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Critical Minerals, Rare Earth Elements, and the Challenges Ahead for the United States

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Executive Summary

The race to secure critical minerals (CM) and rare earth elements (REE) has become an area of increasing geopolitical competition, with China and the United States the two key players. The United States is currently behind in that competition. It is being out-invested, out-innovated, and out-educated. Not only is Washington losing, but it is falling further behind by undermining the alliances and cooperative networks that should play a crucial role in overcoming the existing structural deficit. At the same time, current US policy is weakening the domestic green energy market that relies on CMREE inputs and drives technological innovation and investment as much of the world pushes ahead with the energy transition.

Solely market-driven solutions are unlikely to materialize to address this challenge in the United States. After all, it was this approach over at least the last two decades that helped to create the current imbalance. The central challenge for the United States, then, is how to build a foundation from which market forces can once again play a leading role in driving financing, research, and labor in the sector.

The interlocking web of policies to build this foundation is complex. To be done right, each policy requires others surrounding for support. Completing the puzzle will require broad-spectrum cooperation between government and business. This will include a renewed focus on industrial policy and require setting explicit goals for the United States and its partners to create secure supply chains.

This process is not without challenges and will inevitably produce local, and potentially national, opposition. The refineries required to diversify where CMREE are processed will create environmental hazards as well as stress local water resources, among other vulnerabilities. This set of policies will also demand heavy investment in material sciences to develop new technologies that can reduce and replace CMREE inputs where possible. Pursuing these policies will necessitate much deeper investment in education and training to create a workforce capable of meeting the demands in the CMREE mining, processing, and materials science sector.

Even with extensive government support, there is no guarantee that private investment will materialize to sustain the industry. China's virtual cornering of a vast swath of the market means much of the sector does not operate along traditional axes of supply and demand, discouraging private investment in the process. This makes it more likely that long-term government support in the form of subsidies, tax incentives, and price controls will be required. That puts such funding and support at the mercy of shifting political winds.

Under previous US administrations, a wide-ranging challenge like CMREE would produce the requisite policy papers calling for deeper coordination, cooperation, and integration between the United States and a consortium of like-minded countries. Some of that cooperation may yet be possible, but with a US administration that views the world through a zero-sum lens, it becomes less likely each day. Rather than coordination, it will be absolute dollar amounts that drive cooperation. That approach may be successful in the short term in establishing the building blocks of a secure CMREE supply chain. But its longer-term prospects are uncertain.

This report and its policy recommendations are based on discussions from two seminars and multiple conversations across several countries and continents with policy analysts, industry professionals, and government officials. The first seminar was conducted in cooperation with the Perth USAsia Centre in Perth, Western Australia. This seminar brought together participants from around the Indo-Pacific to share their views on how allies and partners could coordinate their efforts. The second seminar was held in Chicago at the Chicago Council on Global Affairs with industry professionals, minerals practitioners, and academic experts from across the United States. A full list of participants can be found in the appendix.

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Policy Recommendations

1. Narrow the Scope of Critical Minerals

A. Not every critical mineral is critical. The United States and its partners in the Minerals Security Partnership (MSP) should establish an agreed-upon methodology to determine respective lists of critical minerals. This methodology should focus on import reliance, existing stockpiles, future demand projections, and processing choke points. Importantly, it should also establish the likelihood that China will use its control of the CMREE supply chain coercively. This transparency will allow clearer policy coordination and cooperation between MSP members and the projects the MSP funds as they seek to reduce supply-chain risks and offer clearer insight into stockpiles.

B. The United States and its partners must accept that they will not be competitive as CMREE suppliers on the world market. Domestic supply chains should aim to meet the demands required for national security purposes. Even this limited goal will require vast government support, including subsidies, tariffs, tax incentives, and offtake agreements. The end goal should be to stabilize the industry, building a foundation that allows private investment to follow.

2. Prioritize Processing, Not Mining

Growing demand for CMREE has led to a scramble among countries as they broaden exploration for new domestic deposits and attempt to capture as much of the value chain as possible. However, expanding the reserves of raw materials will do little to lessen dependence on China. The complex processing techniques that transform ores and oxides into useful materials will remain dominated by China for the foreseeable future. Given this reality, the United States and its allies and partners should assess their collective minimum CMREE requirements and then coordinate on establishing distributed processing facilities to meet that demand. This is the core of the challenge. These processing plants are expensive, lack the backing of private investment, will create pushback from communities due to environmental impact, and require long lead times to come online.

3. To Attract Private Investment, Government Support Will Be Mandatory

An ongoing challenge for diversifying supply chains is chronically low CMREE prices that discourage private investment in new mining operations and processing facilities. To spur such investment, governments will have to step in to provide a wide range of support. Direct government investment and offtake agreements will be required, as well as support on the demand side to encourage end-product users to switch from Chinese suppliers to suppliers with higher production costs. These steps will help raise the floor for critical minerals prices as well as add predictability to those prices, encouraging private investment in upstream and downstream facilities. Some of this has already been done on rare earth elements. Further support will be required in sectors such as the production of gallium and cobalt.

4. Establish an International Consortium for Research and Development

Catching up with China on processing technologies and material sciences will not be feasible for any company working alone. Instead, the United States—using SEMATECH as the example—should form an international consortium to develop intellectual property (IP) for the creating next-generation technologies that will underpin the energy transition. After making progress on new IP and materials, it can be used by any company involved in the consortium, which will then be free to compete with that technology on the open market. This consortium should not be limited to US companies only. The United States should leverage its relations with Australia, Japan, India, and South Korea, among others, to bring greater expertise and experience into the consortium.

