JULY 2025

# Developing Rare Earth Processing Hubs

## *An Analytical Approach*

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## *Introduction*

The United States led global production of **rare earth elements** (REEs) until the mid-1990s, when China emerged as the dominant supplier. China maintained near-total control of the market until 2012. This monopoly began to face limited competition with the entry of two commercial producers: U.S.-based Molycorp, which later declared bankruptcy, and Australia's Lynas Rare Earths. Today, REEs are once again in the spotlight as China has leveraged its market dominance by imposing export restrictions that limit U.S. access to these key minerals.

The restrictions pose significant risks to U.S. national, economic, and energy security. REEs are essential components in numerous **advanced defense systems**, including F-35 fighter jets, Virginia- and Columbia-class submarines, Tomahawk missiles, radar systems, Predator drones, and Joint Direct Attack Munition (JDAM) smart bombs. For instance, an F-35 contains more than 900 pounds of REEs, an Arleigh Burke-class DDG-51 destroyer requires approximately 5,200 pounds, and a Virginia-class submarine uses about 9,200 pounds. On the civilian side, REEs are essential for **cancer treatment**, MRI and PET scanners, **automotives** (both internal combustion engines and electric vehicles), and **consumer electronics** such as phones, computers, and other products that contain semiconductors. All these industries are acutely affected by REE shortages.

China has demonstrated a willingness to weaponize REEs over the last 15 years. In 2010, it banned the export of REEs to Japan over a fishing trawler dispute. More recently, in 2023, it imposed a global ban on the export of technologies for **rare earth processing and separation**, aiming to obstruct the development of midstream capabilities outside its borders. This move had particularly severe consequences for two key reasons: First, China holds unmatched technical expertise in rare earth processing, especially in solvent extraction—a critical and complex step in REE separation—whereas

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Western companies have struggled due to limited workforce capabilities, research and development, and environmental regulations. Second, while several REE separation and processing facilities are under construction in other countries, these projects require substantial time to complete and fully operationalize, leaving a prolonged gap in global capacity outside of China.

China's recent imposition of export controls on heavy rare earth elements (HREEs) has underscored the dire reality for the United States, which remains almost entirely dependent on Chinese supply. As of 2023, China accounted for **99 percent** of global HREE processing. On the other hand, China has refrained from restricting exports of light rare earth elements (LREEs), which are processed by a more geographically diverse set of countries.

Despite being the world's second-largest producer of REEs—thanks primarily to operations at Mountain Pass, California, which account for about 15 percent of global supply—the United States has long depended on China for REE separation. Until early 2024, the United States was shipping **most** of its domestically mined REEs to China for processing.

Establishing a resilient REE supply chain—which the U.S. Department of Defense (DOD) calls the "**mine-to-magnet**" supply chain—will require close collaboration with international partners. No single country currently possesses the financial resources or technical capabilities to independently outpace China's dominance.

While China **accounts** for approximately 60 percent of global REE production, it is responsible for 90 percent of processing, a dominance achieved through deliberate strategies to source REEs globally and consolidate midstream processing domestically, including overpaying for acquisitions. For example, in May 2025, **Shenghe Resources**, through its subsidiary Ganzhou Chenguang Rare Earths New Material, announced a binding agreement to acquire full ownership of the Australia-based Peak Rare Earths project in Tanzania. The deal, which was announced on May 25, was a $158 million AUD transaction, with a cash offer of approximately $0.359 AUD per Peak share—representing a nearly 200 percent premium over Peak's May 9 closing price of $0.12 AUD and a 160 percent premium over the 20-day volume-weighted average price of $0.138 AUD. The substantial premium underscores the lengths to which Chinese companies are willing to go to maintain their global dominance in the rare earths supply chain.

## *Why Hubs Are a Strategic Approach to Building Capabilities*

A mineral processing hub is a centralized location or facility where raw mineral ores are transformed into refined materials suitable for industrial use. These hubs typically manage several key stages of the value chain, transforming raw ore into high-purity metals suitable for manufacturing. Mineral processing hubs leverage economies of scale by streamlining regulatory requirements, including reducing the number of permits and environmental impact assessments necessary for operations. Additionally, they capitalize on the concentration of key resources, including energy, transportation, and water infrastructure; specialized human capital with advanced technical expertise; and greater access to financial capital. This integrated approach enhances operational efficiency and cost-effectiveness across the value chain.

Hubs can also provide prime ground for research and development (R&D), which is essential to supporting the growth of a nascent rare earth processing industry. At the height of the U.S. REE industry, substantial and consistent investment was directed toward the R&D of REE separation technologies. The Ames Laboratory was founded by the U.S. Atomic Energy Commission in 1947 following its success in solving a key problem for the Manhattan Project: how to purify uranium metal by separating REE impurities. The groundbreaking uranium work positioned the Ames Laboratory to become the **premier REE research facility**, pioneering a cost-efficient method for separating REEs in the 1950s. This research paved the way for the development of new defense technologies including radar instruments and lasers for guided weapons, as well as consumer technologies like color televisions and fiber-optic cables for long-distance telephone calls and the internet.

