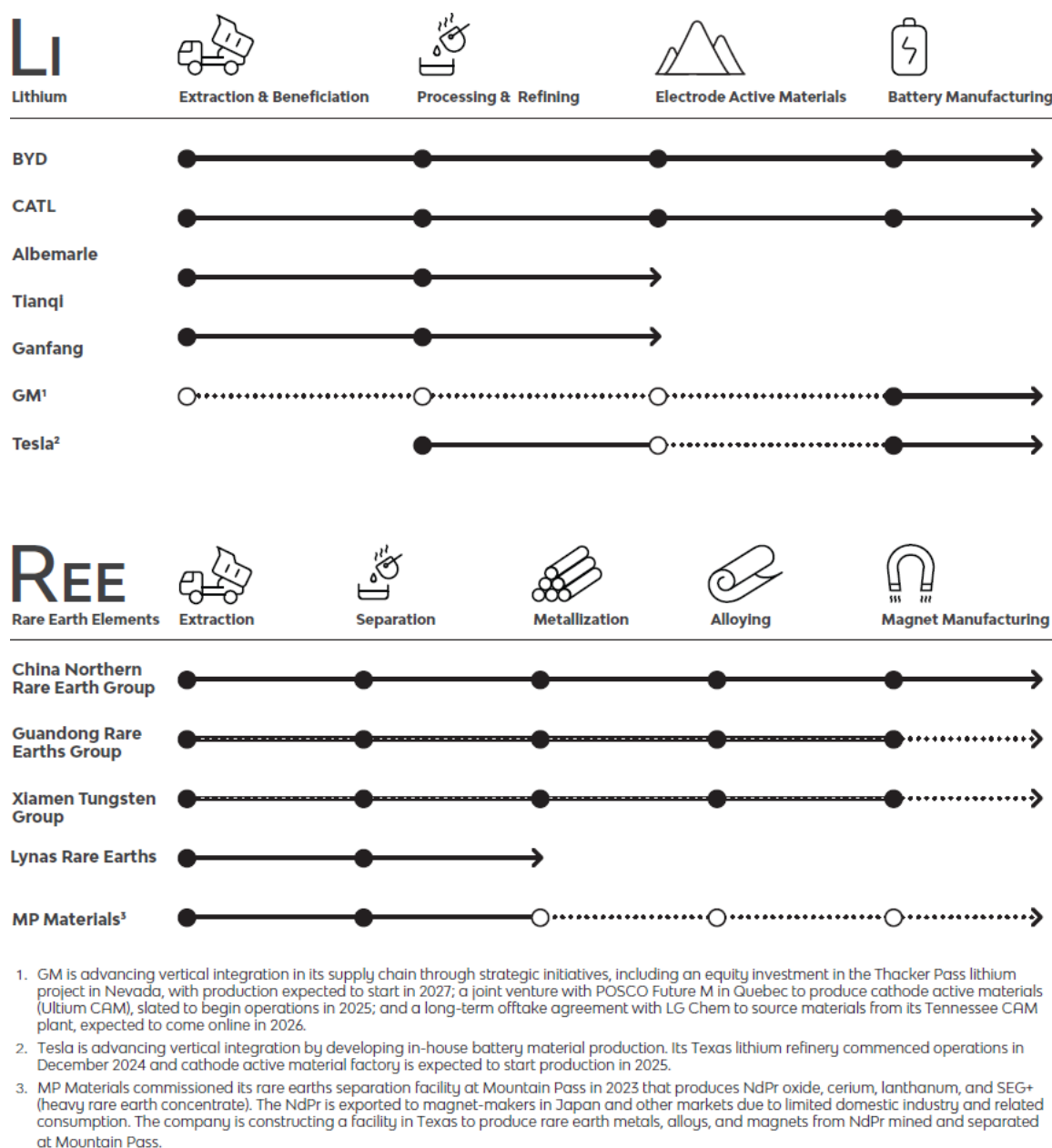
⁸⁹ Tom Daly, “CATL takes stake in China Moly cobalt mine for \$137.5 million,” Reuters, April 11, 2021; “Antam - CATL develop midstream nickel industry,” Indonesia Business Post, July 22, 2024; and Lei Kang, “Global EV battery market share in Jan-Nov 2024: CATL 36.8%, BYD 17.1%,” CNEV Post, January 5, 2025.

⁹⁰ Kenji Kawasaki, “CATL reigns as China’s top subsidy recipient with 35% jump in first half,” Nikkei Asia, September 26, 2024.

⁹¹ Angus Barker, “Critical minerals need insulation from China’s market manipulation,” *The Strategist*, May 21, 2024.

⁹² Adele Stratton, “Iluka Resources (ASX: ILU),” Macquarie Conference, May 8-9, 2024, at 11.

Figure 7. Example of Chinese Vertical Integration and Western Specialization in Lithium and Rare Earth Elements



to these low-cost materials—can be up to ten times the amount invested in building the overcapacity.⁹³ Additionally, by temporarily driving down prices, the PRC can halt project development of incipient producers and force smaller or less-capitalized producers, particularly those in Western markets, to either sell at a loss or exit the market altogether.

As Eugene Gholz, Professor at Notre Dame University and former Pentagon Senior Advisor, notes, PRC market power in critical minerals stems from production dominance and its ability to obscure true market conditions through its control of price discovery mechanisms and trade flows.⁹⁴ This opacity creates fundamental challenges for Western investors trying to evaluate and price market risks. Price manipulation is further facilitated by the PRC and PRC-controlled entities control over the flow of critical minerals

⁹³ Source: SAFE findings from interviews with the mining industry.

⁹⁴ Eugene Gholz, “Here is the Dirty Truth About China’s Rare Earths Threat,” *The Washington Post*, May 31, 2019.

and lack of price transparency. The PRC has become the primary trading hub for most critical materials, given its overwhelming market presence. As a result, benchmark prices for these minerals are often set within the PRC, making Western companies price takers. Furthermore, opacity in critical mineral markets—especially for materials with less mature markets—is exacerbated by the level of vertical integration. Western market participants are blocked from understanding how prices are set and determining when direct manipulation occurs, obfuscating the difference between inherent market volatility and intentional market flooding directed by the CCP to drive down prices.⁹⁵

Investors can handle a wide variety of technical, financial, and compliance risks that were previously discussed. The one risk they can't price is geopolitical risk, the chance of foreign adversary and foreign adversary entity action that could derail profits. Unlike market fluctuations or operational challenges, geopolitical risks stemming from market control are inherently unpredictable and unhedgeable.⁹⁶

Geopolitical Tensions

PRC's policies in the critical minerals sector do not exist in isolation. They are increasingly shaped and influenced by the broader geopolitical landscape. As the geopolitical competition between the United States and the PRC intensifies, critical minerals have not only become a focal point of their rivalry but are also frequently entangled in disputes over trade, technology, and defense. These overlapping arenas of competition drive an intricate cycle of policies and countermeasures. This escalating geopolitical tension creates an environment of heightened uncertainty, adding another layer of risk to the sector and ultimately influencing investment decisions.

When the Trump administration announced sweeping tariffs on goods imported from the PRC in 2018 to address longstanding concerns over PRC trade practices—such as forced technology transfer requirements, cyber-enabled theft of U.S. intellectual property, discriminatory licensing practices, and state-funded strategic acquisitions of U.S.

assets—the PRC responded with a threat. President Xi Jinping and the Chinese state media signaled the possibility of banning the export of REEs to the United States.⁹⁷

It was not until the United States implemented sweeping export bans on advanced semiconductor technologies that the CCP retaliated in a tangible way. Since October 2022, the U.S. government introduced several rounds of export controls on advanced semiconductors and semiconductor manufacturing technology to the PRC, specifically targeting the tools and technologies needed to develop cutting-edge chips with applications in AI, quantum computing, and military systems.⁹⁸ The purpose of these restrictions was to limit the PRC's ability to advance in the strategically important semiconductor industry, which underpins economic and national security.⁹⁹ The United States pressed the Netherlands and Japan, two leading countries in the semiconductor supply chain, to join the effort in 2023, further constraining the PRC's access to essential technology.¹⁰⁰

The CCP responded in July 2023 with its first round of export restrictions on germanium and gallium, two minerals vital to producing semiconductors.¹⁰¹ The tit-for-tat escalated in October 2023, when the U.S. tightened its semiconductor export controls, closing loopholes in the original rules and adding 13 Chinese firms to the Entity List.¹⁰² The Entity List identifies foreign entities that pose risks to U.S. national security, foreign policy, or economic interests.¹⁰³ Entities on the list face strict licensing requirements to access U.S.-origin goods, software, and technologies. License applications are reviewed with a presumption of denial for semiconductor technology or manufacturing equipment exports to PRC firms on the list.

Shortly thereafter, on October 20, 2023, Beijing announced export controls on graphite, including natural flake graphite and advanced artificial graphite products, explicitly citing the U.S. export controls as a motivator.¹⁰⁴ At the end of 2023, the CCP expanded its export restrictions to include REE extraction, processing, and magnet manufacturing technologies.¹⁰⁵

In 2024, Beijing further tightened its grip on critical minerals, announcing export controls on antimony ores and related materials in August.¹⁰⁶ Finally, in December 2024, the PRC

⁹⁵ Beia Spiller and Michael A. Toman, "Critical Minerals: Insights from a Recent Workshop," Resources, August 30, 2023.

⁹⁶ Angus Barker, "Critical minerals need insulation from China's market manipulation," *The Strategist*, May 21, 2024.

⁹⁷ James Palmer, "China Raises Threat of Rare-Earth Mineral Cutoff to U.S.," *Foreign Policy*, May 21, 2019.

⁹⁸ Bureau of Industry and Security, "Commerce Implements New Export Controls on Advanced Computing and Semiconductor Manufacturing Items to the People's Republic of China (PRC)," U.S. Department of Commerce, October 7, 2022.

⁹⁹ Ibid.

¹⁰⁰ Dee-Ann Durbin and Aamer Madhani, "Dutch, Japanese Join US Limits on Chips Tech to China," *Associated Press*, January 29, 2023.

¹⁰¹ Reuters, "China Export Curbs Choke Off Shipments of Gallium and Germanium for Second Month," October 19, 2023.

¹⁰² Lise Test et al., "BIS Strengthens Export Controls on Advanced Computing Items, Semiconductor Manufacturing Equipment, and Supercomputing End-Uses to China and Other Countries of Concern," Global Sanctions and Export Controls Blog, October 25, 2023.

¹⁰³ Bureau of Industry and Security, "Entity List," Webpage.

¹⁰⁴ Siyi Liu and Dominique Patton, "China, World's Top Graphite Producer, Tightens Exports of Key Battery Material," Reuters, October 20, 2023.

¹⁰⁵ Gracelin Baskaran, "What China's Ban on Rare Earths Processing Technology Exports Means," Center for Strategic and Industrial Studies, January 8, 2024.

¹⁰⁶ Reuters, "Explainer: What is Antimony and Why is China Curbing Its Exports?" August 16, 2024.

escalated further by banning the export of germanium, gallium, and antimony to the U.S. market while implementing additional licensing requirements for graphite exports.¹⁰⁷ This announcement was a direct response to the United States tightening semiconductor export rules, aimed explicitly at restricting PRC capability to produce advanced-node semiconductors used in next-generation weapon systems, AI, and advanced computing.¹⁰⁸ The Chinese Ministry of Commerce explicitly shared its intention to prevent the U.S. military from accessing these dual-use materials, which are critical for civilian and military applications.¹⁰⁹

There does not appear to be an end in sight. Most recently, China's Ministry of Commerce has proposed restricting the export of technologies used in lithium processing and the production of lithium iron phosphate (LFP) CAM—key components in electric vehicle batteries and renewable energy storage systems.¹¹⁰

While disruptive for the downstream manufacturing sectors and end-users, export controls on materials create long-term opportunities for alternative producers. The rise in critical mineral prices in the North American market, fueled by export controls, sends a positive signal for the North American market, particularly as governments implement measures to incentivize domestic production. Yet, turning these signals into actionable investments remains the challenge.¹¹¹

Investors must contend with the uncertainty surrounding the policies of the United States, the PRC, and third countries. This includes the risk that export bans could be lifted, causing prices to fall. Additionally, the small size of global and U.S. markets for minerals like germanium, gallium, and antimony amplifies risks, as even minor changes in supply or demand can lead to sharp price volatility. These challenges are further compounded by lengthy permitting timelines, which delay the ability to bring new production capacity online, making it difficult to capitalize on current market signals. Finally, while U.S. actions to counter the PRC seem only to be strengthening, waivers and loopholes in tariffs, entity lists, and sourcing requirements create a murkier investment environment than sectors without fraught geopolitics.

Project Risk Assessment

The Critical Mineral Project Risk Assessment for the Public and Private Sectors (Figure 8) was developed through

extensive private sector consultation via SCOR, a group of leading investment experts who work on critical minerals deals every day. It is a risk assessment tool for government and industry decision-makers to facilitate objective, transparent project evaluation across diverse sectors and proposals. The assessment provides: 1) a standardized framework for public and private sector entities to define and share project and risk information; 2) a level playing field that minimizes lobbying influence; and 3) guidance for government stakeholders to evaluate open-source information and critically assess company claims. This comprehensive evaluation framework provides a structured approach to evaluating minerals projects' commercial viability and strategic importance. It enables more informed

“Governments can help investors with three of the four industry risks – financial, compliance, and geopolitical – with the private sector taking on technical risks that the government is not equipped to address.”

- Sir Mick Davis, Founder & Managing Director, Vision Blue Resources

dialogue between industry and government stakeholders, helps align public support with market realities, and creates a foundation for consistent policy implementation.

Understanding how different stakeholders can address various risk categories is crucial for developing effective support mechanisms. The assessment framework allows policymakers to better understand where targeted support can be most effective while helping the industry articulate project risks and opportunities in terms that resonate with government priorities. The assessment framework's comprehensive nature—covering technical, financial, compliance, and geopolitical dimensions—reflects the sector's multifaceted challenges and aims to provide a common language for public-private collaboration.

¹⁰⁷ See e.g., Gracelin Baskaran and Meredith Schwartz, “China Imposes Its Most Stringent Critical Minerals Export Restrictions Yet Amidst Escalating U.S.-China Tech War,” Center for Strategic and International Studies, December 4, 2024

¹⁰⁸ Bureau of Industry and Security, “Commerce Strengthens Export Controls to Restrict China's Capability to Produce Advanced Semiconductors for Military Applications,” U.S. Department of Commerce, December 2, 2024.