5. Bolstering the Workforce

The mining workforce in the United States is in long-term decline and will require significant support to reshape. First, the United States should explore workforce exchanges with MSP partner countries to send American workers abroad to gain experience and bring workers from MSP-partner countries to the United States to help make up for the shortfall in the American labor force. This would include expanding the number of country-specific visas offered to workers in the CMREE industry. Second, the government should offer financial support for universities to expand existing mining and materials science programs, with a focus on ways to expand student recruitment.

Introduction

The COVID-19 pandemic brought the fragility of supply chains to the attention of governments and publics around the world. As the supply of goods ranging from emergency medical supplies to basic consumer goods was suddenly threatened, there was a deeper rethink about what it means to live with just-in-time supply chains and the vulnerabilities embedded therein. In the United States and elsewhere, industrial policy roared back into fashion, and a push to friendshore, nearshore, or onshore production took hold.

In fact, the wake-up call of supply chain vulnerabilities for CMREE came much earlier.[1] China's 2010 export ban on rare earth elements (REE) to Japan sparked wider concern about China's dominance of the industry, but little was done in the following years to pursue a more diverse supply chain. In the years after COVID-19, however, that effort gained steam. While there has been some progress in manufacturing end goods—products like lithium-ion batteries for cars and other consumer goods—progress has been slow for goods like powerful magnets needed for advanced technologies. As recently as June 2025, US car manufacturers warned that imminent shortages of REE magnets would shut down production lines "within weeks."[2] This highlights the central challenge for the United States and other countries around the world. China's control of the midstream supply chain—processing and intermediate-good production—grants it control of finished-good production in countries around the world. In the case of the United States, the auto industry is the largest manufacturing sector in the country, accounting for roughly 3 percent of GDP.[3] Importantly, CMREE are also key inputs into a wide array of defense goods, including advanced aircraft and a variety of critical sensors.[4]

The challenges facing the United States and its partners and allies on CMREE are long term and will require sustained effort to address. As Minoru Nogimori, senior economist at the Japan Research Institute, argues, countries are caught in a trilemma when it comes to the supply of critical minerals.[5] Given the three goals of seeking to decarbonize, derisk from China, and pursue economic stability, only two can be pursued. The United States seems to have made its choice. With the Trump administration moving the United States away from decarbonization efforts, it is attempting to derisk from China by building

its own critical mineral supply chains and maintaining economic stability by emphasizing reliance on fossil fuels.

The effort to decouple will not be quick or cheap. The United States has identified more than 50 critical minerals, and each of those requires its own unique processing technique.[6] China has spent decades establishing its control of these processes, and much of the world was happy to let it do so given the cost of establishing those industries, China's ability to keep prices low, and the associated environmental costs. Reorienting supply chains by pursuing a broad friendshoring strategy, as advocated by University of California San Diego distinguished professor David G. Victor, for example, certainly has a role to play.[7] But the United States is now on a different trajectory of broad industrial policy. Initiated by the first Trump administration with bipartisan support, the Biden administration took industrial policy to new heights with the Inflation Reduction Act and the CHIPS and Science Act. The book *Critical Minerals and the Future U.S. Economy*, from the Center for Strategic and International Studies (CSIS), offers a comprehensive overview of those two pieces of legislation.[8] The second Trump administration has taken a more direct approach, unveiling direct government investment into companies it deems critical to the country's economy and national security. The cost of this approach will be enormous, likely unsustainable, and may put the country further behind in the CMREE competition if a strategy is not paired with investment in new technologies that aim to leapfrog technological gains being made by China rather than just playing catch up.

The Trump administration's approach of direct government intervention has spurred little pushback, suggesting not only that it will continue but that is likely to expand. This is not to say it will be an unqualified success. It will be costly, suffer from the wandering attention of politicians, and may ultimately prove unworkable. However, this approach also needs to be taken seriously because it is the one being implemented. In that vein, this report hopes to offer options on how to best shape such an approach to limit expenses and move the US efforts ahead while preserving the opportunity for the United States to rejoin more cooperative efforts in the future.

With that in mind, this report is organized by identifying steps the United States can undertake to begin to construct a foundation on which a secured, diversified supply chain can be built domestically. The first step is to identify

priorities in the midstream to ensure the enormous outlays aimed for building refineries to create a secure CMREE supply chain is targeted. This begins with a strict differentiation between minerals that are required for domestic industry and have potential single points of failure and those that are more plentiful and less likely to see their supply restricted. The second step is to establish floor prices to both ensure a market exists for those midstream products and to create certainty around the industry in an effort to attract private investment. Third is to lead an international research and development effort that will help push the United States and its allies and partners to the technologic fore, rather than always chasing China's progress. Finally, labor-force shortages need to be addressed by recruiting foreign-born talent and funding an overhaul of the programs in the United States to ensure students see mining and geological engineering as viable career paths using cutting-edge technologies to address the pressing challenge of climate change.

Section I: Narrowing the Scope of Critical Minerals

From the outset of his second term, US President Donald Trump aimed to bring mineral production back to the United States, with a heavy focus on securing access to raw minerals. He has done this through a combination of spurring domestic production via executive order, making deals with foreign countries to access their mineral reserves, and outright intimidation via proposal to annex Greenland—a country rich in CMREE.