Throughout the 1950s and 1960s, government investment in the Ames Laboratory and other research groups and laboratories provided the **intellectual infrastructure** to support technological breakthroughs in the private sector. The Ames Laboratory established a loan program to supply high-purity rare earths for research to scientists in the public and private sectors and created the Rare-Earth Information Center to disseminate key research. However, by the end of the twentieth century, the United States deprioritized REE technology R&D as the industry shifted to China amid the economy-wide trend of transferring manufacturing capacity overseas.

Simply diversifying sources of mined rare earth ore is not enough to break China's stranglehold on these critical supply chains. Last year, the U.S.-led Minerals Security Partnership backed Brazil's Serra Verde rare earths project—the only mine outside Asia currently producing both light and heavy rare earths. Yet despite this strategic investment, the ore is already locked into **offtake agreements with China** for processing. This is because China's overwhelming dominance in midstream processing left no viable alternative. Without urgently building global processing capacity, new mining projects will continue feeding directly into China's control, perpetuating the very dependency the United States is seeking to escape.

The United States must develop a strategy to rebuild REE technical expertise and establish midstream processing hubs beyond China's control. Given the high cost and complexity of operating processing facilities profitably, consolidating operations into large-scale hubs is essential to achieving economies of scale. To be effective, these hubs should not only advance domestic innovation and industry but also leverage the resources and capabilities of U.S. allies and partners who are best positioned to lead in midstream processing.

## *What the United States Is Currently Doing*

The U.S. government recognizes the urgency of building midstream capacity outside China for REE separation, processing, refining, and manufacturing into permanent magnets for the defense industry. In 2023, the DOD announced its goal of securing a complete mine-to-magnet supply chain by 2027. Achieving this goal will require significant investments in REE processing capacity, a nascent industry in the United States.

In efforts to swiftly scale up processing capacity, the DOD deployed significant funds to rare earths projects via the Defense Production Act. Since 2020, the DOD has awarded over **$439 million** to companies like MP Materials, Lynas USA, and Noveon Magnetics for building LREE and HREE separating and processing and permanent magnet manufacturing capabilities. Most of these midstream investment dollars are headed to Texas; Lynas is building an LREE separation facility in **Hondo** and an HREE processing facility in **Seadrift**, MP Materials is constructing its first rare earth metal, alloy, and magnet manufacturing facility in **Fort Worth**, and Noveon Magnetics is opening its first REE magnet manufacturing facility in **San Marcos**. With this influx of investments, Texas is on track to become the U.S. hub for rare earth processing and magnet manufacturing.

In July 2025, MP Materials unveiled a landmark public-private partnership with the DOD aimed at accelerating the development of a vertically integrated rare earth magnet supply chain within the United States. Backed by a **multi-billion-dollar** package of federal investments and long-term procurement commitments, the initiative will enable MP Materials to scale its annual magnet manufacturing capacity from 1,000 metric tons in 2025 to 10,000 metric tons over the next decade. As part of the agreement, the DOD will acquire $400 million in preferred stock—becoming the company's largest shareholder—and extend a $150 million loan to support HREE separation expansion. Critically, the U.S. government will establish a price floor of $110 per kilogram for neodymium-praseodymium, offering direct payments to MP Materials when market prices fall below that threshold (which stood below $60 per kg as of June 2025). In addition, the Pentagon has committed to purchasing 100 percent of the permanent magnets produced at the new facility, providing a guaranteed demand signal to anchor long-term production.

Despite its strategic significance, the partnership faces two key limitations. First, the Mountain Pass facility primarily contains LREES rather than HREEs. Second, near-term production capacity remains limited: MP Materials is expected to produce only **1,000 metric tons** of neodymium-iron-boron magnets by 2025—representing less than 1 percent of the **138,000 metric tons** China produced as early as 2018. Achieving full-scale capacity will require a gradual and sustained ramp-up over time.

Complementing domestic capabilities with allied capabilities will be critical to meeting the DOD's urgent targets for secure, resilient supply chains—and meeting future demand growth. While the United States accelerates efforts to build domestic capacity, establishing rare earth processing hubs with international partners will unlock critical feedstock, fast-track scalable production, and reduce dangerous dependencies. The most effective partners will combine access to rare earth resources with world-class infrastructure, reliable and affordable energy, a strong commitment to research and innovation, low operating costs, political stability, and regulatory environments that actively encourage industrial investment. Without these global partnerships, the United States risks falling behind in the race to secure the materials vital for defense and advanced technologies.