¹⁰⁹ See e.g., Gracelin Baskaran and Meredith Schwartz, “China Imposes Its Most Stringent Critical Minerals Export Restrictions Yet Amidst Escalating U.S.-China Tech War,” Center for Strategic and International Studies, December 4, 2024

¹¹⁰ Reuters, “China proposes further export curbs on battery, critical minerals tech,” January 2, 2025.

¹¹¹ SAFE findings from consultation with SCOR members.

Figure 8. Critical Minerals Project Risk Assessment for the Public and Private Sectors

RISKS	ASSESSMENT FACTORS	EXAMPLE INDICATORS	GUIDING QUESTIONS	PRIMARY STAKEHOLDERS*
TECHNICAL	Critical Resource Assessment			
	Resource definition: • grade • quality • volume	• Drilling results • Resource models • Geological and metallurgical complexity	• What is the deposit quality?	Private Stakeholders: exploration firms, mining companies, technical consultants
	Reserve estimates	• Technical studies • Resource recovery/processing efficiency metrics • JORC/43-101 compliance	• How reliable is the resource data? • What is the mine life potential?	Public Stakeholders: USGS (DOI), State Geological Surveys
	Technology & Infrastructure			
	Equipment and/or processing technology requirements	• Equipment specs • Technology readiness level (TRL) assessments	• What is technology maturity and reliability? • Is it a cost-effective, quality product?	Private Stakeholders: engineering firms, equipment OEMs, infrastructure operators
	Accessibility and other infrastructure requirements	• Logistics plans • Infrastructure capacity	• How accessible is the project? • What infrastructure gaps exist?	Public Stakeholders: DOE; Support: DOD, DOT
	Capacity Enablers			
	• Downstream capacity • Foreign dependency • Trade flows • Stockpile needs	• Capacity analysis • Supply-demand models • Trade assessments • Strategic stockpiles	• Are there supply chain risks for equipment, technology or material inputs? • What dependencies and gaps exist?	Private Stakeholders: supply chain consultants, trading companies, industry associations
	Workforce	• Ability to deploy and operate the technology employed	• Are constructors and operators skilled in the technology deployed?	Public Stakeholders: DOC; Support: DLA, USTR
FINANCIAL	Project Economics			
	• Capital requirements • Operating costs • Project execution complexity	• Capital cost intensity and certainty • Financial models • Working capital requirements • Debt service coverage ratio	• What are the financial requirements of the project? • What funding gaps exist?	Private Stakeholders: investment banks, private equity firms, insurance providers, mining majors
	• Government support • Development finance	• Funding programs • Credit support	• What support is available?	Public Stakeholders: DFC; Support: EXIM, DOE, DOD
	Market Position			
	• Project maturity • Competition analysis • Access to financing	• Market studies • Commodity price volatility • EBITDA margin	• What is the market position and anticipated variability?	Private Stakeholders: market analysts, trading companies, strategy consultants
	• Export potential • Strategic value	• Trade agreements, • Trade barriers (ex. export controls)	• What trade barriers exist? • What is the strategic value?	Public Stakeholders: DOC; Support: USTR, DOS

* Primary Stakeholders suggests which industry or government actor is typically best positioned to assess, carry, or mitigate the risk. Generally, the private sector is best positioned to examine and mitigate technical risks while the public sector is best positioned to inform and provide assurances for environmental, social, and governance risks. Public-private-partnerships (PPP) are on average best suited to assess and mitigate financial risks, which tends to be highly project dependent and require unique partnership structures and solutions.

RISKS	ASSESSMENT FACTORS	EXAMPLE INDICATORS	GUIDING QUESTIONS	PRIMARY STAKEHOLDERS*
COMPLIANCE	Environmental Impact			
	- Water rights - Land use - NEPA compliance	- Water agreements - Environmental and biodiversity assessments - Permit requirements	- What are the environmental impacts and how are they managed? - What permits are needed?	Private Stakeholders: environmental consultants, engineering firms, certification bodies Public Stakeholders: EPA; Support: DOI, USFS, USACE
	Climate impact	Emissions data	What is the emissions profile of the project?	
	Social License			
	- Tribal consultation - Community benefits - Stakeholder support	- Tribal agreements and indigenous rights frameworks - Community programs	- How is the community engaged? - What benefits are provided?	Private Stakeholders: community relations firms, labor consultants, training providers Public Stakeholders: MSHA, DOL; Support: USAID, DOS
	- Workforce development - Labor standards	- Training initiatives - Labor assessments - Supply chain ethics standards	- What are the workforce needs? - Are there signs of child labor?	
Governance				
- Ease of regulatory compliance - Regulatory stability	- Clarity of regulatory framework - Compliance frameworks - Enforcement history - Changes to mining codes, taxation regime or other regulations	- Are regulations clear and easy to understand? - How is compliance enforced? - What is the government’s track record and capacity for maintainint a predictable regulatory environment?	Private Stakeholders: law firms, compliance consultants, auditing firms Public Stakeholders: DOI, DOC, DOJ, DOS; Support: USAID	
- Anti-corruption - CFIUS reviews	- Reporting requirements - Investment screening	What controls are needed?		
GEOPOLITICAL	National Security			
	- Defense industrial base needs - Supply resilience	- Defense requirements - Supply risk analysis - Ownership structure (domestic vs. foreign)	- What supply chain vulnerabilities exist? - What are the security benefits of a new project?	Private Stakeholders: defense contractors, security consultants, technology firms Public Stakeholders: DOD; Support: DHS, DOS
	- Critical technology - Critical infrastructure	- Technology assessments - Technology transfer risk - Critical infrastructure protection standards	What technological and infrasructure vulnerabilities exist?	
	International partnerships	Partner agreements	What partnerships are needed to mitigate risks?	
	Economic Security			
	- Job creation - Skills development - Linkages to local business	- Economic models - Workforce plans - Domestic supplier programs	- What are the economic benefits and how are they distributed? - What are the impacts beyond the mine life?	Private Stakeholders: economic consultants, workforce developers, local businesses Public Stakeholders: DOC, support: DOL, DOS
Infrastructure legacy	Infrastructure plans	What are spillover infrastructure benefits?		

Analyzing U.S. Agencies and Critical Minerals Programs

Critical minerals projects require diverse funding sources and delivery mechanisms to successfully navigate their inherent risks. While private capital remains an indispensable component for building secure, reliable, and diverse critical mineral mining, processing, and recycling capacity, the report's risk assessment reveals that private sector investors struggle to adequately price and manage the full suite of technical, financial, compliance, and geopolitical risks these projects face today. U.S. government agencies, sometimes mandated by Congress, have developed various tools and programs to bridge these gaps, though their effectiveness varies significantly. This section analyzes these efforts, assessing how well they address the risks identified by industry stakeholders and identifying areas requiring continued attention. The analysis aims to increase awareness amongst the investment community of public sector funding programs while providing context for the following recommendations.

“Multiple levers are available and needed. While encouraging domestic supply through tariffs could help in the short term, policymakers must debate how to increase the domestic supply side response through better regulatory frameworks to create a more mining and minerals processing- friendly environment in the long term.”

- Owen Hegarty, Executive Chairman of EMR Capital

Technical Focus

Technical risks associated with critical minerals projects are often best managed by the private sector, which possesses the specialized expertise and experience needed to address the complexities of extraction, processing, and recycling. However, several systematic market failures, particularly in early-stage project development, R&D, and infrastructure—

create opportunities for targeted government intervention. Some U.S. agencies have focused their technical support on these areas where private capital is more constrained, aiming to expand the pool of viable projects and foster technical advancement. This section examines how effectively these programs address industry technical barriers while enabling rather than displacing private-sector solutions.

Currently, two U.S. agencies, one within the Department of Defense (DOD) and one within the Department of Interior (DOI), have programs focused on exploration. Funding for exploration and early-stage projects to decrease technical risks is limited. The DOD Defense Production Act (DPA) Title III can provide funding for domestic projects.¹¹² The U.S. Trade Development Agency (USTDA) has broader international coverage, where it can provide support for early-stage projects, but it has only used this tool once to date. When it comes to R&D support, Department of Energy (DOE) and the national labs play an outsized role.

Lastly, infrastructure deficiencies pose a significant technical risk to critical minerals projects, increasing upfront costs for developers and creating barriers to investment in what might otherwise be considered competitive assets. In the United States, government agencies such as the Department of Transportation (DOT) and the DOE have been allocated hundreds of billions of dollars from the BIL to address the country's aging infrastructure.¹¹³ However, the BIL does not directly align with the specific needs of mining, processing, and recycling projects with infrastructure funding. While U.S. infrastructure improvements are essential, they do not necessarily support the growth of these critical sectors, which could further strain existing networks and impact investment decisions.

In contrast, mining projects in mineral-rich but less-developed nations often face different infrastructure challenges. A lack of transportation networks, ports, and reliable energy sources makes such projects uninvestable. To address these issues, the U.S. Department of State has been working closely with allies to build multi-use infrastructure, with the simultaneous goal of facilitating the movement of materials westward. Other agencies with funding mandates are supporting the infrastructure development necessary to enable the success of these critical minerals projects.

¹¹² Heidi Peters and Erica Lee, “2022 Invocation of the Defense Production Act for Large-Capacity Batteries: In Brief,” Congressional Research Service, at 3.

¹¹³ White House, “Fact Sheet: The Bipartisan Infrastructure Deal,” November 6, 2021.

Project Development: Exploration Stage

Exploration for critical minerals is inherently risky due to the low probability of success in yielding economically viable deposits. This risk is not new. However, the stakes have risen for certain critical metals, like nickel and copper, which are essential for new forms of energy, defense, and technological advancement. Recent discoveries of these materials are increasingly sparse. As global demand continues to rise, the scarcity of new discoveries could become a long-term problem that threatens to impede the supply chain. Given the long lead times associated with exploration and project development, proactive measures are needed today.

A critical function of the government in addressing these technical risks associated with exploration is enhancing geological surveys to map potential resources. Exploration efforts are more speculative without reliable, high-quality geophysical data, increasing the risks and costs of finding economically viable deposits. The U.S. Geological Survey (USGS) Earth Mapping Resource Initiative (EarthMRI) is an indispensable tool for improving understanding of the U.S. geological landscape.

Resource assessments, however, are labor and time intensive. While significant progress has been made, the program still needs to map the remaining three-quarters of U.S. land where high-quality geophysical data is lacking. New tools and techniques, such as AI and machine learning, can speed up the process and enable accurate identification. The Defense Advanced Research Projects Agency's (DARPA) investment in AI-driven tools under the Critical Mineral Assessments with AI Support (CriticalMAAS) program offers a pathway to improve USGS capabilities and deliver more timely assessments. AI can also help miners assess large amounts of geological data and improve predictions.¹¹⁴

Alongside its scientific and technological initiatives, the U.S. government provides financial support for exploration under its DPA Title III authorities. DPA funds can be particularly valuable during periods of low commodity prices or challenging macroeconomic conditions, such as high interest rates when junior mining companies—the primary players in exploration—struggle to raise capital. These companies often lack the balance sheets to independently fund their exploration efforts and rely on external financing, making them vulnerable when financial markets are tight.

With limited funding, the DOD must be selective in choosing which projects are most likely to support its materials needs over the long term. Talon Metals and Jervois—companies already more advanced in their mine development—receive the only two exploration-related awards under DPA authorities.¹¹⁵ Therefore, DPA Title III funding focuses on exploring existing project sites to identify new resources to support future operational expansion.

Project Development: Feasibility Stage

The transition from discovery to development represents a critical funding gap in the project lifecycle, where government support can help derisk projects for private investment. The ability of mining, processing, and recycling companies to raise capital for scoping, pre-feasibility, and feasibility studies is particularly sensitive to macroeconomic conditions and fluctuations in the minerals markets. Incumbent producers see their revenues and cash flows decrease during low market prices. Companies operating in a single mineral market, which is increasingly common with junior miners today, will feel these effects more acutely than diversified or vertically integrated producers whose financial performance is buffered by revenues from their other operations. On the other hand, new market entrants find it difficult to raise capital to finance their feasibility and engineering studies.

Cutting back on early-stage development activities during market downturns delays projects, preventing them from reaching the maturity needed to capitalize on future price rebounds. Bottlenecks for project readiness also undermine U.S. and allied efforts to diversify critical mineral supplies. For example, insufficient project maturity is one of the main barriers to financing MSP projects.¹¹⁶ Most of the export credit agencies (ECAs) and development finance institutions (DFIs) in MSP countries are restrained in their ability to support MSP projects because many projects are not mature enough to meet their requirements for financing. However, the projects cannot find the necessary capital to progress to a level where they can seek ECA or DFI support. This gap highlights that current U.S. and allied public financing tools do not fully meet market needs, leaving projects in critical sectors without sufficient early-stage support.

Funding limitations at the feasibility stage can lead to more severe outcomes in the mining sector. The inability to raise enough capital in Western markets or the lack of Western miners willing to take over the project can force junior

¹¹⁴ Paul Mitchell, "Top 10 business risks and opportunities for mining and metals in 2025," EY Global Mining, October 1, 2024, at 12.

¹¹⁵ DOD, "DOD Enters Agreement to Expand Domestic Manufacturing and Strengthen U.S. Cobalt Supply Chains," Press Statement, June 15, 2023; DOD, "Department of Defense Enters an Agreement to Strengthen the U.S. Supply Chain for Nickel Production," Press Release, September 12, 2023.

¹¹⁶ SAFE findings from a July 2023 roundtable discussion with public finance institutions from MSP countries.

mining companies to sell assets and enter joint ventures with foreign adversary entities, which are well-positioned to exploit the situation and gain control over key deposits.¹¹⁷ This problem is the exact reason the MSP was created to solve it.

Despite the clear challenges associated with early-stage project development, the costs of overcoming these hurdles are far less than those required for full project development. The costs associated with conducting a comprehensive feasibility study are relatively modest in comparison to the overall capital expenditure of a mining project. On average, completing a feasibility study typically costs between 0.5 and 1.5 percent of the total capital required for the project.¹¹⁸ For example, if a mining project is projected to cost \$1 billion in total capital, the feasibility study would generally range from \$5 million to \$15 million. These early-stage costs, although crucial, are a small fraction of the total expenditure needed to bring a project to completion, yet they play a critical role in de-risking the project and providing investors with the necessary data to proceed confidently.