Domestically, the executive order of March 20, 2025, aimed to "create jobs, fuel prosperity, and significantly reduce our reliance on foreign nations" when it comes to CMREE.[9] To do this, it shortened permitting processes, opened federal lands to mining, and gave companies access to expanded financial tools with the aim of securing supply. Internationally, the Trump administration signed the United States-Ukraine Reconstruction Fund, Article VIII of which grants the United States market-based offtake rights to Ukrainian minerals.[10]

The United States is not alone. Exploration for deposits of CMREE reached a new high in 2024, according to the International Energy Agency.[11] From the Middle East to Asia to South America, countries around the world are on the

hunt for critical minerals and rare earth elements. But there is a significant difference in approaches between the United States and all other countries. Abishek Sharma, a research fellow at the Observer Research Foundation, finds that while most countries seek to derisk their supply chains to work around choke points and defuse the possibility of their use as economic coercion, the United States seems intent on decoupling its supply chain.[12] The US approach to decouple CMREE production will likely prove unattainable and will worsen its position vis-à-vis China.

The goal for the United States and any interested partners should not be to establish a wholly separate supply chain from mining to end-use manufactured goods. Despite the Western-led push for sustainable, green supply chains, much of the world is not interested in paying higher prices for a range of goods related to the energy transition and subsidizing both the morality and bottom line of foreign companies in the process. Many of these countries are battling heavy pollution, and higher prices will only slow the transition to green energy alternatives. Nor should the goal be complete and total self-sufficiency at home. Not only is that goal likely unrealistic, but it also hurts consumers by driving up prices on a range of products.

Instead, the goals for domestic production should be to meet national security needs and the projected growth of those demands, along with establishing a stockpile of designated CMREE. But in a world where seemingly everything is national security,[13] this process begins with creating a methodology to determine what the baseline requirements are for each country in terms of CMREE consumption and production.

> The goal for the United States and any interested partners should not be to establish a wholly separate supply chain.

As part of the effort to determine the current and future demand for potential CMREEs important for national security, a methodology should be applied that focuses on import reliance, stockpiles, demand projections, and potential supply choke points. Critically, this methodology should also consider the

likelihood that China will use those specific CMREE in economically coercive efforts. The National Bureau of Asian Research offers one methodology that could serve as a starting point.[14]

Narrowing the list of CMREEs is important for the simple reason that not every critical mineral is indeed critical. Reuters columnist Clyde Russel draws a distinction between critical and core minerals.[15] A critical mineral is one that is not readily available domestically and the supply of which could reasonably be expected to become restricted in the future. A core mineral is one that remains important to industry but the supply of which is relatively abundant and is expected to remain easily sourced.

A prime example of the difference is lithium.

Lithium is likely the single-best known of all critical minerals given its ubiquity in everyday life, powering everything from electric vehicles to mobile phones to household tools. It is listed as a critical mineral by the US Geologic Survey (USGS), the Department of Energy (DOE), and the Defense Logistics Agency (DLA)[16]—the three entities tasked by Congress with producing lists of critical minerals. But according to the USGS's own methodology, the supply of lithium is not highly likely to be disrupted nor is the US economy highly vulnerable to supply choke points.[17] The National Bureau of Asian Research concurs.[18] In fact, of all the minerals presented in its research, only lithium receives a score of 0.0 on the possibility of the mineral becoming subject to a choke point. Moreover, even as demand continues to increase for lithium, so do reserves. World reserves increased from 28 million tons in 2024 to 30 million tons in 2025, according to the USGS 2025 Mineral Commodities Survey.[19] At the same time, increased exploration has led to increased indicated resources from 105 million tons to 115 million tons in that same period.

Lithium is thus one candidate for removal from critical mineral lists. There are others, of course. Cadmium is determined by the USGS to be one of the least likely to face disruption and is also small in terms of economic importance. It is not listed as a critical mineral by the USGS or the DOE, but it is listed as such by the DLA. This helps to illustrate a broader point: The United States not only needs to refine its methodology to narrow the list of critical minerals but should produce two lists instead of three. The first should combine the USGS and DOE lists, applying a more stringent methodology to reduce the list where

possible. The second should be produced by the DLA to account for the inevitability that there will be minerals that are important for national security but have little importance to the broader economy. This approach would closely follow the Australian model,[20] although the rationale behind strategic-material designation would differ significantly between the two countries given the differences in their defense industrial bases.

Rightsizing these lists is important when, as the USGS notes, the lists guide "federal strategy, investment, and permitting decisions."[21] This is especially true given the scale of investment needed and the scarce resources available with which to address the challenge. But rather than streamlining the list of critical minerals, the USGS critical minerals list expanded in 2025, and now includes 54 elements.[22] The new methodology builds upon the old, and the cutoff for determining criticality is if a cutoff of the mineral in question "would result in a GDP loss of at least $2 million."[23] As Peterson Institute senior fellow Cullen Hendrix notes, that is "7 millionths of 1 percent of annual GDP."[24]

With the US government needing to broadly support the CMREE industry from the outset, narrowing the list as much as possible will help focus attention on the true shape of critical minerals, potential stockpile targets, and deeper vulnerabilities that allies and partners could help to mitigate. Moreover, given that this list helps determine what industries are eligible for subsidies, the lobbying efforts arguing for its continual expansion will be intense.

Section II: Prioritize Processing, Not Mining

While increasing the supply of unrefined CMREE via mining operations will remain an important goal for the United States and other countries, this should be a second-order priority for the Trump administration. Increased demand signals from the global market have led to increased exploration for and production of many of those materials from global producers. The International Energy Agency's 2025 *Global Critical Minerals Outlook* notes that projected supply for nickel, cobalt, and REE is catching up with projected demand, suggesting that the market is already correcting in these sectors.[25] For copper and lithium, future supply remains a concern as demand grows.