The United States is already forging strategic international partnerships to strengthen and diversify its rare earths supply chains. In a landmark move, President Donald Trump prioritized mineral diplomacy during his **first state visit** with Saudi Arabia, laying the groundwork for a critical minerals partnership between the two nations. Building on this, U.S.-based MP Materials signed a **memorandum of understanding** with the Saudi Arabian Mining Company (Maaden) to collaborate across the entire rare earths value chain—from mining and processing to the production of permanent magnets—marking a significant step toward building a resilient mine-to-magnet supply chain outside of China's control. Construction of the mine is expected to begin in 2025—subject to a final investment decision—and production is expected to commence mid-2028. As Maaden CEO **Bob Wilt** emphasized, "Through a potential partnership with MP Materials, and our deepening ties with the United States, we aim to create a global hub for a fully integrated rare earth value chain supporting advanced manufacturing in the Kingdom." MP Materials CEO **Jim Litinsky** called the agreement a critical milestone in "deepening the strategic alliance between the United States and Saudi Arabia." Saudi Arabia is expected to begin producing heavy rare earths in 2028.

Greenland has been a prominent focus in President Trump's foreign policy, primarily because of its rare earth resources. In June 2025, the U.S. Export-Import Bank announced its intent to provide up to **$120 million** in nondilutive financing for Critical Metals Corp.'s Tanbreez rare earth project in southern Greenland. This would mark the Trump administration's first international mining investment of this term.

## *Identifying Ideal Partners for Investment in International Midstream Hubs*

Establishing and sustaining rare earth processing hubs require massive financial investment, advanced infrastructure, and specialized technical expertise—capabilities few countries possess on their own. Concentrating resources into a select number of strategically located hubs offers the greatest chance of success and long-term resilience. This paper presents a data-driven analysis, evaluating 10 quantifiable criteria across 10 countries to analytically identify the most viable locations for these critical hubs.

1. **Government Commitment to Developing REE Capabilities**

Given the financial capital, technical know-how, permitting, and infrastructure required to create a REE processing hub, government support is a crucial enabler in the form of direct financing, policy reforms to create an enabling environment, support to developing R&D capabilities, and other mechanisms. In addition to the partnership between DOD and MP Materials and the **$439 million** the DOD has awarded to companies building domestic REE processing capabilities, the Australian government has given **$1.25 billion** in financing to build a domestic rare earths refinery. Moreover, Japan has **heavily invested** in non-Chinese rare earth projects abroad and domestic technical capacity since 2010, and Saudi Arabia has committed to developing a mine-to-magnet REE supply chain with support from the Public Investment Fund, the kingdom's sovereign wealth fund. Without active government support, getting an REE processing hub off the ground can be both difficult and cost prohibitive, given the limited support from capital markets.

2. **Commercial Cooperation on REE Hubs**

Countries that establish commercial partnerships with U.S. companies to develop rare earth processing capabilities are well positioned to secure long-term strategic cooperation and offtake arrangements. Notably, the Australian firm Lynas Rare Earths is constructing an REE separation facility in Texas, backed by U.S. government support. Similarly, U.S-based MP Materials has signed a memorandum of understanding with Maaden to jointly develop REE separation infrastructure in Saudi Arabia, reinforcing bilateral commercial and strategic ties in critical minerals.

3. **Proximity to Feedstock**

When evaluating international partners for potential collaboration on REE processing, it is critical to consider the geographic alignment of processing hubs with available resources. Locating specialized hubs for both LREEs and HREEs close to their respective feedstock sources improves operational efficiency, lowers transportation expenses, and reduces supply chain vulnerabilities. Transportation costs represent one of the most significant expenditures in the mining industry. In the case of industrial minerals, for example, transportation can constitute more than **50 percent** of the total delivered cost, underscoring the critical importance of proximity to feedstock in determining the commercial viability of a processing hub. This proximity also strengthens the competitiveness of processing operations, which is vital for ensuring their long-term commercial success.

Countries such as Australia, Brazil, India, Saudi Arabia, and Vietnam possess a distinct geological advantage, supported by substantial REE reserves. At the same time, nations including Canada and Saudi Arabia are actively advancing exploration initiatives to identify and develop new deposits. Diversifying sources of supply across multiple jurisdictions is essential. For instance, the United States' Mountain Pass mine primarily yields LREEs such as praseodymium and neodymium, whereas critical HREE production, including dysprosium and terbium, remains overwhelmingly concentrated in China and **Myanmar**. However, **Brazil** represents a key alternative source for HREEs. As the United States builds its HREE processing capabilities in Texas and California, Brazil is geographically closer to the United States than it is to China. In Saudi Arabia, Jabal Sayid, located 350 kilometers northeast of Jeddah, is estimated to have significant deposits of HREEs.

