The innovation imperative

Bridging the supply-demand gap for critical raw materials by 2030

Executive summary – North America

GLOBSEC
IDEAS SHAPING THE WORLD

GLOBSEC IDEAS SHAPING THE WORLD GeoTech Center

GLOBSEC US FOUNDATION

Acknowledgements

The report draws on multiple sources, including analysis from McKinsey & Company. The GLOBSEC GeoTech Center is responsible for the conclusions and recommendations of the research.

We are grateful to the many industry leaders, experts, and government officials in Europe and the US who participated in consultations and whose insights helped inform this report.

GLOBSEC GeoTech Center

www.globsecusfoundation.org

globsec.org

April 2025

About GLOBSEC

GLOBSEC is an independent, pan-European policy organization with offices and affiliates in Prague, Brussels, Vienna, Kyiv, Bratislava, and Washington, D.C. Founded in Central Europe, GLOBSEC is dedicated to advancing security, prosperity, and sustainability in Europe and beyond. Its mission is to shape the future by generating new ideas and actionable solutions for a stronger, more competitive, and stable Europe, underpinned by robust global partnerships.

GLOBSEC brings together the right stakeholders at the right time to facilitate the free exchange of ideas and foster meaningful dialogue. Over the years, it has become one of Europe's leading voices in security policy, hosting world-class high-level events and producing original, impactful policy-focused research and recommendations. Building on strong in-house expertise, GLOBSEC also serves as a hub for collaboration between experts, thought leaders, and decision-makers from both the public and private sectors — working together to drive change and address the most urgent global challenges.

The **GLOBSEC US Foundation** is a nonprofit, non-partisan, and non-governmental public policy organization headquartered in Washington, D.C. Its mission is to enhance understanding of Europe's geopolitical landscape and strategic relationships, helping to better inform American communities and foster transatlantic dialogue.

Led by General John R. Allen, the **GLOBSEC GeoTech Center** aims to foster a more informed, strategic, and systematic dialogue on technology and digital innovation policies and their intersections with national security and economic frameworks. The Center's mission is twofold: first, to strengthen Europe's capacity to develop, shape, scale, and absorb critical technologies that enhance its global competitiveness; and second, to advance transatlantic and global tech-centric partnerships rooted in democratic values.

GLOBSEC GeoTech Center team

Petr Pudil, President and Chairman of the Board of Directors, GLOBSEC US Foundation; Chairman of the Board, Draslovka

John R. Allen, Director, GLOBSEC GeoTech Center; Former Commander, NATO International Security Assistance Force, and US Forces in Afghanistan, and former Special Presidential Envoy

Alena Kudzko, Executive Director, GLOBSEC US Foundation, and Deputy Director, GLOBSEC GeoTech Center

Diana Sarah Ondrejkovičová, Project Coordinator, GLOBSEC GeoTech Center

Synopsis

By 2030, North America is likely to experience significant gaps between demand and local supply in many critical raw materials (CRMs) required in strategic industries, as strategic industries like semiconductors and defense grow rapidly, while the energy transition advances. Growth in demand for these materials is expected to far outpace growth in local supply, resulting in North American local supply of less than 50 percent of demand in copper, lithium, and synthetic graphite.

Although North America is likely to remain reliant on global supply chains for critical raw materials CRMs in 2030, regionalization of CRM value chains could play a key role in reducing imports, mitigating supply chain risks, and safeguarding strategic industries. The persistently low levels of local supply pose significant strategic risks, already becoming evident through recent developments — such as China's restrictions on the export of rare earth elements (REE) — which expose the vulnerability of current global dependencies. To address the growing supply-demand gap, the United States must pursue solutions that address both supply and demand side. Supply-side solutions, including expanding mines, increasing mining yields, and rcycling. could alleviate some of the pressure, but ultimately would not be sufficient to overcome the challenge by 2030. On the demand side, the US should aim to reduce reliance on CRMs, including shifting the battery mix towards emerging battery technologies and substituting materials in critical components.

By adopting solutions across the value chain, North America could potentially close the gap in all CRMs, except for copper, manganese and synthetic graphite, for which local supply would cover 52 percent, 87 percent and 94 percent of demand, respectively. Although North America benefits from its head start policy-wise, significant amounts of capital are still needed to increase local CRM supply underscoring the importance of quickly deploying pilot projects and R&D programs, combined with the provision of sufficient risk capital to minimize risk, and developing regional business ecosystems.