But the report also makes the important observation that even as supply has increased along with demand, the concentration of processing and refining taking place in China of "key energy minerals rose from around 82% in 2020 to 86% in 2024."[26] Moreover, it is not a trend that seems likely to reverse in the near term. China continues to build rare-earth separation plants—roughly 50 over the past decade according to the CEO of MP Materials.[27] Meanwhile, the rest of the world has only three plants capable of creating rare-earth oxides at scale: one in California, one in Estonia, and one in Malaysia. (The processing facility in Kalgoorlie, Western Australia, produces mixed rare-earth carbonate that then requires further processing at locations closer to end users.[28])

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Reducing China's control of the processing of CMREE will require additional processing capabilities to be built outside China, and that will mean commitments across a number of sectors that often conflict. Building these processing plants requires large capital outlays—on the order of $500 million per plant—amid market conditions in which China is able to set prices based on its output quotas. These conditions have made the industry unattractive to private investment, necessitating broad-spectrum, long-term government support in the forms of subsidies, tax incentives, and concessional loans. The refineries themselves will likely energize strong local opposition, especially because of the expected environmental impact. The process is water-intensive, further depleting resources in places like Texas, where Lynas is building its REE refinery. The cracking and leaching process used in refining REE creates radioactive waste. While that waste may be the result of naturally occurring radioactivity already present in the feedstock, it will galvanize strong public opposition. Finally, recruiting qualified labor will remain a challenge given the relative lack of experience in processing and refining CMREE in most countries.

Work done by the Wilson Center's Supply Chain Initiative presents the challenge in breaking the concentration of processing most starkly for several key CMREE.[29]

Cobalt—used in cathodes for lithium-ion batteries—is primarily mined in the Democratic Republic of the Congo (DRC), which produces roughly 60 percent of the world's unrefined cobalt. But the DRC does not refine any of the metal mined there. Instead, the vast majority of that is sent to China, where roughly 75 percent of the world's cobalt is refined. Ontario, Canada, is home to the only cobalt refinery in the Americas, and that was only made possible by support from the Canadian government and a $20 million grant from the US Department of Defense (DOD).[30] A price collapse in 2022 and 2023 sent private investment fleeing, meaning the choice was between government support to complete the project or having no project at all. Even when completed, expected output is estimated to satisfy just 4 percent of global demand, a percentage that will decrease as demand for cobalt increases. For a truly diversified cobalt supply chain, millions more in government support will be required.

Rare earth elements—best known for their use in advanced magnets—offer another example. The only rare-earth processing facility outside of Asia and Oceania is in Estonia, where 368 metric tons of REE were refined in 2024. With a global total of 66,100 metric tons refined globally, that means Estonia was responsible for 0.6 percent of global output. China is responsible for refining 90 to 95 percent. The effort to diversify this supply chain is underway but faces obvious challenges. The Australian-headquartered Lynas Rare Earths is in the process of constructing the first US-located rare earth refinery, with an expected output that would meet roughly one-third of the REE needs of the US defense industry. The Defense Department is footing a large portion of the original $400 million bill via a $288 million award.[31] That number is likely to rise. Unanticipated challenges in treating wastewater have led to delays and cost increases. The new estimate is roughly $575 million, a more than 40 percent hike. Lynas is, of course, petitioning DOD for more support. These numbers should help add perspective to the recent announcement from the Department of Energy that it is making available $1 billion in funding to advance the development of US critical minerals and materials: It will not be nearly enough.[32]

Despite the delays and inevitable cost increases, this model of diversification—with the United States offering extensive support or directly financing foreign partners to build refineries in the United States—is one that may also fit the "America First" political agenda. It could be extended to cover CMREE where production is most concentrated and most likely to suffer from choke points and coercion.

Nickel production is one potential target. Nickel is a key component for the defense industry and is listed as a critical mineral on all three US government agency lists. Its reserves are highly concentrated in Indonesia, and 45 percent of the world's processing takes place there as well—with no refineries in the United States and only relatively minor refining operations in Australia.[33] The United States could follow the Lynas model, funding an Indonesian venture to build a nickel refinery in the United States to take advantage of its expertise in the sector. However, such a facility would not use feedstock from Indonesia. The country has banned the export of nickel ore as it attempts to move downstream to capture greater portions of the supply chain.[34] To fill that vacuum, feedstock would be sourced from Australia and South Africa (and the DRC if substantial nickel deposits are discovered there).

Efforts like these should be coordinated—and may overlap—with those of the Minerals Security Partnership Finance Network (MSPFN). It has brought the financial weight of development finance institutions from around the world as well as the relevant export credit agencies to offer funding to new projects aimed at securing diversified supply chains. As of September 2024, there were more than 30 active MSPFN projects, including 19 focused on upstream activities, 15 involved with processing, and 3 covering recycling.[35] This is considerable progress for a country grouping formed only three years ago. But this rapid growth is due, at least in part, to funding projects that predated the forming of the MSPFN but were unable to raise private capital.

Take, for example, the cobalt refinery being built in Canada by Electra Battery, now listed as an MSPFN project thanks to a $20 million grant from the US Department of Defense. Construction on the project began in early 2022—predating the formation of the MSNFP[36]—and then had to be stopped in late 2023 because of a lack of funding. Even with the $20 million MSPFN funding, it is unclear if the project can be completed.[37] In a March 2025 interview, the Electra CEO noted completion of the project would require an additional $80

million of yet-to-be-secured funds. It's likely the MSPFN funds are intended to help crowd in private funding.

But doing business in CMREE is notoriously volatile, and it seems likely more government funding will be necessary to bring the project online.

A potentially more successful example is the Dubbo project in New South Wales, Australia. A proposed vertically integrated mining and processing plant that will deal with a range of critical minerals and rare earths, it is the most prominent project being supported by the MSPFN via $600 million in debt financing from the Export-Import Bank of the United States.[38] It also has support from the Export Development Bank of Canada ($260 million) and Export Finance Australia ($130 million).[39] Even with that support, Australia Strategic Materials—the owner of the project—will need to raise roughly $200 million in private funding based on the 2021 estimate of a total cost of $1.1 billion.[40] That number is likely to rise when project costs are reassessed ahead of the final investment decision.