Targeted and narrow government support is needed to prevent foreign adversaries from acquiring vital mineral deposits. Public financing can also help avoid delays in projects considered particularly strategic from a national security perspective. This is determined by the level of U.S. import dependence on foreign adversaries and their applications in high-priority sectors such as defense.

The U.S. government has two initiatives to help support projects at the feasibility stage. The DPA Title III program, discussed further in the next section, is already being used to support strategic projects. For example, Graphite One received \$37.5 million, enabling it to fast-track its feasibility study by a year.¹¹⁹ The company is planning an integrated supply chain for graphite extraction in Graphite Creek, Alaska, as well as processing, anode active material (AAM) production, and recycling facilities in Washington State.¹²⁰ Similarly, the \$20 million awarded to South32's Hermosa project, which is at its pre-feasibility stage, will help the company accelerate its project development timeline by two years.¹²¹ Once operational, South32 will become the only producer of battery-grade manganese in the United States.¹²²

The USTDA can offer financing to early-stage projects in developing and middle-income countries to diversify supply chains away from PRC market control and create ex-China feedstock opportunities for U.S. manufacturers. So far, USTDA has only used its authority once to fund a pre-feasibility study to evaluate the technical and economic viability of developing a nickel processing facility at an existing nickel mine site in the Philippines.¹²³ Considering the financing challenges facing the projects under consideration for MSP support, there is room to deploy USTDA capabilities more broadly.

Research and Development

Government support for R&D can de-risk domestic mining projects, making them more attractive to investors. Declining ore grades require advanced technologies to ensure cost-effective extraction and processing of lower-grade ores. Additionally, advancements in technology are essential to enable critical minerals extraction from unconventional sources and to enable more efficient and competitive processing and recycling. By investing in R&D, the U.S. government can strengthen its supply of critical minerals from the most secure sourcing jurisdiction (the United States). Additionally, these R&D efforts can lead to the development of technologies that benefit domestic

“While permitting reform remains the most pressing issue, Western countries face two additional challenges. First, a lack the experiential knowledge compared to those that have learned how to operate and optimize processing facilities through a willingness to operate sub-scale operations at a loss. Second, an inability to compete with the willingness of others to use more labor-intensive or less sophisticated technologies to solve operational challenges.”

- Ryan Coté, Principal, Hatch Advisory

¹¹⁷ See e.g., Charles Chang et al., “China’s global reach grows behind critical minerals,” S&P Global, August 24, 2023.

¹¹⁸ Ruprecht, S., Establishing the Feasibility of Your Proposed Mining Venture, RSG Global, Helderkruijn, Republic of South Africa, 2004.

¹¹⁹ DOD, “DOD Enters Agreement to Expand Capabilities for Domestic Graphite Mining and Processing for Large-Capacity Batteries,” Press Release, July 17, 2023.

¹²⁰ Ibid.

¹²¹ DOD, “DOD Awards \$20 Million to Enhance Domestic Manganese Supply Chain,” May 17, 2024.

¹²² See e.g., South32, “Final investment approval to develop Hermosa’s Taylor deposit,” February 15, 2024.

¹²³ U.S. Trade and Development Agency, “Vice President Harris Launches USTDA Critical Minerals Processing Project in the Philippines,” November 22, 2022.

Developing Substitutes

Given the complex challenges in critical minerals supply chains, an all-of-the-above approach is crucial. Substitute development is emerging as a nuanced strategic option. While substitutes are not a silver bullet solution, they offer important strategic advantages in addressing critical minerals constraints.

Substitutes can enhance performance in some instances. Synthetic graphite and silicon carbide anodes provide compelling examples of alternative materials that can match or even improve upon traditional mineral inputs. However, the substitution strategy is not universally applicable. Certain high-performance applications, particularly in defense and advanced technologies, require specific critical minerals with unique characteristics that substitution would compromise. In these domains, performance is paramount, and material substitution could risk critical functional capabilities.

Even when full substitution is not feasible, developing alternative materials can help alleviate demand pressures on critical mineral inputs. Current R&D efforts, supported by the MSP, national laboratories, and the DOE, are actively exploring substitutes for battery materials, rare earth permanent magnets, and other critical applications.

Moving forward, the key policy challenge is to ensure technology-neutral support mechanisms that avoid creating unintended competitive disadvantages or market distortions for emerging substitute technologies. This approach requires a delicate balance: supporting innovation without picking technological winners and maintaining flexibility to respond to evolving material science and industrial needs.

projects and can be deployed in global markets, helping the United States reduce its exposure to market manipulation by the PRC.

The U.S. Advanced Research Projects Agency-Energy (ARPA-E) and national laboratories are advancing early-stage R&D for a broader range of critical minerals and technologies. For instance, ARPA-E's Biotechnologies to Ensure a Robust Supply of Critical Materials for Clean Energy advances bioleaching processes using bacteria to recover copper and manganese from low-grade ores and REEs from electronic wastes. The DOE geothermal lithium extraction prize, administered by the National Renewable Energy Laboratory, aims to explore innovative methods of extracting lithium from geothermal brine.¹²⁴ Argonne National Laboratory's ReCell Center, funded by the DOE Vehicle Technologies Office, is developing novel recycling technologies to make lithium-ion battery recycling cost-effective.¹²⁵ National Energy Technology Laboratory's Carbon Mineralization and Monitoring processing develops novel materials and processes to concentrate critical minerals from dilute sources like oil and gas-produced waters, acid mine drainage, and mineral processing streams.¹²⁶ These initiatives are illustrative and crucial for

developing new and efficient methods to extract, process, and recycle critical minerals, though they remain in the early stages.

The DOE Fossil Energy and Carbon Management (FECM) office and the Advanced Manufacturing and Materials Technology Office (AMMTO) are critical in advancing innovations in the critical minerals sector by supporting proof-of-concept, bench, and pilot demonstration-scale projects. FECM focuses on REEs from unconventional sources like coal waste and acid mine drainage, with key programs such as the CORE-CM Initiative, which targets the upstream and midstream supply chain, and investments like the \$19.5 million for recovering REEs from coal and recycled feedstock.¹²⁷ AMMTO accelerates the development of innovative materials and manufacturing technologies, with programs like the Critical Materials Accelerator validating small-scale technologies to process, recycle, and substitute critical materials.¹²⁸ In addition to these two agencies, the BIL authorized a \$140 million Rare Earth Elements Demonstration Facility administered by the Office of Manufacturing and Energy Supply Chains (MESC).¹²⁹ The program supports the development of technologies for extracting and processing REEs from

¹²⁴ DOE, "Geothermal Lithium Extraction Prize," Webpage.

¹²⁵ ReCell, "The Challenge: An increase of lithium-ion batteries is headed for US recyclers," Webpage.

¹²⁶ National Energy Technology Laboratory, "Critical Minerals and Materials," Webpage.

¹²⁷ "The Carbon Ore, Rare Earth, and Critical Minerals (CORE-CM) Initiative," National Energy Technology Lab, Webpage; and Office of Fossil Energy and Carbon Management, "DOE Announces \$19.5 Million to Develop a Secure Domestic Supply Chain of Critical Minerals and Materials," September 25, 2024.

¹²⁸ DOE, "Funding Selections: 2024 Critical Materials Accelerator," Webpage.

¹²⁹ DOE, "DOE Launches \$140 Million Program to Develop America's First-of-a-Kind Critical Minerals Refinery," Press Release, February 14, 2022.

secondary and unconventional sources like acid drainage, mine waste, or other deleterious materials.¹³⁰

The current focus of DOE pilot and demonstration-scale funding programs, directed by Congress, is primarily on validating and advancing the recovery of REEs from secondary and unconventional sources. Moving forward, as technologies—particularly those developed within the national lab pipeline—mature from early-stage research to commercial readiness, there will be a critical need to make pilot and demonstration-scale support to a broader range of innovative extraction, processing, and recycling technologies across the critical minerals spectrum.

The U.S. Economic Development Agency’s tech hubs provide an alternative model to support R&D through regional centers. These tech hubs create an environment that encourages collaboration across businesses, academic institutions, and government agencies. The public-private partnership allows for the sharing of resources, technical expertise, and risk to enable technology maturation. The program supports programs aiming to prototype technologies and prepare the workforce for jobs resulting from technological advances.¹³¹ While the program offers an interesting opportunity, it currently only supports one lithium technology hub in Nevada.¹³²

Other technical risks the government can play a role in are scaling and execution challenges associated with commercializing new extraction, processing, and recycling routes. Transitioning from pilot-scale to commercial-scale production often involves significant adjustments and learning curves, increasing the chances of project delays, cost overruns, and operational disruptions, all of which are substantial barriers to obtaining financing in the private market. These risks elevate the cost of capital as investors demand higher returns to compensate for the perceived uncertainty. Furthermore, downstream investors often hesitate to commit substantial resources to projects until technologies have been successfully deployed commercially.¹³³ These failures warrant government intervention to support the deployment of technologies that are crucial for enhancing U.S. competitiveness in the long term.

The DOE Loan Program Office’s (LPO) Title 17 program is the primary U.S. government vehicle to help mitigate the risks of scaling novel processing and recycling routes to the commercial production stage. Its goal is to finance projects that employ new or significantly improved manufacturing processes.¹³⁴ LPO shares risks associated with technology commercialization by offering patient projects that face technological risks. It is important to acknowledge that LPO has yet to use its Title 17 authorities for minerals projects. To date, all LPO loans awarded to critical mineral producers were allocated through the Advanced Technology Vehicles Manufacturing (ATVM) program.¹³⁵ Limitations of LPO funding are discussed further in the “Financial Focus” section of this report.

Infrastructure

Infrastructure is a key technical risk factor for critical minerals projects, and its deficiencies significantly increase upfront costs for developers, creating barriers to investment. In the United States, the BIL has directed significant resources to modernize the nation's infrastructure, with the DOT and the DOE receiving over \$100 billion in funding to address critical transportation, energy, and clean technology needs.¹³⁶ For instance, the BIL designates \$450 million annually for the Port Infrastructure Development Program over the next five years, totaling \$2.25 billion.¹³⁷

While BIL investments are critical for modernizing U.S. infrastructure at a national level and improving overall logistics, they do not address the tailored infrastructure needs of mine projects, such as access roads, power and gas lines, water access, or on-site power generation. Developers must navigate these gaps, adding financial and logistical strain. The U.S. approach contrasts with Canada’s targeted infrastructure programs. Canada’s Critical Minerals Infrastructure Fund (CMIF), with a commitment of up to \$1.5 billion in federal funding, directly ties infrastructure improvements to the competitiveness of new industrial manufacturing projects.¹³⁸ The CMIF targets preconstruction activities and shovel-ready infrastructure projects in critical minerals, which include essential transportation networks, power generation, and market

¹³⁰ Office of Manufacturing and Energy Supply Chains, “Rare Earth Elements Demonstration Facility,” Webpage.

¹³¹ Economic Development Administration, “Tech Hubs Aim to Make United States the Global Leader in Technologies of the Future. A Conversation with Eric Smith,” October 20, 2023.

¹³² Economic Development Administration, “Tech Hubs Consortia Members List,” April 19, 2024.

¹³³ SAFE findings from interviews with investors.

¹³⁴ Loan Programs Office, “How the DOE Loan Programs Office Understands and Manages Portfolio Credit Risk,” February 8, 2024.

¹³⁵ See the financing risks section for more discussion on LPO.

¹³⁶ U.S. Department of Transportation, “Bipartisan Infrastructure Law.”; U.S. Department of Energy, “DOE Fact Sheet: Bipartisan Infrastructure Deal Will Deliver for American Workers, Families, and Communities.”

¹³⁷ Maritime Administration, “Port Infrastructure Development Program,” DOT, Website.

¹³⁸ Government of Canada, “Critical Minerals Infrastructure Fund,” Webpage.

access. It is important to note that Canada's mineral resources exist in vast expanses of undeveloped parts of the country, demanding more tailored infrastructure development to attract investment.

However, the most significant risk to U.S. mineral projects lies not in the absence of infrastructure capital but in the challenges related to permitting the ancillary transportation infrastructure. This report's Compliance Focus section will further discuss these permitting bottlenecks.

In addition to gaps in local and last-mile infrastructure, the technical risk of mining projects in developing regions is also connected to the lack of essential transportation networks, reliable energy sources, and port facilities at the national and international levels. This infrastructure deficit often makes large-scale mineral extraction and processing projects unviable, as the scale of investment required to address these gaps is beyond the capacity of individual project developers.

The PRC alleviates project developers' burden by taking on surrounding infrastructure investments, enabling smooth integration from resource extraction to final processing. This report's Risk Analysis section discussed BRI abroad, showing how infrastructure support facilitated an influx of PRC capital into Indonesia's nickel sector. The PRC uses this same strategy at home. For example, in inner Mongolia, the PRC has invested in power plants and transportation for their REE sector's processing facilities.¹³⁹ These examples illustrate the model the U.S. investors and companies have to compete with globally, and it underscores the need for a similar level of government intervention in infrastructure development to ensure competitiveness in the critical minerals sector.

The Department of State (DOS), through the Partnership for Global Infrastructure and Investment (PGI), has taken a leading role in international efforts to develop the infrastructure necessary for critical minerals production. A prime example is the Lobito Corridor, which spans from Zambia and the DRC to Angola, unlocking access to vast mineral resources, including copper and cobalt.¹⁴⁰ Through PGI, the United States and its partners are mobilizing investments to construct multi-use rail lines that cross-country borders and port facilities—critical infrastructure that will enable the transportation of minerals to Western markets. To date, nearly \$1 billion has been secured for this project, involving PGI countries, host governments, and the Africa Finance Corporation.¹⁴¹

The Lobito Corridor highlights how international governments can share the responsibility of developing surrounding infrastructure. This approach reduces the risk for developers and investors while ensuring these projects are designed for multi-use purposes. It can also be equally beneficial in a domestic context, where government support is needed to build the infrastructure that enables critical minerals projects and their surrounding communities to thrive.

As the rail line and port facilities are developed, additional investments will be required to address power deficits and improve local transportation infrastructure, connecting mines, refineries, manufacturing facilities, and special economic zones to the Lobito Corridor. The DFC plays a pivotal role in financing power and local transportation projects. At the same time, Power Africa also supports infrastructure development across the African continent, further facilitating the movement of critical minerals from these regions to global markets.

The benefits of U.S. government intervention in infrastructure development extend far beyond facilitating connectivity and growth. Strategic investments can create multi-purpose platforms that support broader economic and geopolitical objectives, like how the PRC leverages the BRI.