Australia is emerging as a dominant rare earth producer and processor. The world's fourth-largest producer of these minerals, it is developing several domestic processing facilities, including Iluka Resources' **Eneabba Rare Earths Refinery** in Western Australia, which was backed by a $1.25 billion government loan contingent on offtake agreements with **like-minded countries**. Iluka will produce separated oxides including neodymium, praseodymium, dysprosium, and terbium. The refinery is expected to be commissioned in 2026. Arafura Rare Earths Limited's Nolans Project has received **$840 million** in federal funding and is expected to produce **4 percent** of the world's neodymium and praseodymium beginning in 2032. Moreover, Australia is set to triple its **mined rare earth oxide supply** between 2025 and 2027.

In May 2025, Australia's **Lynas** achieved a historic milestone, becoming the first company outside China to produce commercial quantities of dysprosium oxide—one of the world's most critical HREEs—at its Malaysian facility. Production volumes were not disclosed. Lynas sources its feedstock from the Mount Weld mine near Kalgoorlie, Western Australia, which holds an estimated 2 million tons of total rare earth oxides in reserves. Lynas also signed a **memorandum of understanding** with Malaysia's Kelantan state government to jointly develop the state's rare earth deposits as potential future feedstock for Lynas's processing facility. However, a substantial portion of its output continues to be sent to China for refining.

4. **Infrastructure**

A mineral processing hub requires comprehensive infrastructure, including transportation networks, water supply systems, and waste management facilities. Mineral processing operations require well-developed transportation infrastructure—specifically major railways and ports—to enable the efficient movement of materials. As stated, transportation costs are one of the most significant costs in the mining supply chain. Australia, Canada, and Japan rank highly in terms of developing the infrastructure needed for any large manufacturing project: roads, rail, bridges, ports, and airports.

Rare earth production also demands substantial water infrastructure. On average, producing one kilogram of rare earths from monazite consumes **11,170 kilograms of water**. Water usage varies by element, from 3,803 kilograms of water per kilogram of samarium or gadolinium to as high as 29,902 kilograms of water per kilogram of yttrium.

Even countries with a strong record of water management must innovate to meet the water needs of REE processing. Canada has access to nearly 20 percent of the world's fresh water but is still investing in efficient water management systems for rare earth processing. The Saskatchewan government and Saskatchewan Research Council are developing an REE processing facility that will **recycle and reuse** all water within the plant. Saudi Arabia is combating its water challenges with the construction of **desalination facilities** to meet demand. In 2023, Saudi Arabia announced a plan for 12 desalination projects and 40 water tanks valued at $1.3 billion to address water needs for industry. Since Indonesia's mineral export ban, the country has invested $1.7 billion into its water infrastructure to meet the increased water demand from processing facilities. Namibia and South Africa face greater water challenges: Namibian water resources are stretched thin amid **severe droughts**, and South Africa experiences frequent water interruptions. British mining company Anglo American attributed a **9 percent drop** in platinum production at its Rustenburg operations in 2023 to a five-day water stoppage.

Infrastructure is also essential for handling waste gases, wastewater, and radioactive by-products generated during production. For **each ton of rare earths** produced, the process generates approximately 13 kilograms of dust, between 9,600 and 12,000 cubic meters of waste gas, 75 cubic meters of wastewater, and one ton of radioactive residue.

5. **Energy**

Mining is among the most energy-intensive industries worldwide. It **accounts** for approximately 38 percent of global industrial energy use and around 15 percent of total electricity consumption globally. The **complexity** of separating and processing rare earths makes it especially **energy intensive**. Separating a single ton of rare earths can require **9–13 times** initial extraction.

Creating a rare earth processing hub will require significant energy investments. While Australia has substantial energy capacity, its high energy prices remain a barrier to low-cost processing. In contrast, Saudi Arabia is rapidly positioning itself as a global leader in energy affordability and availability, underpinned by record-breaking investments in renewables. Its **Al Ghat wind project** holds the world record for the lowest electricity cost from wind power at just 1.56558 cents per kilowatt-hour (kWh), while the Wa'ad al Shamal project follows closely at 1.70187 cents per kWh. Saudi Arabia also holds the world's lowest levelized cost of energy (LCOE) for solar photovoltaics, making it unparalleled in affordable renewable power. These strategic investments have positioned the kingdom to emerge as a major player in mineral processing, with ambitions to rank among the world's top seven mineral processors by 2030.

6. **Ease of Doing Business**

Processing and manufacturing facilities are subject to a number of permits, taxes, and regulations that can increase the complexity and overall cost of operating. Countries with opaque laws, burdensome red tape, and export restrictions make long-term investments in large-scale mineral refining more challenging.