As these projects advance with taxpayer money ultimately underwriting their development even as profits remain private, there will come a time when they face significant public pushback. In the United States, the broader public is in favor of industrial policy, with a plurality (41%) saying the United States should reduce international trade and seek greater self-sufficiency in all areas, according to polling conducted by the Chicago Council on Global Affairs.[41] But as mines and refineries related to CMREE begin to take shape, they will likely face some degree of local opposition. While those new industries may bring jobs to the local area, they will also add new stressors to public infrastructure. Water resources, roads, bridges, electric grids, rail lines, and ports will all see additional heavy-load traffic, threatening to further degrade those public goods. As a part of each project that is financed, a specific percentage of each investment should be set aside to upgrade local services. While many upgrades to US infrastructure are taking place under the Biden-signed Infrastructure Investment and Jobs Act, these would serve to tie infrastructure improvements directly to subsidized investments and aim to increase their palatability among local communities in the medium to long term.

The processing and refining of CMREE is perhaps the most difficult and costly part of a complex supply chain that sustains advanced technologies and fuels

a transition to greener energy around the world. Building those capabilities across the United States and partner countries will take time and money, and will feature setbacks. It is also going to require government focus to continue its support even as costs pile up. Some of this is already being done, as an overlapping set of refineries begins to take shape around the world. But the United States and the rest of the world are playing catch up. As demand for CMREE grows, it will likely outpace the refining capacity coming online, increasing China's output as a percentage of total output. That will continue to discourage private investment, making long-term government funding a requirement.

Section III: Supporting Prices and Manufacturers

Lack of private investment is one of the biggest roadblocks to establishing fully secure supply chains for CMREE in the United States and other advanced economies. The sector itself is relatively small in terms of the larger economy, yet large capital investments are required to commence operations. That might be an attractive investment if prices of CMREE on the open market were set via traditional supply and demand. However, China's dominance in processing allows it to control prices via output quotas, and in recent years it has flooded the market in a range of CMREE, driving prices down to near all-time lows. While cost considerations for its domestic manufacturers may be one factor, part of the calculus is also likely aimed at discouraging private investment in other countries. This has led to an environment where private investors and mining companies do not see potential profits in the sector and are either delaying or canceling planned investments in it.

The best example of the effect of collapsing prices is the story of the now-shuttered cobalt mine in the Silver Mountains in Idaho.[42] When the mine was planned in 2022, cobalt was priced at $40 per pound. A year later, prices had fallen to $25 per pound, and just one week before it was slated to open, the entire operation was shuttered despite $150 million in investment from the company. In early 2025, Jervois—the company behind the mine—filed for bankruptcy.[43] Moreover, prices of cobalt have not recovered. As of mid-July

2025, the price of cobalt was roughly $15 per pound, prompting the DRC to extend its cobalt export ban in an effort to raise prices.[44]

With the vulnerability of the CMREE market, private investment in the sector is hard to justify. To fill the gap, governments have stepped in. The first type of intervention is via concessional loans like those offered by the financial institutions that are part of the MSPFN. More recently, however, the US government shifted the CMREE investment landscape by picking a winner.

On July 10, 2025, the Department of Defense took a $400 million stake in MP Materials—owners of the only active REE mine in the United States—becoming the company's largest stakeholder.[45] The details of the agreement have several components, offering a glimpse of how the Trump administration intends to reset the field on investment in CMREE.

Over the past several years, MP Materials has ridden the REE prices rollercoaster, as evidenced by its 2024 10-K filing with the Securities and Exchange Commission (SEC).[46] In 2022, it reported a net income of $289 million, which turned into a $65 million loss by 2024.[47] Its 2022 10-K makes clear that its profits that year were "driven by a higher realized price" per metric ton for rare earth oxides (REO).[48] As those prices decreased, so did MP Materials' profits. Its 10-Q filing with the SEC for the first quarter of 2025 reported a loss of nearly $23 million and noted "profitability of the Company's operations are significantly affected by the market price of rare earth products."[49] It is, of course, unclear how long MP Materials could have absorbed losses due to low prices for REO. But the agreement with the DOD effectively ends those concerns.

Not only did the DOD take a 15 percent stake in the company itself, the agreement also secures future operations via generous offtake agreements in which the DOD guarantees a floor price of $110 per kilogram (about $50 per pound) for its neodymium-praseodymium. To put that in perspective, in July 2025 the market price for neodymium-praseodymium was just over $30 per pound.[50] The agreement also helped secure $1 billion in loans to construct a new rare earth magnets facility in Texas. On top of that, the DOD will guarantee that all magnets produced at this facility, dubbed 10X, will be purchased by either "defense or commercial customers."

This type of transformative investment not only makes MP Materials a national champion—and brings criticism along with it[51]—but is meant to catalyze private investment in the industry. There has already been one notable success on this front. Just 10 days after the announcement of the agreement with DOD, MP Materials struck a $500 million partnership with Apple to supply rare earth magnets made wholly from recycled materials and tailored to Apple's specifications.[52]

The government stake in MP Materials is not risk or criticism free. First, what becomes of a potential competitor like Wyoming Rare Inc.—a wholly owned subsidiary of the Sydney-based American Rare Earths—remains to be seen. The company owns the Halleck Creek Project in Wyoming, a deposit estimated to produce 7.5 million tons of rare earth oxides[53]—five times larger than the estimated reserves at the Mountain Pass mine operated by MP Materials.[54] Halleck Creek may eventually benefit from the government's largesse, or MP Materials may use its government-backed position and guaranteed offtake agreements to consolidate its market, undercutting companies like Wyoming Rare Inc. in the process.