Beijing integrates transportation corridors, industrial parks, and urban development into cohesive ecosystems that advance its strategic foreign and economic policies while bolstering its national security objectives. Many BRI ports are developed under a 'port-parks-city' model, combining industrial parks and support industries such as shipbuilding and resupply services. These features enhance the ports' commercial capacity and expand their ability to support Chinese naval operations, establishing a dual-use infrastructure that strengthens Beijing's military presence and power projection capabilities. Countering this model is essential to safeguarding U.S. national security interests and ensuring the resilience of global critical mineral supply chains, vital for defense and advanced technology industries.

Financial Focus

The risk assessment informed by the private sector highlighted how current market conditions create significant financial barriers for critical minerals projects, from high upfront capital requirements to market uncertainties driven by foreign advisory manipulation. U.S. agencies, specifically

¹³⁹ "China Three Gorges plans a 16 GW multi-energy project in Inner Mongolia (China)," Enerdata, July 2, 2024.

¹⁴⁰ Sarah Way, "What to know about the Lobito Corridor—and how it may change how minerals move," AfricaSource, December 20, 2024.

¹⁴¹ Ellington Arnold, "The Lobito Corridor: Building Africa's Most Important Railway," U.S. Chambers of Commerce, February 15, 2024.

the DOE, Department of Treasury (Treasury), and DOD have responded with funding programs and incentives to change investors' risk calculations. This section analyzes these tools—ranging from grants and loans to equity investments and tax credits—evaluating their ability to mobilize private capital while maintaining appropriate risk-sharing between private and public sectors. While not included in this analysis, the Department of Commerce (DOC) also received a modest amount of funding from the CHIPS and Science Act, which contained some provisions related to semiconductor mineral supply chains.

Department of Energy

When it comes to government agencies that can mitigate financial risks in mining, processing, and recycling, the DOE has been allocated the most critical minerals-related funding by Congress. Between the BIL and IRA, DOE boasted approximately \$8 billion in grant funding targeted at critical minerals and an additional \$250 billion in loan authority—although not all of this funding was designated toward critical minerals.¹⁴² A little more than \$1 billion in grant funding and \$112 billion in loan authority remain, with the latter specifically allocated to Title 17 and the ATVM programs, both of which can support critical minerals initiatives.¹⁴³ This funding, however, comes with constraints, such as a focus on battery materials or commercial-scale projects, and has predominately been awarded to processing and recycling projects (not mining) to date.

The DOE LPO and MESC are crucial in supporting commercial-scale efforts. LPO offers loans and guarantees to companies working on commercial-scale critical minerals projects. These companies can apply for low-cost debt financing under Title 17 and the ATVM program.¹⁴⁴ Title 17 specifically targets innovative technologies, providing loans for projects that introduce groundbreaking solutions to energy challenges, including those related to critical minerals.¹⁴⁵ The ATVM program, on the other hand, focuses on critical materials that are key components of advanced technology vehicles, such as electric vehicle batteries and lightweight materials.¹⁴⁶ LPO loans offer a crucial source of financing at rates lower than those provided by commercial

lenders.¹⁴⁷ The low-cost debt financing can cover up to 80 percent of a project's investment costs. However, project cashflows and credit risk considerations often lower

LPO's Evolving Authorities to Finance Critical Minerals Production

Historically, critical minerals were not explicitly identified as a technology sector eligible for financing under the LPO program. In 2020, following Executive Order 13953, which declared a national emergency regarding the U.S. dependence on foreign adversaries for critical minerals, the LPO clarified that critical minerals processing could be financed under its Title 17 and ATVM authorities. However, the definition of production was not yet fully clarified, and subsequent investments targeted critical minerals processing and recycling.

The IRA codified critical minerals as a technology sector under Title 17 but, again, did not define production.¹ It was not until April 2024 that LPO clarified further that "production" included mining and extraction activities, broadening the scope of eligible projects under Title 17 authorities to encompass the entire critical minerals value chain.^u

leverage ratios, with many projects ending up in the 50 to 70 percent range.¹⁴⁸ This makes it an especially valuable resource for projects requiring significant capital investment in critical minerals production and recycling.

Active LPO loans to critical minerals producers total \$2.8 billion, with an additional \$3.5 billion in conditional commitments—all disbursed using ATVM authorities.¹⁴⁹ These loans support six projects, with three finalized loans and three with conditional commitments.¹⁵⁰ Finalized loans include direct loans to Lithium Americas for lithium

¹⁴² Department of Energy, "Inflation Reduction Act of 2022," Webpage.

¹⁴³ Department of Energy, "IRA Year Two: A Clean Future in Clear Focus," Webpage.

¹⁴⁴ "Notice of Guidance for Potential Applicants Involving Critical Minerals and Related Activity," Federal Register 85:231, December 1, 2020, at 77202.

¹⁴⁵ 42 USC §16513(b)(13).

¹⁴⁶ Loan Programs Office, "How LPO Can Support All Stages of the Critical Minerals Supply Chain," April 30, 2024.

¹⁴⁷ Department of Energy, "Critical Materials Projects," Webpage.

¹⁴⁸ Ibid.

¹⁴⁹ Ibid.

¹⁵⁰ Loans Programs Office, "Pricing for LPO Financing by Program," March 15, 2024.

¹⁴⁸ Loan Programs Office, "LPO's Loans and Loan Guarantees: Overview and Characteristics of its Financing Options," March 14, 2024; and Loan Programs Office, "Program Guidance for Title 17 Clean Energy Financing Program," May 19, 2023, at 9.

¹⁴⁹ SAFE analysis using LPO's project tracker.

¹⁵⁰ Ibid.

processing at Thacker Pass, Li-Cycle's Rochester Hub, which transforms black mass into recycling intermediates for battery-grade materials, and Syrah Resources' Vidalia project, an integrated graphite producer and AAM producer based in Louisiana (currently in operation). Conditional loans have been committed to Redwood Materials to expand their battery recycling, CAM, and anode foil production campus; Loneer's Rhyolite Ridge project for lithium processing; and Novonix's synthetic graphite plant in Chattanooga, Tennessee.

LPO has two key advantages, making it an ideal program to support domestic critical minerals supply chains. First, LPO authorities are not limited to battery materials or the critical materials defined by DOE. They extend to all critical minerals on the USGS list, providing LPO with the ability to support both the commercial sector and defense needs. Second, the ATVM and Title 17 programs have a combined loan authority of \$112 billion remaining—the largest remaining funding capacity across federal agencies—though not all of this will be allocated to critical minerals production.¹⁵¹

However, LPO's ability to support critical mineral development is limited to large-scale projects. For example, LPO has not provided loans below \$100 million, which could signal its preference for larger-scale projects.¹⁵² Still, this suggests that the costs and complexity of navigating the LPO application process act as a natural barrier for smaller-scale projects. For projects below the \$100 million threshold, the benefits of LPO funding are outweighed by the cost of accessing the program.

The MESC office, charged with distributing the BIL's \$6 billion in grants for battery materials processing, manufacturing, and recycling, supports the domestic supply chain for lithium-ion batteries.¹⁵³ Of the announced and finalized awards, 30 percent was allocated to critical minerals processing and 16 percent to recycling, primarily targeting lithium, nickel, and natural graphite alternatives.¹⁵⁴ By covering up to 50 percent of the total project cost, the grants improve the financial feasibility and global competitiveness of U.S. processors and recyclers.

Of the available funds, \$5.11 billion were awarded in two phases. Projects in Phase 1 finalized the awards, while Phase 2 project selections were announced in September 2024.¹⁵⁵ These projects are now finalizing loans, and if all announced projects in the second round finalize their contracts, the program will have \$890 million in remaining funds.¹⁵⁶

The MESC grants have faced their fair share of challenges. In the first round of funding, 20 companies were selected to negotiate grant agreements totaling \$2.8 billion.¹⁵⁷ Only 14 of those finalized their grant agreements.¹⁵⁸ The key obstacle was the tangible property interest clause, which allows DOE to retain a partial ownership stake in these facilities equal to the funding it provides. This tangible property interest complicates efforts for project developers with MESC grants to secure additional debt financing.¹⁵⁹

Department of Treasury

Treasury plays a crucial role through its administration of tax incentives related to critical minerals, which can improve project economics while driving investment toward strategic priorities. Working closely with DOE on implementation, Treasury oversees two key programs supporting critical mineral development: the 48C Advanced Energy Project Investment Tax Credit and the 45X Advanced Manufacturing Production Tax Credit. Facilities must choose between these programs, as they cannot qualify for both. Like the DOE-funded programs, these incentives focus predominately on the midstream – with 45X even prescribing purity levels for eligibility.

The 48C investment tax credit provides up to 30 percent for qualifying advanced energy projects. While the program supports a broad range of clean energy initiatives in the critical minerals sector, it explicitly targets projects that re-equip, expand, or establish industrial facilities for processing, refining, or recycling critical materials. The program is capped at \$10 billion, effectively operating as a competitive grant program.¹⁶⁰ Project selection happened over the course of two rounds. The first round, announced in March 2024, allocated \$4 billion in tax credits, including approximately \$296.6 million for lithium processing, \$103 million for synthetic graphite production, and \$26.7 million

¹⁵¹ LPO, "Updates to Estimated Remaining Loan Authority for LPO Programs," November 12, 2024.

¹⁵² LPO, "Title 17 Clean Energy Financing Program," Factsheet.

¹⁵³ Office of Manufacturing and Energy Supply Chains, "Battery Materials Processing Grants," Webpage.

¹⁵⁴ Note: The 30 percent allocated to critical minerals does not include funds allocated to the processing of battery materials such as binders, solvents, separators, and electrolytes. Source: SAFE analysis based on MESC press releases. See e.g., Office of Manufacturing and Energy Supply Chains, "Bipartisan Infrastructure Law: Battery Materials Processing and Battery Manufacturing Recycling Selections," Webpage.

¹⁵⁵ Ibid.

¹⁵⁶ Ibid.

¹⁵⁷ MESC, "2023 MESC Information Session," Presentation, December 7, 2023.

¹⁵⁸ Ibid.

¹⁵⁹ SAFE findings based on interviews with project developers.

¹⁶⁰ 26 USC § 48C(e)(2).

for battery material recycling.¹⁶¹ The second round, announced in January 2025, allocated \$6 billion in tax credits, including approximately \$300 million for lithium

production, \$200 million for REE extraction, and \$150 million for graphite processing.¹⁶²

The 45X Advanced Manufacturing Production Credit, which began in 2023, provides production-based incentives for

The Effect of Tax Credits on Critical Minerals Investment

The interconnected tax credits enacted in 2022 are reshaping critical minerals supply chains through a combination of domestic production incentives and international sourcing requirements. The Clean Vehicle Credit (30D) has created new demand signals for critical minerals while establishing specific sourcing requirements from the United States and Free Trade Agreement (FTA) countries. This policy framework aims to develop supply chains that reduce dependence on foreign entities of concern.

Domestically, the Advanced Manufacturing Production Tax Credit (45X) and Qualifying Advanced Energy Project Credit (48C) have catalyzed substantial investment, with battery manufacturing and supply chain investment reaching more than \$140 billion in the United States.^v The 48C program's second round allocated \$6 billion for clean energy manufacturing and critical materials processing. Notable domestic projects receiving first round 48C funding include American Battery Technology Company's \$19.6 million battery recycling facility in Nevada and NOVONIX's \$103 million synthetic graphite manufacturing plant in Tennessee.^w

American manufacturers are already seeing significant benefits. Tesla's domestic battery manufacturing qualified for \$1 billion in tax credits in 2023, and their Nevada Gigafactory could be eligible for up to \$17.5 billion annually if they reach their target of 500 gigawatt hours.^x The growing battery production capacity in the United States is expected to support 10 million new EVs annually.^y

Internationally, the sourcing requirements are driving strategic investments and partnerships. Japan signed a Critical Minerals Agreement with the United States in March 2023 as a workaround to qualify for IRA tax credits while similar negotiations were underway with the European Union. Australian mining companies have secured \$13 billion in IRA-related deals with U.S. automakers, while Korean battery manufacturers are pursuing partnerships with Australian critical minerals companies.^z Other FTA countries are also seeing increased activity – Moroccan mining group Managem is investing in a new EV battery processing plant and Umicore invested in a \$1 billion cathode active material facility in Ontario, Canada—though this project is currently on hold.^{aa} These investments demonstrate how the IRA's sourcing requirements are reshaping supply chains and driving significant capital investment in FTA production capacity.

The sourcing provisions have also contributed to the emergence of North American recycling as a crucial component of the domestic supply chain. Redwood Materials has invested significantly in lithium-ion battery recycling capacity, successfully extracting enough lithium and nickel from recycled batteries to produce approximately 20 gigawatt hours of new batteries, equivalent to 250,000 EV batteries.^{bb}

As sourcing provisions restricting content from foreign entities of concern come into effect in 2024-2025, these tax credits continue to reshape investment patterns, prioritizing both domestic production and strategic partnerships with allied nations. The combination of domestic incentives and international sourcing requirements has increased mineral supply chain diversification.

¹⁶¹ SAFE analysis based on self-disclosed 48C projects.

^v DOE, "Building America's Clean Energy Future," Webpage.

^w "American Battery Technology Company Awarded \$20 Million Tax Credit through Competitive US DOE Process to Advance its Critical Minerals Battery Recycling Facility," *PR Newswire*, April 3, 2024; and "U.S. Government Selects NOVONIX to Receive US\$103 Million in Qualifying Advanced Energy Project Tax Credits," Novonix, April 1, 2024.

^x Suvrat Kothari, "How Section 45X Is Revolutionizing Domestic Electric Vehicle Production," *InsideEVs*, June 14, 2023.

^y DOE, "Building America's Clean Energy Future," Webpage.

^z Mevelyn Ong et al., "Critical minerals: Ripple effects from the US to Australia to Asia," Norton Rose Fulbright, September 2024; and Hwang Joo-young, "Posco chief urges closer Korea-Australia ties," *The Korea Herald*, September 2, 2024.

^{aa} Benchmark Source, "How Saudi Arabia and Morocco are shaping the EV battery supply chain," February 19, 2024; and Umicore, "Umicore confirms expansion of its EV battery materials production footprint with CAM and pCAM plant in Ontario, Canada," October 16, 2023.