In the United States, the development of a commercially viable rare earth processing hub faces two regulatory challenges. First, permitting delays continue to hamper project execution. For example, Lynas Rare Earths has halted construction of its planned HREE processing facility in Seadrift due to delays in securing a key **wastewater disposal permit**. Without this authorization, site development cannot proceed, placing the project's target of becoming operational by 2026 in jeopardy and risking further delays to production. Second, recent revisions to the Inflation Reduction Act's Section 45X

Advanced Manufacturing Production Credit create uncertainty for long-term investment. In 2024, MP Materials received **$12.2 million** in benefits through this credit. However, the recently passed federal budget includes a **phaseout** of the 45X credit by 2033—a timeline that does not align with the multi-year development horizons typical of rare earth processing facilities. This limited incentive window weakens the commercial case for expanding domestic rare earth capacity.

On the other hand, Japan, Canada, Saudi Arabia, and Australia score highly for having regulatory systems that encourage business investments. Australia has taken significant strides to create an enabling tax environment: In early 2025, Australia's parliament passed a law to give **production tax credits** worth 10 percent of processing and refining costs for 31 critical minerals, including REEs, with the intent of attracting more minerals processing to Australia.

Saudi Arabia has also implemented a new regulatory regime for the mining sector to foster the industry. In 2021, it implemented a new Mining Investment Law, a comprehensive set of reforms designed to support the country's critical minerals ambitions laid out in its **Vision 2030** and, specifically, to attract foreign private investment. The legislation includes a streamlined licensing process whereby exploration licenses are issued for up to 15 years and mining licenses for 60 years. Under the law, Saudi Arabia has seen a **138 percent** increase in exploration licenses since 2021. The Mining Investment Law is further supported by new incentive programs. For example, the Global Supply Chain Resiliency Initiative offers $2.7 billion in incentives to strengthen critical domestic mineral supply chains. The initiative has already led to over $9 billion in investment deals, including a partnership with Australia's Hastings Technology Metals to establish a fully integrated rare earth downstream processing supply chain in Saudi Arabia.

In contrast, Brazil's **minerals licensing processes** are a major impediment to the development of its minerals sector. The regulatory landscape is complex, as companies are required to navigate federal, state, and local regulations that are sometimes inconsistent. Due to burdensome red tape, obtaining a mining license in Brazil takes an average of 16 years. The CEO of the Brazilian Mining Association has noted that other countries take half to one-third the time Brazil does to approve licenses and believes that minerals investments in Brazil could be even greater if the processes were streamlined. In January 2025, Brazil announced **$815 million** in financing for projects aimed at boosting development of critical minerals and rare earths in the country, but rare earth company Meteoric Resources is still **struggling to finance** its Caldeira project in Brazil. Unless bureaucratic challenges are addressed, these financing incentives will not catalyze the amount of private investment needed.

7. **Exploration Investment**

Rare earth deposits are being actively mapped and discovered worldwide, fueled by growing investment from mining companies focused on geologically promising regions. Exploration spending plays a vital role—not only in identifying commercially viable deposits, but also in sending important signals to midstream processors about which jurisdictions are advancing as future sources of reliable feedstock.

Australia currently leads the world in **REE exploration**, accounting for 42.9 percent of global exploration spending aimed at identifying new mining opportunities. This sustained investment has played a key role in recent discoveries of dysprosium, a heavy rare earth vital to reducing global dependence on China's supply chains. Outside Australia, countries like Brazil, South Africa, and Saudi Arabia are also seeing increased interest in REE exploration. Across Africa, rare earth exploration is gaining momentum, with South Africa, Malawi, Uganda, and Namibia ranking among the top 10 destinations for exploration investment in 2024. This trend signals a strategic shift as these nations actively prepare for future production and seek to strengthen their role in global critical mineral supply chains.

### Table 1. Rare Earth Exploration by Country, 2024

| Country/region | Exploration budget (in USD, millions) | Global budget share |
|---|---|---|
| Australia | $64.2 | 42.9% |
| Brazil | $13.3 | 8.9% |
| South Africa | $12.5 | 8.3% |
| United States | $10.6 | 7.1% |
| Canada | $10.1 | 6.7% |
| Malawi | $8.7 | 5.8% |
| Uganda | $7.7 | 5.1% |
| China | $6.6 | 4.4% |
| Saudi Arabia | $5.2 | 3.5% |
| Namibia | $4.6 | 3.1% |
| Chile | $1.7 | 1.1% |
| Sweden | $1.3 | 0.9% |
| Finland | $0.7 | 0.5% |
| Tanzania | $0.7 | 0.5% |
| Angola | $0.5 | 0.3% |

Source: S&P Global, S&P Capital IQ database.