Moreover, cost overruns for MP Materials in building its 10X magnet production are a near certainty. Those added costs may eventually dwarf the initial $400 million investment, and private companies will not step in to fill the gap knowing the government will be compelled to increase its funding or put the project in jeopardy. These cost overruns may eventually subject the entire project to shifting political winds.

Regardless of these substantial risks, this is unlikely to be the last of this type of investment by the US government. China controls roughly 90 percent of REE used to make permanent magnets.[55] The investment in MP Materials will lessen that control but will not break it. In 2023, US domestic consumption of rare earth magnets required roughly 10,000 tons of REE.[56] When it reaches full scale, MP Materials' magnet production will roughly match that. However, this excludes the 30,000 tons that are embedded in products imported into the United States, putting real demand at roughly 40,000 tons.[57] Moreover, demand is expected to grow at roughly 17 percent per year in the future. Without further investment into the REE ecosystem to increase production, US

reliance on China will diminish in the short term but may eventually start to return to previous levels as US domestic supply is unable to match demand growth.

The DOD investment in MP Materials lays out the Trump administration's model for building secure, diverse supply chains across the CMREE space. Previous administrations would have taken a more deliberative approach, focusing on multilateral efforts, combining finance, technological expertise, and close coordination to focus on derisking rather than decoupling from China. The Trump administration, however, is one that prefers brute force. Given the current state of CMREE supply chains as they exist in the United States, this aggressive approach—which primarily means throwing money at the problem—is certainly the fastest way to begin making strides. It also opens the door for more direct, transactional cooperation with allies and partners moving forward.

Gallium, a key component in manufacturing advanced semiconductors, offers a further example of how this model can be extended. China controls 98 percent of its production, according to a report from CSIS.[58] But gallium is not found in nature in abundance. Instead, it is a byproduct of the Bayer process used in refining bauxite ore to produce aluminum. According to the US Environmental Protection Agency, roughly 80 plants around the world use the Bayer process, two of which are in Louisiana.[59] But as the USGS Mineral Commodity Survey makes clear, these are unlikely candidates to produce gallium, noting that no gallium has been recovered in the United States since 1987.[60]

While China dominates this type of refining, there are small operations in Australia, South Korea, and Canada producing Bayer liquor from which gallium can be extracted. Under a more traditional US administration, offtake and other agreements to coordinate and secure supply would likely be sufficient to satisfy a base level of US demand. The Trump administration could yet take this approach. Rio Tinto, in partnership with the US company Indium Corporation, began trial gallium extractions in the first half of 2025 at its operations in Canada; if the plant reaches its full scale, it would produce 40 tons per year. This would amount to nearly 7 percent of the more than 600 tons per year of global gallium production, assuming a flat demand line, roughly 94 percent of which takes place in China.[61]

To secure this supply, one option would be for the DOD to use its authority under the Defense Production Act to underwrite the Rio Tinto-Indium operations in Canada to help it reach capacity production as quickly as possible. However, given the America First policies of the Trump administration, such an approach will likely be unsatisfactory. Instead, a more politically palatable approach will be for the United States to elicit proposals from Rio Tinto and Indium to build a processing plant in the United States. If viable, such a proposal would receive many of the same benefits offered to MP Materials. This would include significant funding from the DOD, generous offtake agreements, and access to financing from either US financial institutions or the MSPFN. Of course, these processing plants would require bauxite feedstock, of which the United States does not hold large deposits. However, Jamaica and Brazil do hold significant bauxite reserves. As part of building out a secure gallium supply chain, the United States should reach offtake agreements with both countries to secure a supply of feedstock to fuel its new domestic processing capabilities. Once these refineries come online, the gallium they produce would then feed the growing US semiconductor-fabrication industry.

Thus far, the US approach has focused heavily on the supply side with relatively less attention on the demand side. To more fully build out the supply chain, demand-side incentives will also require government intervention. Take, for example, Chicago-based Shure, which uses neodymium magnets in a range of its high-end microphones and headphones and operates production lines in China and Mexico. While it does not disclose the country of origin of its neodymium magnets, it is safe to assume they are sourced from China, considering that it produces roughly 90 percent of world supply.[62] For its Mexico lines, Shure should be incentivized via subsidies, tax incentives, or other measures to switch suppliers to rare earth magnets produced in the United States or another MSP partner country. This would allow Shure to find a supplier that qualifies it to receive government support, balancing the need to keep costs down with diversifying demand across the supply chain.

While Shure offers one example, this dual-hosting of production lines is a common approach for companies doing business in both regions and could be applied much more broadly to ensure market demand for MSP- and US-produced rare earth magnets. With demand underwritten by the government

subsidization, more certainty will be created around prices, and private investment will flow into the sector.

This type of direct government intervention is full of potential pitfalls related to market making, sheer cost, and the vagaries of long timelines. But the CMREE sector is not operating on a typical supply-demand axis. China has cornered the market, giving it the power to drive down prices in order to squeeze competitors out or to discourage their entry in the first place. That approach has been successful thus far. A more direct government hand among countries seeking to lessen China's control will be the cost of entry into building a secure supply chain.