^{bb} Tim Higgins, "In the Desert With an EV Entrepreneur Who Insists Trump Will Be Good for Business," *The Wall Street Journal*, November 30, 2024.

critical minerals processing facilities. Unlike other technologies eligible for 45X tax credits, the critical minerals portion does not sunset. The program maintains a specific list of critical minerals, informed by the 2022 USGS Critical Minerals List, along with required forms and purity levels that qualify for the tax credit. Eligible facilities receive tax credits equal to 10 percent of their production costs. The program is uncapped, meaning all producers who meet the technical specifications can receive the credit.¹⁶³

Department of Defense

An essential mission area for the DOD is ensuring the U.S. military's industrial capabilities are secure, robust, and resilient. Part of this effort involves securing critical mineral supply chains, which are vital for national security and the defense sector's operations. DOD investment tools, which range from grants, contracts, loans, loan guarantees, and purchase commitments for mineral projects, aim to secure these supply chains essential for national defense.

The DOD has two primary programs directly supporting critical mineral producers: DPA Title III and Industrial Base Analysis and Sustainment (IBAS). The DPA Title III program

Leveraging DPA Title III for Beryllium in the 2000s

Beryllium is used in aviation, surveillance, reconnaissance, and missile systems. Its properties as one of the lightest metals with significant strength, electrical and thermal conductivity, and heat resistance make beryllium a crucial input for aerospace and defense applications with highly demanding performance requirements.^{cc} There are no suitable substitutes for beryllium, without performance losses, in airborne Forward Looking Infrared (FLIR) systems for fighter aircraft and attack helicopters, guidance systems on existing strategic missiles, surveillance satellites, ballistic missile defense systems, and reflectors for high flux, nuclear test reactors.^{dd}

The United States has 60 percent of beryllium reserves but faces challenges that necessitate government intervention to shore up the supply of this small but mighty material. Materion Corporation (previously Brush Wellman) is the sole producer of high-purity beryllium metal in the United States. The company's beryllium reduction facility closed in 2000 due to environmental concerns and outdated equipment. Addressing these concerns would be costly, and the low volumes with limited revenues did not justify the costs.

With no other dependable suppliers, the DOD struggled to maintain a domestic supply of high-purity beryllium metal. In 2005, the DOD leveraged its authorities under the DPA Title III to re-establish domestic beryllium production capacity.^{ff} The U.S. government covered a new beryllium facility's engineering, design, and equipment costs, while Brush Wellman contributed land, technology, and operational services.^{gg} Thanks to government support, the new plant in Ohio opened in 2011.

In the face of losing beryllium access, the U.S. response was swift and effective. What worked here? First, total beryllium production and the amounts needed to achieve its unique performance impacts are minuscule. In 2023, global production of beryllium was approximately 330 metric tons. Compare that to the 3.6 million metric tons of nickel and 180 thousand metric tons of lithium mined globally in 2023.^{hh} The one Ohio facility nearly completely meets U.S. beryllium consumption year in, year out. Second, the price tag was smaller, so government support went further. The DOD covered almost 95 percent of the new beryllium facility. It cost the United States 85 million USD to secure half the world's Beryllium production. In contrast, today, it costs upward of \$1 billion to stand up a single new mine in the United States, without certainty that it will be competitive.

^{dd} See e.g., U.S. Geological Survey, "U.S. Geological Survey Releases 2022 List of Critical Minerals," Press Release, February 22, 2022; and Girish Linganna, "Stronger Than Steel: Why the U.S. Military Runs on Beryllium," August 11, 2022.

^{ee} CSEG, "Beryllium Pebble Plant," 2010.

^{ff} Air Force Research Laboratory, "Defense Production Act Title III project establishes domestic source for beryllium," Wright Patterson Air Force Base, September 17, 2013.

^{gg} Ibid.

^{hh} U.S. Geological Survey, *Mineral Commodity Summaries 2024*, January 31, 2024, at pages 44, 111 and 125.

¹⁶³ 26 USC § 45X.

targets investments into domestic sources that create, maintain, protect, expand, or restore domestic industrial base capabilities. Domestic sources for DPA funds include critical minerals projects in the United States, Canada, Australia, and the United Kingdom.¹⁶⁴

The 2022 invocation of DPA funding to support domestic mining, beneficiation, processing of value-added processing of strategic and critical materials for the production of large-capacity batteries, combined with \$600 million from the Ukraine Supplemental Appropriations Act and \$250 million from the IRA, significantly increased DOD investment in securing critical mineral supply chains.¹⁶⁵ As previously mentioned, DPA Title III can provide broad support for critical mineral projects through exploration, feasibility studies, and enhancing by-product or co-product production.

While the DPA Title III is well known for its recent invocation and significant Congressional allocations to secure critical mineral supply chains, it has been funding critical minerals projects for far longer. One example is the \$9.6 million Technology Investment Agreement (TIA) awarded to MP Materials in 2020 under the Trump administration.¹⁶⁶ The TIA supported MP Materials in establishing domestic processing for separated light REEs. The U.S. government assisted MP Materials in recommissioning its light REE separation facility in 2023.¹⁶⁷ The United States is now a net exporter of neodymium praseodymium (NDPR) oxide, a primary ingredient for the world's highest-strength permanent magnets—although it is important to note that MP's exporter status is also primarily due to the lack of a domestic market for NDPR.¹⁶⁸ Another notable example is the use of DPA Title III in the 2000s to secure the domestic production of beryllium, a critical material needed for aerospace and defense applications, as noted in the call-out box on the previous page.

The IBAS program aims to improve the readiness and competitiveness of the U.S. industrial base by establishing high-priority domestic capabilities for new supply chains needed for national security and mitigating exposure to global supply chain risks. The program focuses on six

priority industrial capability areas: submarine and shipbuilding workforce, kinetic weapons, microelectronics, energy storage and batteries, critical chemicals, and castings and forgings.¹⁶⁹ While critical minerals fall primarily under the critical chemicals portfolio, they are also essential building blocks for technologies across other priority areas, from microelectronics to energy storage systems.

Together, these two programs have publicly announced over \$1 billion in awards for critical minerals production to date.¹⁷⁰ The most notable support under the IBAS program went to Lynas Rare Earths' separation facility.¹⁷¹ This award alone accounts for about 20 percent of all publicly announced awards.¹⁷² While important public financing tools, both programs are limited to projects that directly benefit defense supply chains and the defense industrial base, restricting their ability to address broader commercial market development needs.

A newer program under DOD is the Office of Strategic Capital (OSC), established in December 2022. OSC targets 31 critical technology areas, including critical minerals and materials, which are essential for various applications such as microelectronics, energy storage, and defense technologies. Modeled after loan program offices in other agencies, OSC offers low-cost debt financing to projects in dual-use sectors, specifically for strategic projects where the defense sector represents a smaller share of overall market demand. It has \$984 million in loan authority and targets direct loans of up to \$150 million per project.¹⁷³

Commercial Diplomacy Tools

Commercial diplomacy agencies, such as DFIs ECAs, provide strategic financing to promote a country's commercial interests in international markets. Globally, these agencies are increasingly vital in promoting secure and resilient critical mineral supply chains.¹⁷⁴ The United States is no different. Recognizing the geological constraints that prevent the United States from meeting its growing demand for critical minerals through domestic production alone, U.S. commercial diplomacy agencies, especially the

¹⁶⁴ Note: DPA Title III funds can only be awarded to producers in Australia and the UK for products that cannot be produced in the United States or Canada. Source: FY24 NDAA.

¹⁶⁵ Joseph R. Biden Jr., "Memorandum on Presidential Determination Pursuant to Section 303 of the Defense Production Act of 1950, as amended," The White House, March 31, 2022; and Office of the Assistant Secretary of Defense Industrial Base Policy, "DPA Title III Overview," Webpage.

¹⁶⁶ MP Materials, "MP Materials Receives Technology Investment Agreement from the U.S. Department of Defense to Support Domestic Rare Earth Supply Chain," *MP Materials*, November 18, 2020.

¹⁶⁷ MP Materials, "MP Materials Awarded \$58.5 Million to Advance U.S. Rare Earth Magnet Manufacturing," MP Materials, April 1, 2024.

¹⁶⁸ SAFE findings from stakeholder interviews.

¹⁶⁹ Industrial Base Policy, "Innovation Capability and Modernization," Webpage.

¹⁷⁰ SAFE analysis based on a review of DOD press releases.

¹⁷¹ Industrial Base Policy, "DoD Awards Key Contract for Domestic Heavy Rare Earth Separation Capability," September 19, 2023.

¹⁷² SAFE analysis.

¹⁷³ Office of Strategic Capital, "Investment Strategy for the Office of Strategic Capital," January 2, 2025, at 14.

¹⁷⁴ International Trade Administration, "Commercial Diplomacy," Webpage.

EXIM and DFC, have been increasingly leveraged to fund minerals projects. While they have had a critical impact, their current structures limit their full potential—especially compared to their international counterparts.

U.S. EXIM, the nation's official export credit agency, offers competitive financing solutions to promote U.S. job creation, prosperity, and security.¹⁷⁵ EXIM, which has \$135 billion in authorized lending potential, supports critical mineral producers through three key initiatives.¹⁷⁶ The China and Transformational Exports Program (CTEP), established by Congress in 2019, helps U.S. exporters compete against Chinese state-backed entities, offering enhanced financing flexibilities for critical minerals projects, such as extended loan tenors, exceptions from EXIM's Country Limitation Schedule, reduced fees, and content flexibility. Overseas projects using U.S. equipment and services can be eligible for support under CTEP.¹⁷⁷ The Make More in America Initiative (MMIA) is designed to strengthen U.S. manufacturing and infrastructure capabilities by financing domestic projects linked to exports. This initiative supports a broad range of activities in the critical minerals sector, including domestic critical mineral producers and technology providers focused on extracting, processing, or recycling critical minerals.¹⁷⁸

Lastly, the new Supply Chain Resilience Initiative (SCRI), launched in January 2025, takes a significant step forward to better position the United States to counter its dependence on the PRC.¹⁷⁹ Unlike traditional export-focused programs, SCRI supports projects based on U.S. offtake agreements, ensuring access to upstream raw materials without requiring U.S. goods or services. This tool will address a critical piece of the puzzle by helping build a secure, reliable supply of critical minerals essential for downstream manufacturing and strengthening U.S. supply chain resilience.

The DFC, the development finance institution of the United States, supports critical minerals projects in developing and lower-middle-income countries.¹⁸⁰ DFC has a wide range of tools to invest in critical minerals projects, including debt financing, loan guarantees, equity investments, technical assistance for activities such as feasibility studies, support for emerging market investment funds, and political risk

insurance.¹⁸¹ The institution's commitment to this sector is evident, as it has already announced more than \$230 million in equity and debt financing for critical minerals projects—many of these investments were initiated under the Trump administration and completed under the Biden administration.¹⁸²

EXIM and DFC face unique structural challenges compared to their international counterparts. Areas for reform include both agencies' authorization timelines, EXIM's co-financing restrictions and risk tolerance, DFC's equity limitations, and a general need for more dedicated technical expertise to deploy capital strategically and quickly. Additional challenges to leveraging ECAs and DFIs broadly to finance minerals projects should also be carefully considered.

While most Asian and European institutions benefit from indefinite mandates established through legislation, U.S. agencies operate under relatively short seven-year authorization periods. This frequent renewal requirement creates a fundamental mismatch with critical minerals project development times, introducing significant uncertainty for developers and investors. With DFC's authorities set to expire in October 2025 and EXIM's in December 2026, the upcoming reauthorization cycle presents a critical opportunity to address these issues and strengthen their capacity to support minerals projects.¹⁸³

Compared to its global counterparts, U.S. EXIM falls short in two key areas: its limited risk tolerance for critical minerals projects and its constrained ability to co-finance them effectively. While Export Finance Australia (EFA) and Korea's ECA, KEXIM, can deploy specialized facilities with higher risk tolerance for critical minerals projects, EXIM remains constrained by its 2 percent default gap.¹⁸⁴ Higher risk tolerance is crucial for critical minerals projects due to the inherent technical, financial, compliance, and geopolitical challenges in developing these resources, as discussed earlier in the report.

Even if it did have a higher risk appetite, U.S. EXIM's charter imposes constraints on co-financing arrangements, making it unattractive to partner with other ECAs to finance critical

¹⁷⁵ Export-Import Bank of the United States, "Helping American Businesses Win the Future," Webpage.

¹⁷⁶ Ibid.

¹⁷⁷ Export-Import Bank of the United States, "EXIM Support for Critical Minerals Transactions," Webpage.

¹⁷⁸ Ibid.

¹⁷⁹ Export-Import Bank of the United States, "Supply Chain Resiliency Initiative," Webpage.

¹⁸⁰ U.S. International Development Finance Corporation, "Overview," Webpage.

¹⁸¹ Ibid.

¹⁸² SAFE analysis based on DFC press releases and annual reports.

¹⁸³ Office of Inspector General, "Top Management Challenges Facing DFC in FY2025," U.S. International Development Finance Corporation, at 4; and "Shayerah Akhtar, "Export-Import Bank of the United States (Ex-Im Bank)," *Congressional Research Service*, updated January 19, 2024, at 1.

¹⁸⁴ 12 USC § 635e(a)(3).

minerals projects.¹⁸⁵ For instance, the EXIM charter dictates that the total amount of a co-financed or re-insured export deal counts against its portfolio limit, often causing U.S. EXIM to reach its lending ceiling faster because co-financed deals are usually much larger than a single-financed deal.

Despite EXIM's cofinancing limitation, the United States has made significant strides in coordinating financing support with allied countries' agencies. A prime example of this coordination is the Single Point Entry (SPE) system established between EXIM and Export Finance Australia (EFA) to secure critical minerals supply chains and strengthen economic resilience. Initially announced by President Biden and Prime Minister Albanese in 2023, the SPE is now fully operational as of August 2024, providing U.S. and Australian companies with streamlined access to financing support from both agencies.¹⁸⁶ The SPE allows Australian and U.S. critical minerals businesses to approach either U.S. EXIM or EFA and receive coordinated financing support from both institutions through a simplified process.

The DFC also faces some notable limitations when supporting critical minerals projects. While it has the unique ability to provide equity investments in projects, this capability is limited by how these equity investments are scored, making it difficult to allocate sufficient funds for high-risk ventures. Furthermore, the DFC's restrictions to only provide financing to developing and lower-income jurisdictions, with certain exceptions, does not always align with where viable critical minerals projects are located.