The transition to electrification, growing energy demand from widespread use of AI, as well as rapid grid expansion to support new energy flows represent one of the largest capital reallocation efforts in human history, with total capital outlays estimated at USD 5.4 trillion. Thus, an "all of the above" approach to innovation is needed to close the gap between local supply and demand of CRMs. Still, we conclude that for some materials this will not be possible by 2030. However, by implementing proactive policies that encourage innovation in battery technology, chemical processing, and resource recycling, North America can significantly reduce the long-term supply chain risks stemming from CRMs.

Executive summary

What we looked at

Several raw materials are especially critical for North America. The energy, semiconductor, and defense manufacturing industries are essential to lasting prosperity and security for North America. These industries rely heavily on numerous CRMs, of which the six deemed most critical were selected as the focus of this report — copper, lithium, nickel, manganese, rare earth elements, and synthetic/natural graphite. Crucially, North American access to these CRMs face long-term supply risks due to significant expected gaps between local supply and demand combined with the concentration of supply outside North America. Some of these risks are already becoming evident through recent developments — such as China's restrictions on the export of rare earth elements (REE) — which expose the vulnerability of current global dependencies.

How we did it

Compared to other reports on the issue of CRM supply chains, this report applies a unique methodology with rigorous bottom-up approach to quantify long-term supply risks. CRM supply forecasts were modeled bottom-up based on projected outputs of each individual mining asset, as well as each new project likely to become operational by 2030. Demand forecasts were modelled bottom-up based on the growth and CRM intensity for 23 individual economic sub-sectors

(e.g., automotive, aerospace, energy infrastructure). Finally, this report performs a fact-based quantification of the impact of the most important levers towards reducing local supply and demand gaps on the level of each individual CRM and region.

65%

In North America, supply is expected to meet more than 65 percent of the demand for all materials, except copper at 47 percent

Key takeaways

The current gap between demand and local supply of CRMs will widen further by 2030 under the current trajectory, due to the rapid growth of strategic industries, localization of supply chains, and limited growth in local supply

Demand for these materials in North America is expected to grow rapidly to keep pace with developments across strategic industries. US and Canadian policy makers are working to incentivize local manufacturing while de-risking supply chains.

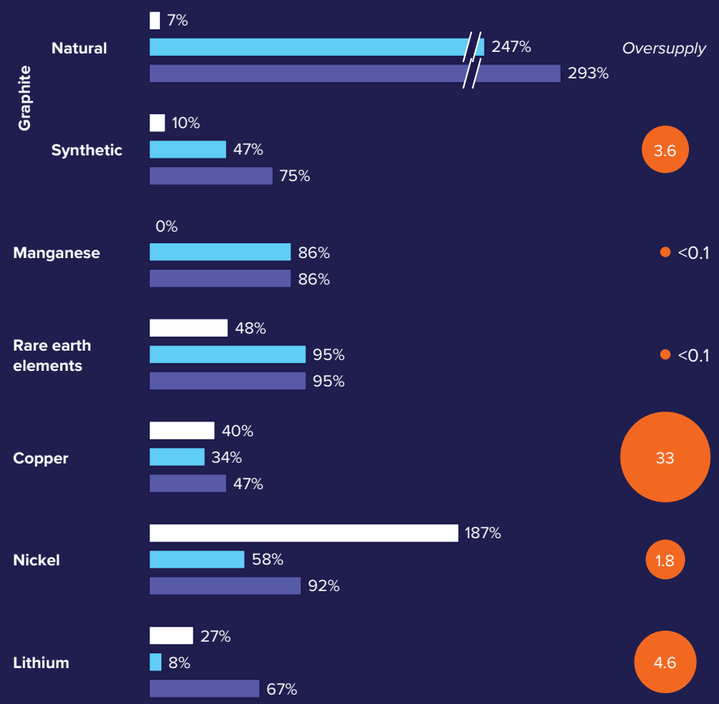
The energy transition is expected to fuel widespread deployment of renewable energy sources, development of transmission and distribution infrastructure, and the electrification of industry, household heating, and transport. At the same time, development of domestic semiconductor manufacturing capacity in North America, combined with increased defense spending, is likely to drive further demand growth, and make it less sensitive to changes in the pace of the energy transition. As a result, demand for all CRMs is expected to grow significantly, with demand for manganese, lithium, and synthetic graphite likely to increase more than 20 percent per year until 2030.