8. **Operation Costs**

Labor, water, energy, processing materials, and technology costs make rare earth processing a high-cost endeavor with slim profit margins. This price environment creates additional challenges for REE processors struggling amid such tight margins, and low operation costs are a significant determinant of whether a hub can be competitive. Chinese rare earth processing operations remain the most cost-efficient in the world due to lower labor costs, fewer environmental and regulatory hurdles, and the achievement of large-scale operations that absorb large volumes of feedstock and sustain profitability. While little data exists on the exact costs of rare earth processing due to limited facilities outside of China, operating costs for other commodities offer a benchmark to estimate comparative costs for REE operations, given they require similar inputs.

The world's lowest-cost rare earth producers can make a kilogram of rare earth oxide for **$11 or less**. These are mostly hard rock mines, which tend to have higher concentrations of LREEs. Many of these mines are already in operation, including China's Baiyun Ebo and the Sichuan hard rock projects, which are among the largest global suppliers. The U.S.-based Mountain Pass mine and Australia's Mount Weld also operate at competitive costs, though they produce smaller volumes. A cost-competitive mineral processing hub depends on more than just securing competitively priced raw material feedstock; it also requires reliable access to low-cost energy, efficient transportation infrastructure, advanced processing technologies, and affordable, skilled labor.

9. **Research and Development**

Prioritizing R&D is essential for advancing innovative technologies that improve the efficiency of rare earth separation and refining processes. Continued investment in R&D enables the development of new methods that consume less water and energy, reduce environmental impacts, and maximize the recovery of high-quality materials from lower volumes of raw feedstock. As global demand for rare earths intensifies—particularly for use in advanced technologies such as electric vehicles, renewable energy systems, and defense applications—enhancing processing efficiency and reducing associated costs will be critical to ensuring long-term supply security.

Countries that make significant R&D investments are better positioned to lead in the development of next-generation rare earth processing technologies. These nations are more likely to allocate resources to specialized REE initiatives, including advanced material science research, the deployment of cutting-edge separation technologies, and the exploration of alternative, environmentally sustainable refining techniques. Japan and Australia lead the way in total **R&D investment** as a percentage of GDP.

A few countries lead the way in developing critical minerals and REE-specific R&D initiatives to support the development of the strategic sector. The **Australian Critical Minerals R&D Hub** is working to boost international cooperation on critical minerals R&D. The hub includes rare earth and downstream **processing initiatives** led by government agencies working in partnership with industry and universities to boost **technical capacity**. Japan has the **Center for Rare Earths Research** within its Muroran Institute of Technology, as well as a **joint initiative** with Vietnam to improve REE extraction and processing at the Rare Earth Research and Technology Transfer Centre in Hanoi. The initiative was launched in 2012 as Japan looked to strengthen and diversify its REE supply chains in response to a 2010 Chinese REE export ban. In July 2025, Japan announced that it would begin "**test mining**" for REEs extracted through deep-sea mining near Minamitori Island, 1,900 kilometers off the coast of Tokyo, as early as January 2026. These initiatives are critical to unlocking the next generation of processing technology and finding innovative ways to boost profitability and compete against Chinese adversaries.

10. **Political Stability**

Finally, political stability is crucial to the success of any long-term business venture but especially in the mining and minerals industry, which is prone to social unrest, asset seizure, and export bans. Rare earth processing hubs are most effectively established in countries with a low risk of political violence or instability that could disrupt operations. Stable, predictable policy environments also provide investors with greater assurance that regulatory frameworks will remain consistent, reducing the risk of unexpected policy shifts that could negatively affect business operations. In the **2023 Fraser Annual Survey of the mining industry**, 54 percent of Canadian respondents and 52 percent of Australian respondents indicated that political stability was a key factor encouraging investment in their countries.

In contrast, only 5 percent of respondents expressed the same confidence regarding South Africa, highlighting the challenges of attracting investment in regions with political instability.

## *Identifying Priority Jurisdictions for Rare Earth Processing Hubs*

This paper applies the 10 previously outlined criteria to systematically assess and quantify the performance of 10 selected countries in each area. The objective is to provide a data-driven evaluation of which countries are best positioned to develop into cost-competitive hubs for rare earth processing. Each country was assigned a score from 1 to 3 across all ten categories, with the specific quantitative thresholds used to determine these scores detailed in Appendix 1.

By analyzing these countries across a standardized framework, the authors aim to highlight comparative advantages and identify critical gaps that may facilitate or hinder their ability to attract investment, establish competitive processing infrastructure, and integrate into global REE supply chains. This approach not only supports strategic decisionmaking for policymakers and investors but also offers practical insights into where future development efforts and policy initiatives should be concentrated to strengthen global rare earth processing capabilities. Ultimately, this analysis provides a comprehensive, evidence-based ranking of countries based on their potential to emerge as leading centers for rare earth processing, taking into account both current capabilities and future opportunities for growth and competitiveness.