For agencies that support critical minerals projects, having the right personnel and expertise is essential to effectively deliver on their mandates in such a high-risk sector. The specialized knowledge required to navigate issues like resource extraction, processing, and market dynamics is crucial for ensuring that projects are financially viable and technically sound. International best practices demonstrate the value of specialized organizational structures designed to address these challenges. For instance, Japan's Japan Oil, Gas, and Metals National Corporation (JOGMEC) has embedded dedicated technical expertise in mining and processing, ensuring its initiatives are backed by in-depth industry knowledge.¹⁸⁷ Similarly, the EFA has created a \$4 billion critical minerals facility that adjusts risk parameters

to facilitate project development, showcasing how purpose-built programs can evaluate and support strategic projects.¹⁸⁸ These international examples underscore the importance of having the right personnel and specialized structures to support complex projects and ensure long-term success in the critical minerals sector.

More broadly, a fundamental challenge lies in better leveraging the distinct strengths of public and private sectors in project selection. ECAs and DFIs must navigate the perception of picking winners and losers when directly involved in project selection. This concern is particularly acute in the critical minerals sector, where technical expertise required to evaluate these multifaceted projects—from assessing novel extraction methods to analyzing complex metallurgical processes—often resides primarily in the private sector. Public finance institutions, meanwhile, are uniquely positioned to address broader market inefficiencies and strategic gaps that private capital alone cannot solve. These include first-mover disadvantages in emerging markets, coordination failures across supply chains, and projects that generate positive externalities beyond commercial returns. One promising solution draws from international models: creating specialized investment entities that harness private-sector expertise while maintaining strategic oversight. This approach ensures that project selection benefits from market-driven insights while serving national interests.

Additionally, the financial landscape of critical minerals projects is moving past traditional equity and debt finance.¹⁸⁹ Project financing is becoming more sophisticated to accommodate a diverse set of stakeholders—ranging from commodity traders to venture capital funds and principal purchasers—who are playing increasingly important roles in bridging investment gaps.¹⁹⁰ Each player brings unique capabilities and expectations, demanding complex deals.¹⁹¹ To remain effective, public finance institutions must develop greater agility in structuring and supporting these multilayered transactions, ensuring their toolkit evolves alongside market innovations.

¹⁸⁵ 12 USC § 635e(a).

¹⁸⁶ Export-Import Bank of the United States, "Export Finance Australia and Export-Import Bank of the United States Single Point of Entry "Open for Business", August 29, 2024.

¹⁸⁷ Nayan Seth, "How to Diversify Mineral Supply Chains – A Japanese Agency has Lessons for All," *New Security Beat*, August 15, 2024.

¹⁸⁸ Export Finance Australia, "We're growing Australia's critical minerals sector," Webpage.

¹⁸⁹ Daisy East et al., "Financing Mining & Minerals" Rising to the Challenge Set by COP28," Watson Farley & Williams, Webpage.

¹⁹⁰ Gregory Wischer et al., "Supercharging US Mineral Exploration: A Call for Federal Support," *New Security Beat*, August 20, 2024.

¹⁹¹ East et al., "Financing Mining & Minerals" Rising to the Challenge Set by COP28," Watson Farley & Williams, Webpage.

The MSP: Transcending Financial, Compliance, and Geopolitical Risks

The MSP is an international initiative of 14 countries and the European Union (EU) to catalyze private and public sector investment in strategic and responsible critical minerals projects. This ambitious initiative aims to provide support that tackles the financial, political, geopolitical, and compliance risks associated with critical minerals projects.

Given that most MSP Partner countries task their foreign affairs ministries to lead MSP engagements, the MSP primarily intervenes in project risks through diplomatic engagement with host governments. In 2024, the United States and European Union took this a step further, launching the MSP Forum, which now posts 15 members, to deepen the MSP's engagement with mineral-rich countries. Through this platform, particularly the EU-led policy dialogues, countries can elevate investment challenges stemming from new regulations or policies.

MSP Partners also directly support projects to decrease their financial risks. The MSP's coordinated approach enables larger-scale investments than a single country could support independently, creating more attractive conditions for private sector participation. The 32 supported projects are across the supply chain – nineteen upstream, fifteen midstream, and three recycling and recovery. Projects also range in minerals: ten REEs, six graphite, six cobalt, three nickel, two copper, two lithium, two gallium, two germanium, one high-purity aluminum, and one manganese. These projects are also across jurisdictions, with thirteen in Africa, eight in the Americas, six in Asia-Pacific, and five in Europe. A project is made public usually when government or private sector funding is secured. The MSP Finance Network and Minerals Investment Network (MINVEST), which together cover private and public funding potential, are the MSP's avenues toward driving needed investment.

Also related to compliance risks, specifically on standards, the MSP released its “Principles for Responsible Critical Mineral Supply Chains,” focusing on principles for ESG, projects, and government cooperation.ⁱⁱ Currently, these principles serve as a non-binding guide for projects and countries to commit to. For buyers of critical minerals and investors, the implied adherence of MSP projects to this framework provides an additional reference point for identifying projects that meet required compliance criteria. However, it is not intended to replace investors' due diligence processes. The mechanisms for monitoring and ensuring compliance with these standards over the course of long-term project development timelines are still under development as part of the MSP's ongoing efforts to refine its approach.

Lastly, and most pertinent to the risks faced by downstream purchasers of minerals and their investors, one of the MSP's most significant impacts has been its coordinated response to escalating geopolitical tensions and trade restrictions on critical minerals. Specifically, the MSP has supported projects involving key minerals such as germanium, gallium, and graphite, which have been significantly impacted by China's Ministry of Commerce export controls over the past year. By coordinating efforts among partner countries, the MSP aims to ensure a more diversified supply of these minerals, helping to reduce vulnerabilities and promoting alternative sources and pathways for their production and trade. Through this collective approach, MSP assists in minimizing the impact of geopolitical disruptions on critical mineral supply chains.

MSP Public Projects:

Project	Country	Company
Balama	Mozambique	Twigg Exploration & Mining
Chvaletice	The Czech Republic	Euro Manganese
Dubbo	Australia	Australia Strategic Metals
Electra Cobalt Refinery	Canada	Electra Battery Materials
Epanko	Tanzania	EcoGraf
Gecamines-Umicore Germanium Project	Democratic Republic of Congo	Umicore/Gecamines
HyProMag	The United Kingdom	MKango/CoTec
Iron Flow Battery (IFB) Modules	United States	ESS Inc.

Kabanga Nickel	Tanzania	Lifezone
Longonjo	Angola	Pensana
Mahenge Graphite Project	Tanzania	Black Rock Mining
Mingomba Copper Exploration Project	Zambia	KoBold
Townsville Energy Chemical Hub	Australia	Queensland Pacific Metals

Compliance Focus

Two areas of concern stand out when managing compliance risks in critical minerals projects: regulatory uncertainty and permitting challenges. While private companies can adopt best practices and maintain high operational standards, they rely on government frameworks to provide clear, predictable pathways for project development. One U.S. agency within the Department of Commerce (DOC) offers technical assistance to help countries establish reliable regulatory and legal frameworks for mineral sector development. Despite these efforts and due to shifting regulatory landscapes that could impact U.S. companies abroad, the United States also engages in ISDS mechanisms to provide a structured framework for resolving disputes between investors and host governments. While ISDS provisions are often the subject of public debate, they are relevant to this sector, known for its high upfront capital costs. Domestically, the United States faces its own compliance challenges, primarily tied to the permitting regime, which has been noted as a significant barrier to investment. This section examines how U.S. agencies engage in the two areas industry stakeholders have identified as most problematic for investment.

Regulatory Uncertainty

While companies can adopt rigorous operational standards, they rely on stable regulatory frameworks to guide long-term investment decisions. When unavailable for investment certainty, they lean on dispute settlement mechanisms, such as ISDS. The United States has entered into over 50 bilateral investment treaties, including ISDS provisions, providing a framework for resolving disputes between investors and host governments.¹⁹² Additionally, the United States is a party to various trade agreements incorporating ISDS mechanisms, such as the North American Free Trade

Agreement (NAFTA), which was replaced by the United States-Mexico-Canada Agreement (USMCA).¹⁹³

ISDS mechanisms, embedded within international investment treaties and contracts, enable foreign investors to bring claims against host governments through arbitration when they believe their treaty-protected rights have been violated. Under ISDS, cases are adjudicated by a tribunal of three arbitrators – one selected by each party and one selected jointly – who can order states to pay monetary damages if treaty violations are found. The extractive sector has emerged as one of the most frequent users of ISDS, with mining and oil and gas companies initiating hundreds of cases seeking substantial compensation. From 2013-2021, over half of all ISDS cases were filed by extractive companies, with individual claims frequently exceeding \$1 billion and average awards reaching \$437.5 million - nearly five times higher than in non-extractive cases.¹⁹⁴

The critical minerals sector faces unique challenges that make investment protection mechanisms particularly relevant. Mining projects require billions in upfront capital expenditure and face extensive regulatory, operational, and social risks over their multi-decade lifespans. Environmental challenges frequently arise even after companies secure permits - as evidenced by cases like Ecuador's Rio Blanco mine, where courts suspended silver and gold operations following anti-mining protests despite valid permits, leading to a \$480 million ISDS claim.¹⁹⁵ The sector also contends with deep-rooted public distrust stemming from historical environmental and social impacts, intensifying NIMBY opposition and conflicts with Indigenous communities. These tensions are compounded by regulatory uncertainty both domestically, where permitting timelines can stretch over a decade, and internationally, where companies face risks of resource nationalism, arbitrary regulatory changes, and corruption. For instance,

¹⁹² U.S. Department of State, "MSP Principles for Responsible Critical Mineral Supply Chains," February 2023.

¹⁹³ U.S. Trade Representative, "Facts: Investor-State Dispute Settlement—Safeguarding Public Interest, Protecting Investors," accessed January 12, 2025.

¹⁹⁴ Debevoise & Plimpton LLP, "From NAFTA to USMCA: The Main Changes to the Investment Chapter," May 2020.

¹⁹⁵ Matthew Hodgson et al., "2021 Empirical Study: Costs, Damages and Duration in Investor-State Arbitration," British Institute of International and Comparative Law, June 2021, at 28.

¹⁹⁶ Alexandra Valencia, "Exclusive: Chinese consortium Ecuagoldmining opens dispute with Ecuador over halted mine," *Reuters*, February 18, 2020.

Tanzania's 2017 abolition of specific mining licenses and Indonesia's 2009 requirement for foreign miners to divest majority ownership illustrate how policy shifts can fundamentally alter project economics.¹⁹⁶

One small but mighty government agency within the DOC aims to provide technical assistance and support to foreign governments in developing stable regulatory frameworks—ultimately, to prevent disputes from ever happening. The Commercial Law Development Program (CLDP) can support critical mineral projects globally by providing legal technical assistance to host governments. This program has a broad mandate, focusing on helping countries establish strong legal frameworks essential for the sustainable development of energy and mineral resources.¹⁹⁷ By partnering with ministries, regulators, and state-owned entities, CLDP addresses legal and regulatory challenges hindering development, ensuring that projects can proceed in a transparent, legally secure environment.¹⁹⁸

An example of CLDP's intervention in the critical minerals sector is its work with Mongolia, a country rich in mineral resources, including copper, gold, and REE, which are crucial for the global supply chain.¹⁹⁹ CLDP assisted Mongolia in updating and improving its mining laws and regulatory frameworks to foster more responsible and transparent practices in the mining sector.²⁰⁰ Through its legal technical assistance, CLDP helped Mongolia address challenges such as resource management, environmental sustainability, and investor protection.²⁰¹ These reforms aimed to enhance Mongolia's ability to attract responsible foreign investment while ensuring that the extraction of critical minerals is done in a way that benefits both the country and the global market. By strengthening Mongolia's mining regulations, CLDP has promoted sustainable practices essential for securing a stable and ethical supply of critical minerals.

The program also helps craft policies that balance economic growth with environmental stewardship and social responsibility, promoting investment in critical minerals industries. CLDP assists with establishing dispute resolution mechanisms to address potential conflicts between stakeholders and works to create investment-friendly legal structures that protect and attract foreign investments.

Through these efforts, CLDP contributes to developing critical minerals supply chains, supporting U.S. foreign policy objectives, and ensuring that countries develop their mineral resources in a manner that is both responsible and unlocks investment. However, the agency operates within certain limitations. CLDP's role is advisory, and partner governments are not required to adopt its recommendations. Even when partner governments act on CLDP's recommendations, implementing reforms can take time and face delays or complications due to political and economic challenges. Finally, the agency is limited by the availability of its resources, which can restrict the scale and reach of its interventions.

Permitting

For private sector actors, compliance risk extends beyond meeting regulatory requirements to maintaining environmental stewardship and securing a social license to operate. Many responsible corporations voluntarily adopt stringent industry best practices and abide by international standards that often exceed local regulatory mandates. This proactive approach reflects their commitment to sustainability, corporate responsibility, and long-term stakeholder trust.

However, no project can move forward without obtaining the necessary permits, regardless of how rigorous a company's standards and practices are. Permitting is inherently a regulatory action and falls squarely within the jurisdiction of governments. Governments must ensure that regulatory frameworks are stable, efficient, and transparent to mitigate developers' risks and attract the investments needed for critical minerals production. Beyond permitting, a stable environmental regulatory framework and strong governance are essential to providing investors with confidence.

The permitting landscape for critical minerals projects in the United States is complex, with relevant agencies involved based on factors such as land ownership and project characteristics, including proximity to bodies of water. For projects on federal lands, the process is guided by the National Environmental Policy Act (NEPA), which ensures that the environmental impacts of proposed projects are thoroughly assessed, and that public input is considered before permits are granted.²⁰² The Bureau of Land

¹⁹⁶ Burure Ngocho and Sadock Magai, "Mining in Tanzania: Effects of the mining legal framework overhaul," DLA Piper, July 2020, at 20; and Kresna Panggabean and Jeremiah Purba, "Indonesia amends the Mining Law," Norton Rose Fulbright, June 2020.

¹⁹⁷ U.S. Department of Commerce, "CLDP: Building Legal Frameworks for Critical Minerals."

¹⁹⁸ U.S. Department of Commerce, "Supporting Energy and Mining Sector Reforms."

¹⁹⁹ U.S. Department of Commerce, *Commercial Law Development Program (CLDP)*, "Support for Mining Legal Frameworks in Mongolia."

²⁰⁰ GB Reports, "Ministry of Mining and Heavy Industry Interview," Mongolia Mining 2024.

²⁰¹ DPLaw, "Recent Amendments to the Minerals Law of Mongolia," *DPLaw*, May 17, 2024.

²⁰² Debevoise & Plimpton LLP, "From NAFTA to USMCA: The Main Changes to the Investment Chapter," May 2020.