Section IV: Support for Material Sciences

As the United States and its allies and partners take measures to ensure a secure supply chain of critical minerals, they are also chasing a moving target. The technologies and chemistries that demand CMREE today will not be those of tomorrow. As the United States tries to stand up its own supply chain, China is already forging ahead. BYD—China's leading EV car maker—recently debuted a lithium iron phosphate battery capable of reaching 80 percent charge from near zero in 15 minutes. CATL—which owns a nearly 40 percent market share of the world's EV batteries—is also diversifying its production basket by pursuing technologies such as sodium-ion batteries.[63] This takes place as the Trump administration continues to undermine demand for electric vehicles and other green energy technologies.[64] If demand dries up, research and development will soon follow, and without a course correction, the United States is increasingly likely to lose the race for key technologies that will power the future.

To counteract this trend, the United States should spearhead the formation of an international research consortium that brings together leading companies from both the supply and demand sides of key industries that require CMREE inputs. Bringing together companies such as MP Materials, South Korea's LG Energy Solutions—one of the world's largest EV battery makers—and end-use

consumers from across the defense and automotive industries, the goal would be to have all elements of the supply chain working together on the research and development of next generation technologies to compete on the global market but also developing new materials that reduce the need for CMREE inputs across the economy.

There is precedent for such a consortium: SEMATECH.[65]

SEMATECH was founded in 1987 as a private-public partnership with roughly $100 million in funding from 14 semiconductor companies that was then matched by the Department of Defense via DARPA. Its goal was to catch up and overturn Japan's lead in producing semiconductors in the 1980s and 1990s by bringing together the members at all stages of the supply chain—from research to manufacturing to end users. The goal at that time was to cut into the lead Japan held in producing semiconductors. The experiment was a success.[66]

> Without a course correction, the United States is increasingly likely to lose the race for key technologies that will power the future.

As outlined in a report by David M. Hart for the Bipartisan Policy Support Center, the US semiconductor industry of the 1980s and 1990s had several key features that made success at SEMATECH possible.[67] The CMREE sector has several key commonalities that make it an intriguing candidate for formation of a successful consortium.

First, like semiconductors, securing supply of CMREE is widely seen as critical to the national security of the United States. In 2024, the DOD outlined its "Mine to Magnet" supply chain plan, and the Trump administration has seemingly followed through on that with its $400 million investment in MP Materials.[68] In August 2025, the Trump administration opened a $1 billion funding line to further develop critical mineral supply chains. That is still likely a drop in the bucket for the financial support the field will require, but ongoing

government commitment will be key to success for the industry and for a potential consortium.

Second, the non-China CMREE sector is likely to be relatively small compared to the sector overall. China's dominance in processing is well documented, but its mining operations in foreign countries is less well covered. For example, Indonesia produced most of the world's nickel, but 40 percent of that is owned by Chinese mining companies.[69] For cobalt, the Organisation for Economic Co-operation and Development reported that 8 of the 14 largest cobalt mines in the DRC—the world's largest supplier of cobalt—were Chinese owned.[70] The US-only portion of the CMREE markets, where mining is limited and there is almost no processing, is virtually nonexistent. When SEMATECH was formed, it included just 14 firms. Despite them being rivals, the smaller size of the firms meant the corporate leadership was invested in the experiment and provided flexibility to the organization.

One priority area for such a consortium would be the development and production of permanent magnets that significantly reduce REE inputs, with the ultimate goal of producing a magnet that requires no REE at all. This is no small task. The dominant permanent magnet chemistry is NdFeB (neodymium-iron-boron), which makes up roughly 60 percent of global magnet production. It was introduced to the market in the 1980s, and no new significant magnetic material has entered the market since.

Alternatives are being pursued by private industry. Niron Magnetics in Minnesota is developing iron nitride magnets that are rare earth free, but their known properties make it unclear if they will ever be able to challenge NdFeB magnets in traction motors for EV vehicles, for example. Firms in India are attempting to develop motors that require no permanent magnets whatsoever.[71] While this may be an example of market solutions at work, it is unlikely that any of these new technologies will challenge the dominant usage of rare earth magnets without government support and some level of cross-cooperation. Such support should be partially based on bringing together firms from the same field to address the challenges they both face in the China-dominated market for CMREE.

A second key feature of such a research consortium would be to connect firms up and down the supply chain. Private firms developing new materials

also face challenges in incorporating new materials into designs that already accommodate the properties of existing technologies. This potentially slows the adoption of new technologies in favor of already established designs. Bringing developers of new technologies together with end-use firms should speed the adoption of new materials as they become available.

Even as research and development is threatened in the United States because of conflicting government priorities, it is not yet too late to reverse course. Part of that should include bringing together top experts from mining companies, processing facilities, and manufacturers, as well as leading academics from across the field. The challenge in developing new materials will be immense and is unlikely to be achieved by single companies working alone.

Section V: Workforce and Education

Success in the exploration, mining, and subsequent processing of CMREE will rely on a well-trained workforce that has the education and experience fit for the job. It is unclear if the United States will be able to meet either criterion in the future. The number of workers in mining and the number of students enrolling in mining programs are in steep decline. To reverse these dual trends, the United States will need a two-pronged strategy. The first prong should focus on bringing in trained foreign talent to help fill looming shortfalls in the labor force in the short to medium term. This is an unlikely approach in the short term given President Trump's targeting of immigrants early in his administration. But without an influx of skilled foreign labor, the CMREE sector will continue to suffer shortages. The second prong should focus on longer-term support for the domestic education system with the goal of expanding the number of mining and mineral engineering programs and broadening the recruitment of students into those programs.