## *Results*

The United States emerges as the front runner as a global rare earth processing hub, scoring 2.7 out of 3.0. Several factors position the U.S. as an ideal location for rare earth processing: In addition to adequate infrastructure, ample feedstock, and significant R&D investment, recent policy developments position the U.S. to become a leader in REE processing. First and foremost, the U.S. government has made a firm commitment to develop REE processing and magnet manufacturing capabilities in the form of the DOD's $400 million equity investment in MP Materials with price support and guaranteed offtake of its permanent magnets. LREE and HREE processing facilities under construction in Texas and California will be well suited to process rare earth feedstock from around the world for secure magnet supply chains independent of China.

Australia (2.6/3.0), Saudi Arabia (2.6/3.0), and Canada (2.5/3.0) are also top performers in the index. Australia and Saudi Arabia are strengthening commercial ties to the United States to co-develop rare earth magnet supply chains through firms such as Lynas Rare Earths and Maaden. These three countries also possess strong infrastructure, regulatory environments, and exploration budgets that are creating enabling environments for rare earth supply chain development. These countries will be key partners for the U.S. to build rare earth supply chains outside of China capable of meeting both defense and commercial industry needs.

A detailed breakdown of how each country performed across the 10 indicators can be found in Appendixes A and B.

## *Conclusion*

Securing resilient and cost-competitive rare earth supply chains is one of today's most pressing strategic imperatives. As global demand for REEs accelerates—driven by their critical role in defense systems, advanced technologies, and the clean energy transition—the United States and its allies must take

## Table 2: Comparative Competitiveness Assessment of Rare Earth Processing Hubs

| Factor | United States | Australia | India | Saudi Arabia | Japan | Indonesia | South Africa | Brazil | Canada | Namibia |
|---|---|---|---|---|---|---|---|---|---|---|
| Government commitment to developing REE hubs (financing and policy measures) | | | | | | | | | | |
| Commercial cooperation on REE processing | | | | | | | | | | |
| Proximity to feedstock | | | | | | | | | | |
| Infrastructure | | | | | | | | | | |
| Energy**total production rank, production per capita, cost) | | | | | | | | | | |
| Ease of doing business | | | | | | | | | | |
| Exploration budget | | | | | | | | | | |
| Operation costs* (estimate based on other commodities) | | | | | | | | | | |
| R&D expenditure (as a percentage of 2022 GDP) | | | | | | | | | | |
| Political stability | | | | | | | | | | |
| Final score | 2.7 | 2.6 | 1.7 | 2.6 | 2.1 | 1.4 | 1.8 | 2.0 | 2.5 | 1.8 |

Notes: *DOD price floor commitment counteracts higher operations costs. **Energy is scored based on three metrics—total energy production country rank by the IEA, energy production per capita, and cost per kilowatt hour of energy. Green indicates the country performs strongly for a given parameter and likely meets the requirements for an REE processing hub. Yellow indicates a country performs moderately for a given parameter and is working to develop the requirements for an REE processing hub. Red indicates a country performs weakly for a given parameter and does not meet the requirements for an REE processing hub.

Source: U.S. Geological Survey; U.S. News & World Report; U.S. Energy Information Administration; World Bank (1, 2, and 3); Our World in Data; World Population Review; and S&P Global.

decisive action to reduce their dependence on China's dominant midstream processing capabilities. Without significant investment in both domestic and international processing hubs, as well as renewed focus on R&D, the West will remain vulnerable to supply disruptions and economic coercion.

This analysis demonstrates that no single country possesses all the necessary factors to independently establish a fully competitive and resilient rare earth supply chain. A successful strategy must therefore combine domestic efforts with targeted international partnerships. Countries such as Australia, Canada, and Saudi Arabia offer strong foundations for processing hubs thanks to their financing commitments to develop REE processing capabilities, stable political environments, advanced infrastructure, and robust R&D ecosystems. While not all of these countries are currently producing large quantities of rare earths, they have the characteristics that provide promising opportunities to develop new hubs, supported by favorable investment climates, abundant energy resources, and increasing REE exploration activity.

Establishing midstream hubs in strategic locations will provide essential economies of scale, reduce transportation and processing costs, and facilitate greater collaboration between mining operations and advanced manufacturing sectors. Equally important is the need to revitalize R&D initiatives to drive technological innovation in processing methods, improve resource efficiency, and reduce environmental impacts.