Management (BLM) and U.S. Forest Service (USFS) are the primary agencies responsible for issuing permits. The BLM manages approximately 245 million acres of public lands, while the USFS oversees nearly 193 million acres of national forests and grasslands.²⁰³ Together, these two agencies control a significant portion of the federal lands where critical minerals projects may be developed. A third federal agency that plays a significant role in permitting is the U.S. Army Corps of Engineers. Permits by the Army Corps of Engineers are required for mining projects situated near a body of water, regardless of land ownership.²⁰⁴

The involvement of numerous other federal, state, and local agencies further complicates the regulatory landscape. Each agency is tasked with a different regulatory compliance mechanism, which can lead to long wait times, a lack of cohesive interagency coordination, and an overall convoluted process. Addressing challenges requires improved interagency collaboration and the capacity, resources, and expertise of all agencies involved to manage workloads efficiently and make timely, well-informed decisions—an area that remains a significant gap in the current system and demands urgent attention.

Procedural inefficiencies are exacerbated by the lack of clear guidance at the beginning of the permitting process. Permitting requires some nuance. The level of information needed to permit a mine depends on the project's unique circumstances and complexity of operations. Regardless of how clear the written rules and regulations are, it is difficult to judge precisely what project-specific information the permitting agencies will ask for without engaging with them first. The inability to anticipate what information agencies will require often leads to incomplete applications, triggering requests for additional information that stall the NEPA process.²⁰⁵ Identifying potential conflicts early on and setting clear expectations for environmental review requirements and nuances can streamline the review process. To this end, BLM introduced a new policy in November 2024, directing field offices to promote pre-planning coordination with project operators.²⁰⁶

One initiative designed to help streamline the federal permitting process more broadly is the Federal Permitting Improvement Steering Council (Permitting Council), established in 2015 under Fixing America's Surface

Transportation (FAST-41) Act.²⁰⁷ The Permitting Council aims to expedite the permitting and review process for specific infrastructure projects, including critical minerals development, to provide a more predictable and transparent decision timeline.²⁰⁸ It creates a structured framework for project proponents to interact with federal agencies and encourages early collaboration between interagency stakeholders. It also has the authority to transfer funds to federal agencies, states, and tribal and local governments to facilitate timely and efficient environmental reviews and authorizations.²⁰⁹ While the Permitting Council has success in certain infrastructure sectors, its application to critical minerals projects is still lagging. It accepted its first and only critical mineral project, South32's Hermosa zinc and manganese mine, in Arizona in 2023.²¹⁰

Mine projects on private lands encounter similar complexities as they navigate permitting processes at the state and local levels. Moreover, if these projects aim to access federal funding through programs like LPO or the MMIA under EXIM, they are also required to go through the NEPA process. Though well-intended, these requirements create a dual regulatory burden requiring developers to align with state and federal permitting requirements, further prolonging decision timelines and increasing investor risks.

Developers and investors' reluctance to navigate the NEPA process unless absolutely necessary limits the ability of projects on non-federal lands to access federal funding support. The uncertain and potentially prolonged timelines for regulatory decisions deter developers from pursuing low-interest loans and other financial assistance, even when such support could provide critical resources for advancing projects.

Geopolitical Focus

Private sector investors cannot effectively manage the growing geopolitical risks posed by the PRC's control over the critical minerals market. The market is heavily distorted by subsidies, price manipulation, and strategic stockpiling, undermining fair competition. In response, the United States deployed a combination of trade tools to protect strategically important projects while building more resilient supply chains—with mixed results. U.S. policymakers are

²⁰³ Bureau of Land Management, "What We Manage Nationally," Webpage; and DOI, "The Department of Agriculture's Forest Service (FS)," Webpage.

²⁰⁴ DOI, "Recommendations to Improve Mining on Public Lands," September 12, 2023, at 49.

²⁰⁵ Ibid, at 6.

²⁰⁶ BLM, "BLM announces actions to improve mine permitting, early engagement," U.S. Department of Interior, November 20, 2024.

²⁰⁷ Permitting Council, "Our Mission & What We Do," Webpage.

²⁰⁸ Ibid.

²⁰⁹ Ibid.

²¹⁰ Permitting Council, "Permitting Council Announces First-Ever Critical Minerals Mining Project to Gain FAST-41 Coverage," May 8, 2023.

also currently weighing how to use market tools already in place, such as stockpiling, and under consideration, such as minerals reserves, market makers, or price insurance, to tackle geopolitical risks. This section examines how trade policies, specifically tariffs, counter market distortions and evaluates the potential policy ideas around market tools.

For a deeper understanding of how trade policies, including and beyond tariffs, influence critical mineral supply chains, please read SAFE's Trading Tensions: Navigating Policy Tools for a Diverse Critical Minerals Supply Chain (Released October 2024). The analysis further details the complexities of balancing trade policy with supply chain security and the strategies needed to strengthen U.S. competitiveness in this critical sector.

Trade Tools

The primary trade tool available to directly respond to the PRC's market intervention in critical minerals is the imposition of tariffs. The United States has historically used tariffs to protect domestic industries and counter unfair trade practices, such as those in the PRC's state-subsidized critical mineral sector.

Section 301 tariffs have been imposed on various Chinese imports, including several critical minerals, to counteract market-distorting practices. Similarly, Section 232 of the Trade Expansion Act allows the United States to impose tariffs on imports that threaten national security, as has been done for steel and aluminum. Finally, Section 201 tariffs—sometimes called safeguard tariffs—were put in place after the U.S. International Trade Council determined that a surge in imports of solar modules and cells seriously injured domestic industry production.²¹¹ Despite focusing on downstream technologies, the 201 tariffs are worth mentioning because of the countermeasures they precipitated on U.S. polysilicon producers.

Tariff mechanisms outlined above are implemented through a structured process where the Office of the U.S. Trade Representative (USTR) and the DOC conduct investigations, assess market impacts, and provide recommendations to the president. The president, aiming to safeguard national security, bolster domestic industries, and promote fair competition, ultimately determines whether to impose tariffs.

Although an indispensable part of the U.S. policy toolkit, tariffs on intermediate products like critical minerals present a trade-off. While tariffs may help reduce dependency on the PRC in the long run, they also create challenges for downstream manufacturers who depend on

affordable and scalable supplies of these minerals. Tariffs to address CCP market distortion can increase costs for U.S. manufacturers and consumers by raising the price of materials imported from the PRC. Unless viable domestic or other foreign alternative sources of product exist or can be brought to market in a short period, downstream producers will be forced to absorb the higher costs of inputs, which can erode margins and stifle growth. Tariffs on manufacturing inputs must, therefore, be carefully calibrated to strike a balance between addressing unfair trade practices challenging upstream while maintaining the competitiveness of downstream U.S. industries. Additionally, tariffs do not address structural barriers, such as permitting challenges or infrastructure gaps, that impede domestic critical minerals production.

Tariffs can level the playing field within the U.S. market by addressing unfair market practices, such as subsidies or market distortions, and enabling domestic mineral producers, processors, and recyclers to compete. Alone,

“Tariffs are necessary [to counteract China’s market distortion] but not sufficient... While they are justified if part of a broader strategy to level the playing field, China is finding giant loopholes that we [the United States] cannot address quickly or that we cannot see.”

- SCOR Member

however, tariffs do not improve the global competitiveness of U.S. industries. Strengthening U.S. government programs designed to mitigate technical, financial, and compliance risks can bolster the effectiveness of tariff policies.

Market Tools

Most tools available to policymakers to counter CCP market interventions are not designed to offer protection against market volatility and price manipulation. One area that received renewed attention is the National Defense Stockpile (NDS). After the FY2024 National Defense Authorization Act (NDAA) granted the stockpile a new multi-

²¹¹ U.S. International Trade Commission, “Understanding Safeguard Investigations,” Webpage.

year procurement authority for REEs or magnets processed in the United States by domestic sources, stakeholders started assessing the merits of using a government stockpile to provide price stability.²¹²

The NDS, however, is designed primarily to store materials for use during national emergencies and war. It lacks the mandate to intervene in markets or stabilize supply chains for civilian industries and is not the appropriate tool for market stability. These limitations and significant market downturns across critical minerals in early 2024—including cobalt, nickel, lithium, and REEs—prompted stakeholders to explore alternative tools to address price challenges.

Several policies have been proposed to help provide some pricing support or stability to Western investors and critical mineral project developers. These include creating a new critical minerals reserve modeled after the Strategic Petroleum Reserve (SPR) to intervene in commodity markets, offering loans to market-makers to time-shift demand, providing government-backed price insurance, and launching new government bodies that can provide direct pricing support in the form of contract for differences, offtake guarantee, or advanced market commitments.

These proposals aim to reduce market volatility, support long-term supply stability, and incentivize investments in U.S.-producing companies. However, each faces unique challenges. Key limitations include the need for substantial government funding, taxpayer risk exposure, and the difficulty of aligning these programs with the distinct characteristics of critical minerals markets.

For example, financial tools such as contracts of differences require substantial government appropriations and expose taxpayers to the full pricing risk associated with them. For the market maker proposal, the government's risk exposure would be limited to the loan it provides market makers. Market makers then use this funding to time-shift demand by purchasing materials during market downturns and warehousing them for future sales when prices recover. However, its success requires a sufficient number of buyers and sellers outside of the PRC's controls. Government-backed price insurance carries the risk of significant taxpayer liabilities during market downturns or periods of price manipulation, as the government would need to cover substantial losses beyond the insurer's guaranteed return. A government reserve modeled after the SPR could be

leveraged to intervene in markets. However, the sheer volume and cost required to stockpile certain minerals to make a dent in the market render SPR-like mechanisms impractical for critical and strategic materials with high market volumes, such as copper and nickel.

Ultimately, the challenges and limitations, including substantial funding requirements, significant taxpayer risk, and the practical difficulties of implementing these tools in critical minerals markets, prevented these proposals from gaining sufficient traction to move forward.

The lack of transparency in most critical minerals markets adds another layer of complexity to efforts to stabilize supply and mitigate geopolitical risks. In markets dominated by Chinese traders and refiners, it is often difficult to determine whether genuine supply-demand dynamics or artificial distortions drive price fluctuations. This opacity makes it challenging for any strategic reserve to intervene effectively, as mistimed actions could further destabilize markets rather than provide the intended stability. These challenges highlight the need for alternative approaches that address market volatility while reducing reliance on direct stockpiling.

In this context, the 45X Production Tax Credit and the sourcing provisions and foreign entities of concern restrictions in the 30D Clean Vehicle Tax Credit emerged as the most meaningful tools to support market stability. The per-unit subsidy offered under 45X offsets revenue losses, increasing the likelihood of maintaining operations when market prices fall. On the other hand, the sourcing requirements under 30D create strong demand signals for domestic and allied producers and create a “compliance premium” for materials that meet the requirements—shielding these compliant producers from low market environments.

²¹² Stephanie Barna and Daniel Raddenbach, “Key Supply Chain Provisions of the National Defense Authorization Act (“NDAA”) for Fiscal Year (“FY”) 2024,” Covington, January 9, 2024.

Recommendations

The report's analysis reveals significant vulnerabilities in the U.S. critical minerals supply chains, ranging from limited domestic production and processing capabilities to regulatory barriers and financial constraints. These challenges are compounded by growing global demand, concentrated foreign control of resources, and intensifying geopolitical competition. Drawing from an assessment of investor insights and current U.S. government programs, this report proposes recommendations across five crucial dimensions: financial, technical, compliance, geopolitical, and coordination.

These recommendations are designed to address immediate supply chain vulnerabilities and long-term strategic needs. They build upon existing policy frameworks while introducing new mechanisms to strengthen U.S. competitiveness in the critical minerals sector. The proposed actions range from expanding federal financing tools and streamlining permitting processes to fostering international partnerships and advancing technological innovation. Each recommendation responds to specific gaps and opportunities identified in the proceeding analysis, emphasizing areas where U.S. government action can catalyze private sector investment and deployment.

These recommendations aim to reallocate existing funding and leverage government resources to catalyze private-sector investment. They would decrease the financial burden on U.S. taxpayers while maximizing the impact of public funding.

Improve Coordination and Strategy

The first Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals, released in 2017, was a crucial step in addressing the United States' reliance on foreign sources for critical minerals. However, much has changed since then, including shifting geopolitical realities, technological advancements, and evolving market conditions. It is now essential to update this strategy to reflect these changes, assess inefficiencies in federal action, and provide clear direction for future policy development.

This updated strategy is also vital for investors, as it will offer clearer signals on U.S. government priorities and goals in the critical minerals sector, helping to guide private sector investment decisions and ensure long-term market confidence.

The updated strategy should:

- 1. Appoint a Minerals Czar to lead a newly launched Critical Minerals Task Force.**
 - a. The Critical Minerals Task Force should operate under the National Security Council, unifying efforts across the Departments of Defense (DOD), Energy (DOE), Interior (DOI), State (DOS), Commerce (DOC), and Environmental Protection Agency (EPA).
 - b. This Critical Minerals Task Force should report directly to the National Security Advisor (NSA) and have direct tasking authority over any Cabinet member to ensure immediate compliance with key national security needs.
- 2. Define strategic goals tailored to specific mineral markets,** recognizing that different approaches are necessary for various mineral types, including:
 - a. Minerals with established markets but concentrated supply (like nickel),
 - b. Emerging minerals with rapidly growing demand (like battery materials and REEs),
 - c. By-product minerals where production economics are tied to primary metals (like germanium, gallium, and antimony),
 - d. Processing-constrained minerals where raw material exists but midstream capacity is limited.
- 3. Incorporate lessons learned from recent supply chain disruptions and international partnerships,** ensuring the updated strategy adapts to the evolving global landscape and leverages opportunities for greater international collaboration.
- 4. Identify specific actions needed to resolve current misalignments between agencies and programs,** such as inconsistent policies, conflicting regulations, or overlapping responsibilities.

Financial

While the private sector is ultimately responsible for building the mining, processing, and recycling capacity needed for critical minerals supply chains, there remains a vital role for public financing to derisk projects. Government intervention is necessary for two key reasons: first, to better compete with the PRC, whose state-backed entities leverage low-cost financing and market distortions to dominate global supply chains, and, more importantly, to ensure that private capital flows to projects that align with national policy goals. Targeted public support should prioritize “domestic” processing projects that face inherent cost

disadvantages, as well as co- and by-product production for niche minerals essential to defense, advanced technologies, and energy infrastructure. The government also needs tools to support projects that may not generate sufficient returns to attract private investors but are strategically important for national security reasons. Finally, public financing, especially during early-stage development, can prevent adversarial entities from acquiring promising deposits. Without such interventions, strategically significant projects risk being overlooked or lost to foreign adversarial control due to economic and market barriers.