Drawing on data from the Society for Mining, Metallurgy & Exploration, Tom Hale notes in a report for CSIS that roughly half of all workers in the mining industry will need to be replaced by 2029 as workers retire from the industry.[72] Moreover, US institutions are not graduating nearly enough students in

mining and mineral engineering programs to make up for the shortfall. As Hale notes, US institutions graduated just 327 students in mining and mineral engineering in 2020. In 2023, that fell to 300, according to Data USA, down from 517 in 2015.[73] At the same time, programs offering degrees in mining or mineral engineering are also disappearing. For example, there are now only 14 programs, down from 25 in 1982.[74]

Two factors appear to be driving these declines. First, the outlook for mining and geological engineers is not optimistic. According to the Bureau of Labor Statistics, projected employment in 2034 is expected to be the same as it was in 2024. To put that in perspective, engineering overall is expected to grow 7 percent in that same period, and all occupations are expected to grow at 3 percent.[75] Second, mining has an image problem. It conjures work that is dark, dirty, and dangerous, and the industry is broadly seen as environmentally deleterious, shedding toxic waste, and destroying communities in the process.[76] A survey conducted globally by McKinsey in February 2023 found that 70 percent of those 15 to 30 would not consider working in the mining industry.[77] While the industry has much to do to correct its image, the increasingly complex engineering, technology, and chemistry involved in identifying, accessing, and processing minerals remains underappreciated.

In the short term, the United States will struggle to meet labor demands in the mining sector. The most direct path to overcoming this is to begin to recruit foreign-born labor with expertise and experience in the mining sector. Of course, this approach faces its own hurdles. The Trump administration's hostility to immigration might make this a difficult policy to advance within the government, as such a program would become an easy target for the most anti-immigrant wing of his constituency, given the image of mining as the long-standing domain of blue-collar workers.

But existing recruitment of H-2B workers—a visa designation for temporary nonagricultural jobs—suggests there is room to expand recruitment of those working in mining without creating anti-immigrant backlash. Each year, the United States grants 66,000 H-2B visas, and in some years that number is expanded.[78] For the 2024 fiscal year, an additional 64,716 H-2B visas were made available.[79] According to Department of Labor statistics for that same year, 675 visas were applied for in the Standard Occupation Category (SOC) code 47-5000, which identifies extractive industries, excluding those that

specifically designate oil and gas sectors. Of those, just 585 were certified. That means just 0.4 percent of all available 2024 H-2B visas went toward extractive industries. And that is likely a generous reading of the data. When excluding the SOC code for rock splitters hired at quarries, the total drops to just 31 certified workers, or .02 percent of all available visas.[80]

Of course, jobs that are likely more difficult to fill are those that require expertise and higher levels of education, such as mining and geological engineering. These jobs fall under the Labor Condition Application program and include H-1B visas, H-1B1 for Chile (and Singapore), and E-3 visas available only to Australians. In the 2024 fiscal year, across a number of SOC codes related to mining, the Department of Homeland Security reports there were 723 H-1B petitions approved in the mining sector, divided between 311 new certifications and 412 continuing certifications. That amounts to 0.2 percent of all H-1B visas.[81]

Given the small number of visas granted to the mining industry, there is clearly room to expand that recruitment. While that could be done within the existing frameworks, the United States should instead seek to formalize that recruitment by leveraging the Minerals Security Partnership to create a labor exchange program that would fall under a new visa type. Such visas already exist for workers from Chile, Singapore, and Australia. A new visa type for South Korean workers is being proposed by H.R. 4687 currently before Congress.[82] Such a program would grant workers from across MSP countries fast-track status to receive work visas in fields related to mining in the United States. The visa could be limited to one year, renewable for one year, but would not allow family members to join workers in the United States. In exchange, US workers would have access to similar opportunities across MSP countries. Such an exchange would seek to deepen the pool of expertise across the MSP, as well as attract talent to the United States to share knowledge with US industry.

In the medium to long term, the United States will also need to address the domestic dimensions of the labor force challenge. Some of this has already begun. The Mining Schools Act of 2025, which is still awaiting appropriation, is expected to allocate $10 million per year from 2026 to 2023 to mining school across the country.[83] This is a step in the right direction, but Congress needs to do more. As written, the act functions as a grant program with a maximum of 10 grants available each year, meaning that some mining schools will be left out. Moreover, these funds are to cover a variety of activities, including recruiting students, supporting existing programs, and developing new technologies related to CMREE. What initially may seem like a large grant is quickly diminishes once overhead and other ancillary costs are subtracted.

To expand on these programs, Congress should increase its funding for mining schools and do so along two tracks. The first tranche should operate as intended in the Mining Schools Act to drive research and development and to recruit students to take part in those specific projects that are awarded. A second tranche of an equal $10 million should be allocated to mining schools to expand their recruitment efforts and update them to help make these programs more attractive to a younger generation with different career priorities and interests. At the same time, these funds should be used to build upon existing partnerships with other mining schools and programs around the world.

The US mining industry faces significant challenges when it comes to the workforce. Some of this is simply a numbers problem. Too few workers are entering the sector to replace all the workers that will soon leave it. That challenge can be addressed in the short term by increased recruiting of foreign talent. But the industry also has an outdated image that discourages young workers from entering it. That is a trickier problem, but solving it will be essential in rightsizing the workforce as the United States seeks to establish a safe, secure CMREE supply chain at home.

Conclusion

If developing a secure, diverse supply chain for CMREE truly is a national priority for the United States, it will require a deep and ongoing government response. Ideally, that government involvement would then crowd in private investment to sustain the industry. But that private investment is not guaranteed. If it does not materialize, sustained government funding will be required to prop up the industry well into the future. Touching every corner of the sector, government support would underwrite exploration, building processing facilities and broadening the labor force.

While building a secure supply chain offers opportunities for collaboration with US partners and allies, current US policy is making collaboration less likely without significant US government funding. The demand for CMREE will only continue to grow over the coming decades. The question now is how far the United States will be left behind in the race to develop new materials and technologies that will shape the future.

Appendix

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