To meet urgent national security and economic objectives, the United States must pursue a dual-track approach: (1) rapidly building domestic REE processing and magnet manufacturing capacity while (2) working with trusted allies to establish global processing hubs. This integrated strategy will strengthen supply chain resilience, promote innovation, and ensure that the materials critical to modern economies and defense capabilities remain secure and accessible. Without swift and coordinated action, the window to counter China's entrenched dominance will continue to narrow, placing critical technologies, industries, and security interests at ongoing risk. ■

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*This report is made possible by general support to CSIS. No direct sponsorship contributed to this white paper.*

# Appendix A

Table A-1: Performance Threshold

| Criteria | Green | Yellow | Red |
| --- | --- | --- | --- |
| Government commitment to developing REE hubs | Major government financing or policy announcement made to support REE processing facilities | n/a | No major government financing or policy announcement made to support REE processing facilities |
| Commercial cooperation on REE processing | Formal investment or partnership between<br>▪ U.S. firm and foreign firm; or<br>▪ U.S. government and foreign government | n/a | No formal investment or partnership between<br>▪ U.S. firm and foreign firm; or<br>▪ U.S. government and foreign government |
| Proximity to feedstock | > 800,000 tons | 100,000–800,000 tons | Unconfirmed reserves or < 100,000 tons |
| Infrastructure | 1–33 | 34–66 | 67–100 |
| Energy | 1st–15th total production rank; and<br>> 10,000 kwh production; and<br>< $0.15 per kwh cost | 1st–15 rank; or<br>> 10,000 kwh production; or<br>< $0.15 per kwh cost | 16th–150th rank; and<br>< 10,000 kwh production; and<br>> $0.15 per kwh cost |
| Ease of doing business (based on Fraser Index, World Bank, and S&P) | Authors' elaborations | Authors' elaborations | Authors' elaborations |
| REE exploration investment | > $5 million | n/a | < $5 million |
| Operation costs (based on production cost curves of other commodities in respective jurisdictions, given data constraints)* | Authors' elaborations | Authors' elaborations | Authors' elaborations |
| R&D expenditure | > 1% | 0.5%–1% | < 0.5% |
| Political stability | > 60 | 30–60 | 0–30 |
| Final rank | > 2.5 | 2.0–2.25 | < 2.0 |

Note: *DOD price floor commitment counteracts higher operations costs.

# Appendix B

Table B-1: Performance Across Key Metrics

| Factor | United States | Australia | India | Saudia Arabia | Japan |
|---|---|---|---|---|---|
| Government commitment to developing REE hubs (financing and policy measures) | | | | | |
| Commercial cooperation on REE processing | | | | | |
| Proximity to feedstock (metric tons) | 1,900,000 | 5,700,000 mt reserves | 6,900,000 mt reserves | 907,000 tons | 16,000,000 tons deep-sea resource |
| Infrastructure score (rank) | 3 | 12 | 60 | 26 | 2 |
| Energy score (total production rank, price, production per capita, cost) | 2nd, 12,700 kwh, $0.181/kwh | 9th, 10,400 kwh, $0.204/kwh | 6th, 1,400 kwh, $0.182/kwh | 4th, 11,500 kwh, $0.074/kwh | 35th, 8,220 kwh, $0.212/kwh |
| Ease of doing business | | | | | |
| Exploration budget (US $ millions) | $10.6 | $64.2 | Negligible | $5.2 | Negligible |
| Operation costs (estimate based on other commodities)* | Low with DOD price floor guarantee | High | Medium | Low | High |
| R&D expenditure (as a percentage of 2022 GDP) | 3.59 | 1.83 | 0.65 | 0.46 | 3.30 |
| Political stability score | 47 | 80 | 21.33 | 39.81 | 81.52 |
| Final score | 2.7 | 2.6 | 1.7 | 2.6 | 2.1 |

| Factor | Indonesia | South Africa | Brazil | Canada | Namibia |
|---|---|---|---|---|---|
| Government commitment to developing REE hubs (financing and policy measures) | | | | | |
| Commercial cooperation on REE processing | | | | | |
| Proximity to feedstock (metric tons) | Potentially modest reserves in copper, tin, and gold mining by-products | 860,000 mt reserves | 21,000,000 mt reserves | 830,000 mt reserves | Potentially 570,000,000 tons in new discovery |
| Infrastructure score (rank) | 61 | 42 | 47 | 6 | 90 |
| Energy score (total production rank, price, production per capita, cost) | 7th, 1,260 kwh, $0.109/kwh | 19th, 3,780 kwh, $0.161/kwh | 10th, 3,295 kwh, $0.175/kwh | 5th, 16,400kwh, $0.123/kwh | 142nd, 526 kwh, $0.151/kwh |
| Ease of doing business | | | | | |
| Exploration budget (US $ millions) | Negligible | $12.5 | $13.3 | $10.1 | $4.6 |
| Operation costs (estimate based on other commodities)* | Low | Medium | Low | High | Low |
| R&D expenditure (as a percentage of 2022 GDP) | 0.28 | 0.6 | 1.15 | 1.55 | 0.35 |
| Political stability score | 28.91, 2.2 | 20.85 | 28.44 | 76 | 63.51 |
| Final score | 1.4 | 1.8 | 2.0 | 2.5 | 1.8 |

Note: *DOD price floor commitment counteracts higher operations costs.