The following recommendations aim to strengthen and expand existing federal financing tools to alleviate financial risks.

- 1. The Loan Programs Office (LPO) should leverage its existing authorities under the Title 17 and Advanced Technology Vehicles Manufacturing loan programs to provide low-cost debt financing to critical mineral projects.** With \$112 billion in loan authority remaining across the two programs, the DOE has a significant pool of funding available to support innovative projects. While not all available funding will be allocated to critical minerals projects, LPO should explore opportunities to utilize its Title 17 authorities better to increase support for domestic critical minerals processing, recycling, and extraction projects beyond battery materials.
- 2. Congress should reauthorize the Defense Production Act (DPA) Title III program and reallocate unused funds from canceled Inflation Reduction Act (IRA) programs.**
 - a. The DPA Title III program should continue to focus on critical minerals processing, recycling, and co- and by-product production. Funds should also be available to help strategic mine projects accelerate their development timelines.
- 3. Congress should maintain the 45X Production Tax Credit and make amendments to disqualify foreign adversary entities from the tax credit.**
 - a. The learning curve during the initial years of operation often results in higher OPEX for new critical minerals producers as they refine processes, optimize efficiency, and address technical challenges. The 45X Production Tax Credit provides financial relief to new processors as they transition to more stable, cost-efficient producers.
 - b. The credits also function as a pricing support mechanism, bolstering U.S. critical mineral producers' resilience against market volatility. This critical incentive must be preserved to improve the competitiveness of U.S. projects.
 - c. However, Congress should amend Section 45X to prevent U.S. operations of foreign adversary entities from accessing the tax-payer-funded incentive.
- 4. Congress should reauthorize the U.S. International Development Finance Corporation (DFC) and strengthen its ability to finance critical minerals projects.** DFC reauthorization should include the following provisions to enhance DFC ability to support critical minerals projects:
 - a. Fix the equity scoring methodology to unlock additional investment dollars and increase the impact of DFC financing.
 - b. Expand the list of eligible countries for critical minerals project funding to include upper-middle-income countries. Currently, funding support is not eligible for Chile, a leading producer of lithium and copper. Argentina, another important lithium and copper producer, is expected to graduate to the upper-middle income category as early as 2025, making it ineligible for DFC investments under existing criteria. The U.S. Export-Import Bank (EXIM) does not operate in Argentina, highlighting the need for DFC to fill this gap.
 - c. Increase DFC financing authority to \$100 billion.
 - d. Increase DFC risk tolerance to deploy its political risk insurance tool more effectively.
 - e. Establish a one-year rotating fellowship program for private sector mining and minerals finance experts to bring direct industry expertise into DFC project evaluation and risk assessment processes.
 - f. Extend the DFC authorization period to a minimum of 10 years to ensure consistent support and long-term planning capabilities.
 - g. DFC should prioritize funding for MSP projects and projects that supply raw materials or feedstock to U.S.-funded initiatives.
- 5. Congress should reauthorize the Export-Import Bank of the United States (EXIM) and strengthen its ability to finance critical minerals projects in the United States.** U.S. EXIM reauthorization should include the following provisions to enhance EXIM's ability to support critical minerals projects:
 - a. Increase default cap for critical minerals projects from 2 percent to 4 percent to enable greater risk tolerance.

- b. Establish a one-year rotating fellowship program for private sector mining and minerals finance experts to bring direct industry expertise into EXIM's project evaluation and risk assessment processes.
 - c. When assessing debt financing for foreign operations, EXIM should prioritize alignment with the MSP and focus on projects that provide feedstock to U.S.-funded initiatives.
- 6. **U.S. Trade and Development Agency (USTDA) should be deployed more broadly to support early-stage project development (e.g., pre-feasibility studies) and address a critical gap in project maturity requirements for other financing agencies.**
 - a. USTDA should prioritize actions to prevent foreign adversary entities from purchasing promising mine assets that could be strategic to enhancing U.S. national security.
- 7. **Congress should institutionalize international partnerships by codifying the Minerals Security Partnership (MSP) and urge the DOS to:**
 - a. Create explicit links between partnership frameworks managed by DOS and funding available through EXIM, DFC, and USTDA.
 - b. Utilize the Minerals Investment Network for Vital Energy and Security Transition (MINVEST), a public-private partnership comprised of investors, major mining companies, and principal purchasers of critical minerals to identify priority projects and guide EXIM and DFC investments.
 - i. DOS should build stronger connectivity between MINVEST members and encourage purchase agreements between private sector companies.
 - c. Help strengthen coordination among allied export credit agencies and development finance institutions.

Technical

The private sector should be responsible for assessing and managing technical risks related to individual critical minerals projects. The role of the U.S. government should be focused on promoting an enabling environment that supports the development and scaling of these projects. This includes providing tools like advanced geological mapping and AI to improve resource assessment and increase the chances of success in exploration. Additionally, the government should foster innovation in processing technologies and support the development of critical infrastructure.

- 1. **Congress should extend and expand the U.S. Geological Survey (USGS) Earth Mapping Resource Initiative (EarthMRI).** While not providing immediate supply solutions due to long project development timelines, enhanced mapping of U.S. lands and mine waste will improve understanding of domestic resource potential and help direct exploration efforts to areas with a greater likelihood of success. Congressional action should:
 - a. Extend EarthMRI's appropriations beyond FY2026.
 - b. Expand EarthMRI's mine waste assessments beyond resource characterization and include an evaluation of nearby infrastructure that could provide opportunities to reprocess mine tailings.
- 2. **Congress should use unused funds from canceled IRA programs to launch a seabed equivalent to EarthMRI and direct the USGS and the National Oceanic and Atmospheric Administration (NOAA) to map the U.S. Exclusive Economic Zone.**
- 3. **Congress should establish regional processing and recycling hubs.** U.S. processing facilities face significant competitive challenges against jurisdictions with lower environmental standards, particularly regarding waste management and air quality compliance. In some cases, current processing technologies may not be compatible with Clean Air Act requirements at the commercial scale. These environmental compliance requirements, combined with high domestic energy costs, explain why no new major processing facilities have been built in the United States in recent decades, with new capacity instead being developed in jurisdictions with lower environmental standards and cheaper energy inputs. The hubs should adopt a tech-neutral approach, advancing the development of critical mineral processing technologies and substitute materials:
 - a. Accelerate the development of next-generation processing technologies through sustained support for research, development, and demonstration of more efficient processes that minimize waste generation and energy consumption, thereby reducing both environmental impact and operational costs.
 - b. Facilitate economies of scale, enabling smaller or new processors or recyclers to benefit from shared resources, infrastructure, and expertise.

- c. Enhance the commercial viability of processing and recycling projects by helping foster collaboration among mineral processors, manufacturers, and recyclers and aligning the needs of downstream industries with processing capabilities.
- 4. **DOE should continue to support R&D focused on critical mineral extraction and processing technologies and substitute materials under the ARPA-E level and AMMTO.**
- 5. **Congress should codify the Partnership for Global Infrastructure (PGI) to support and expand infrastructure initiatives in developing and emerging economies that contribute to critical mineral production and transportation.**
 - a. PGI should work alongside DFC, USTDA, and Power Africa, three agencies that can facilitate the development of supportive infrastructure at the local level, including regional transportation networks and power grids.

Compliance

While maintaining high environmental and safety standards, current regulatory frameworks often create unnecessary barriers to critical minerals development in the United States. Modernizing compliance processes to increase efficiency, reduce regulatory burdens, and streamline approvals is essential to de-risking domestic mining projects. By doing so, the U.S. government can uphold rigorous environmental and social safeguards while promoting the timely development of critical minerals projects essential for economic growth and national security. In addition to permitting reform, the U.S. government should support international efforts to enhance the regulatory environment for critical minerals, promoting transparency, sustainability, and responsible investment practices across global supply chains.

1. **The U.S. government should modernize the federal permitting framework.** The current U.S. federal permitting system requires comprehensive reform to enhance efficiency while maintaining stringent environmental standards. This modernization should focus on establishing 1) clear and consistent rules and processes, 2) objective decision-making criteria, and 3) the capacity for timely execution.
 - a. U.S. permitting agencies should develop and implement science-based, reasonable, practical, and publicly available criteria for evaluating permit applications and ensure that these criteria are applied as consistently as possible.
 - b. U.S. permitting agencies should work to eliminate repetitive and redundant reviews across the interagency while maintaining the rigor of environmental assessments.
 - c. Congress should amend the National Environmental Protection Act (NEPA) to create the following requirements:
 - i. All stakeholders will be notified and will participate in the earliest mineral exploration phase of mining and the pre-scoping phase of the NEPA requirements.
 - ii. Any individual or group filing a lawsuit challenging a project must have been formally engaged in the permitting process during its designated phases.
 - iii. Lawsuits challenging a project must be filed within 120 days of the issuance of the Record of Final Decision.
 - d. The Permitting Council should automatically designate all critical minerals projects on federal lands as FAST-41 projects to ensure coordinated, expedited review.
2. **Congress or the Executive Branch should direct the Commercial Law Development Program (CLDP) to establish a systematic program to share regulatory best practices that balance investor protections with environmental and social safeguards.**
 - a. CLDP should develop model legislation for critical minerals incorporating transparent licensing and permitting processes, robust environmental protection standards, comprehensive community consultation requirements, fair labor standards, and strong anti-corruption measures.
 - b. Unless directed otherwise by DOS, the agency should prioritize engagement with countries participating in the MSP Forum under this workstream.
 - c. Congress should consider allocating unspent funds from canceled IRA programs to support the CLDP. This would ensure sufficient resources are available for staffing, outreach, and the development of necessary materials to guide the implementation of model legislation and regulatory frameworks.
3. **DOS, U.S. Trade Representative (USTR), and international counterparts should collaboratively develop alternatives to Investor-State Dispute Settlement (ISDS) mechanisms to strengthen contract mechanisms**

globally. Alternative mechanisms that better balance investor and state interests could include specialized arbitration panels with critical mineral expertise and expedited processes for more minor disputes. Investment protections need strengthening through more explicit force majeure provisions, standardized stabilization clauses, and environmental and social performance requirements. Additionally, new transparency requirements could mandate disclosure of beneficial ownership, public reporting of material contract terms, regular environmental and social impact assessments, and community benefit agreement disclosures.

- a. DOS and USTR should host an international roundtable series with counterpart agencies, including the European Commission's DG Trade, Japan's METI, South Korea's MOTIE, Brazil's CAMEX, and other relevant trade and investment authorities, along with industry stakeholders to solicit feedback on the development of alternative dispute resolution mechanisms, specialized arbitration panels, and enhanced contract provisions.
- b. Regional Consultations should be held in strategic mining jurisdictions across Africa, the Americas, Asia, and Europe to ensure diverse perspectives are incorporated and that the alternative dispute mechanisms gain global recognition.
- c. This forum would allow industry experts, investors, NGOs, multilateral development banks, international arbitration centers, and other stakeholders to provide input on the most effective ways to balance investor and state interests, strengthen investment protections, and integrate environmental and social performance requirements while respecting varying legal traditions and regulatory approaches.

Geopolitical

The critical minerals sector operates within an increasingly complex geopolitical landscape, where market distortions and strategic competition present significant risks to U.S. economic and national security. The opacity of global mineral markets makes it difficult to differentiate between regular market dynamics and the PRC's manipulation. U.S. government actions are essential to assess the full scope of the PRC's geopolitical risks and develop effective strategies for countering its market distortions. Intelligence sharing and monitoring of PRC activities are critical for ensuring the U.S. government is aware of all risks impacting critical mineral supply chains. This awareness will help inform policies that protect U.S. interests and strengthen resilience against disruptions. Additionally, the National Defense Stockpile (NDS) must be strengthened to better safeguard the U.S. defense industrial base from potential supply disruptions during times of crisis.

- 1. The United States Critical Minerals Task Force should establish an arm dedicated to working with close security allies who are also major critical mineral producers.** Building off the MSP, members of this group should harmonize investment screening criteria and focus on intelligence sharing and coordinated efforts in the following areas:
 - a. To develop supply chain vulnerability assessments for comprehensive, shared threat assessments covering state-backed market distortions, non-market trade practices, strategic stockpiling activities, and technology transfer risks.
 - b. Establish warning systems to detect and respond to price manipulation attempts, supply chain disruptions, predatory investment practices, and threats to critical infrastructure.
 - c. To create rapid response mechanisms to address market disruptions, supply shortages, infrastructure attacks, and transportation blockages.
 - d. Develop joint mitigation strategies focusing on stockpile coordination, alternative supply routes, processing redundancy, and technology protection measures.
- 2. To ensure the United States remains competitive in the global critical minerals market, the U.S. government should consider strategically implementing tariffs on critical mineral imports from nations that engage in unfair trade practices to protect endangered U.S. critical minerals supply chains.**
 - a. Tariffs should be designed to protect domestic producers and incentivize the development of domestic critical mineral industries. However, it is essential to balance these upstream policies with the needs of downstream industries that rely on critical minerals for manufacturing and production. The United States should ensure that tariffs do not unduly restrict access to essential supply chains for industries like electronics, automotive, and defense,
 - b. The United States should also work with international partners to harmonize tariffs when possible, creating a unified approach to countering the PRC's market distortions.
 - c. If Section 232 tariffs are leveraged, carveouts should be provided to reliable allies, including the Five-Eye countries (Canada, the UK, Australia, New Zealand.)

3. Congress and the Defense Logistics Agency (DLA) should strengthen and modernize the NDS to better ensure that the United States and its defense industrial base are prepared for national emergencies.

- a. DLA should increase the size and number of defense-critical materials maintained in the NDS to reflect the new geopolitical realities, starting with closing any existing shortfalls for materials where the United States has a high import dependency on the PRC.
- b. NDS can serve as an offtaker of critical minerals. By integrating NDS offtake agreements (up to five years) with DOD funding support, the U.S. government can further de-risk projects for investors. However, the impact of NDS offtake may be limited if the NDS's material needs represent only a small share of the total project output, necessitating additional commercial customers or financial support to ensure the project's long-term viability.
- c. DOD's new Strategic and Critical Minerals Board should include relevant industry leaders in mining finance, extraction, processing, and recycling technologies. This Board should be overseen by the Critical Minerals Task Force and have a dedicated liaison to the arm dedicated to working with allies.