North American supply is unlikely to keep up with this growing demand. The development of new projects faces many challenges, including historical challenges with project execution (significant delays and budget overruns), local opposition to new mining projects, and limited availability of talent.

As a result, North America is expected to see significant gaps between local supply and demand for the six CRMs by 2030. North American production of most CRMs is expected to meet 50 percent or more of demand though local supply of copper, lithium, and synthetic graphite would still meet less than 50 percent of demand.

North American supply is unlikely to keep up with this growing demand

Local supply as a share of demand
%



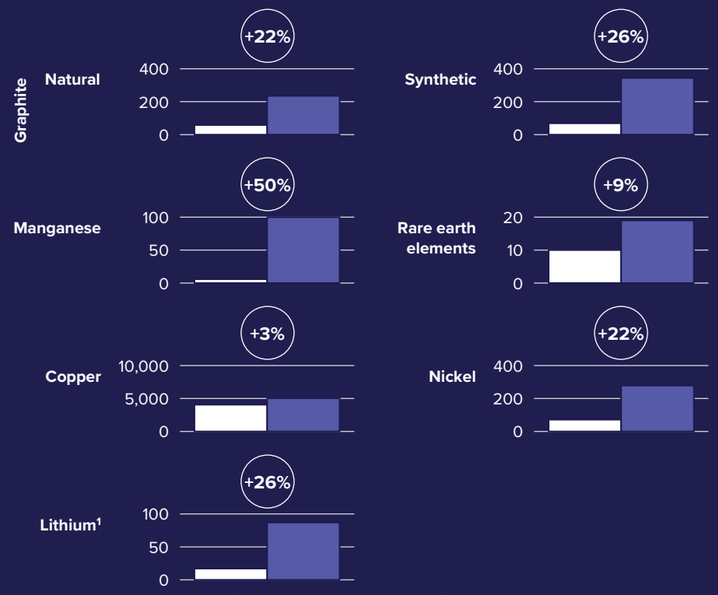
1. Base supply scenario: Projects in construction or projects with feasibility confirmed
2. High supply scenario: Feasibility not yet confirmed; announced early-stage projects
3. Values are subject to change due to market dynamics

Note: Market value calculated as forecasted 2030 gap, multiplied by market spot prices as of Feb 2025 – future price curves were not modelled. Value can differ due to different grades of materials purchased for individual industries

Source: MineSpans – Current trajectory demand scenario, Shanghai metals market, Daily metal prices

Demand for these materials is expected to grow rapidly to keep pace with development across the strategic industries

Critical raw material demand
Kilotons



1. Kt of pure Li contained, which is 5.32 times lighter compared to LCE unit which is also used in some reports

Note: Current trajectory scenario – description available in the methodology section of the report

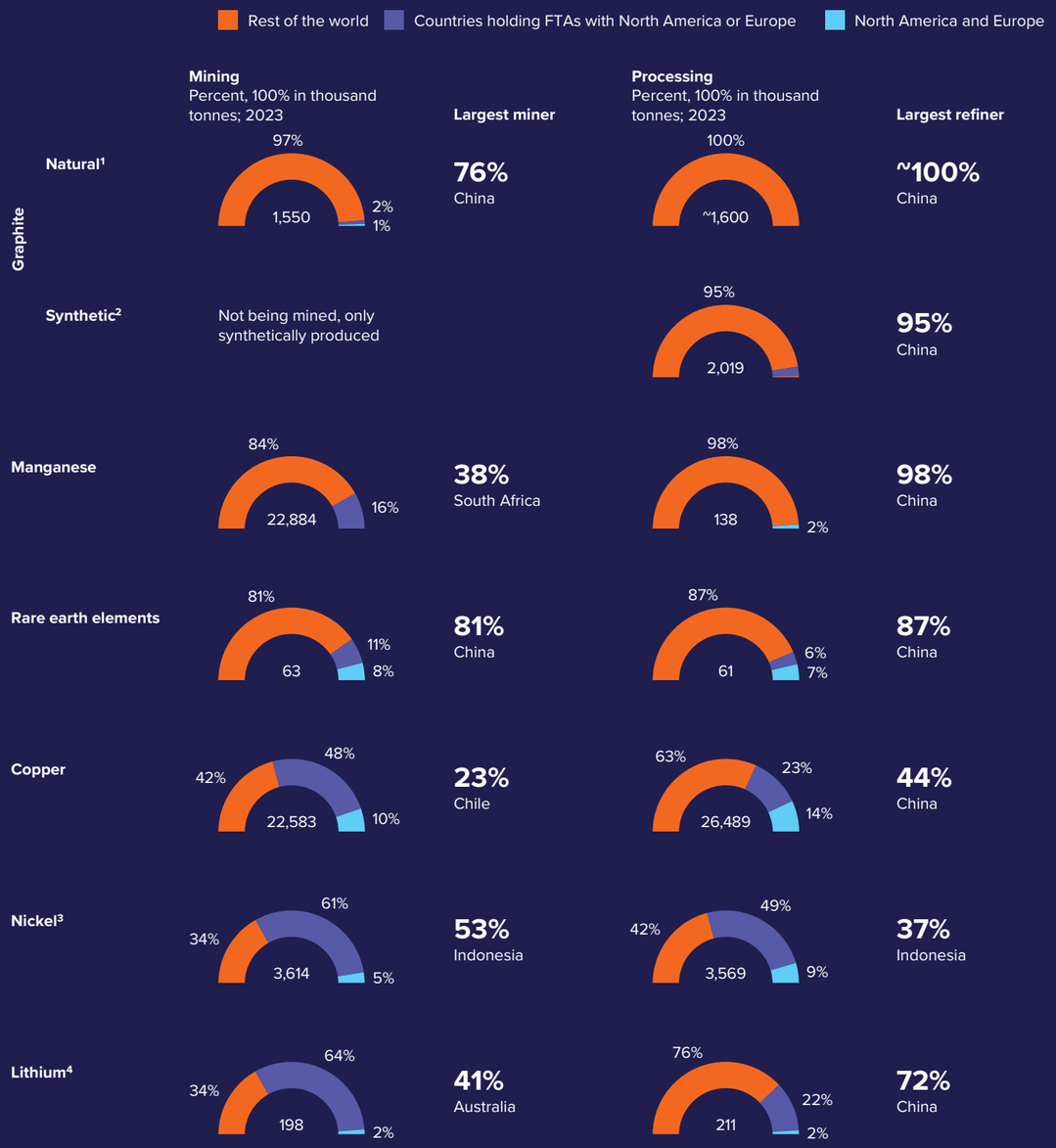
Source: MineSpans

The risks associated with gaps between local supply and demand are compounded by supply chain concentration

Supply risks created by these imbalances are exacerbated by significant geographic concentration of mining and processing in just a few countries. **Notably, China dominates the refining sector, housing more than 70 percent of the processing capacity for four of the six CRMs.** Regions with high concentrations of mining and processing owe their dominance to accessible mineral resources, often combined with state subsidies, commitment to infrastructure build-out, cost advantages attributable to scale and low energy costs, deep expertise developed over many

Workers walking on site

Supply chains continue to be geographically concentrated, China being the largest global refiner



1. kt carbon contained
2. Another big challenge for synthetic-graphite production is to secure suitable supplies of mesocarbon microbeads, a precursor to produce high-quality needle coke, which in turn is essential to produce high-quality synthetic graphite
3. kt metal contained
4. kt Li refined

Note: Net processing output can be greater than mining due to addition of recycled scrap
Source: MineSpans

decades, and lower levels of local opposition to material extraction.

Despite significant cost advantages unlocked through scale, strong supply chain concentration can create vulnerability in the event of unexpected market developments or **country export restrictions, such as Indonesia's 2020 nickel export ban, Zimbabwe's 2022 export ban on unprocessed lithium, and China's 2024 and 2025 restrictions on exports of multiple rare earth elements as a response to the US administration's tariffs.**

The gaps between demand and local supply could be significantly reduced, but would require implementing a broad set of innovative demand- and supply-side approaches

Supply and demand side innovations are necessary to close the gap between the local supply and demand in North America. To address the supply and demand imbalance, we identified three supply-side and three demand-side categorical approaches. **In North America, these approaches could close the gaps across most CRMs, except for copper, manganese and synthetic graphite, for which local supply would cover 52 percent, 87 percent and 94 percent of demand, respectively.**

Supply-side approaches, based on traditional methods and deploying a mix of new and existing technologies, would include:

— **New and expanded sites** — expanding existing mining and processing sites and accelerating projects currently in the pipeline through simplifying permitting and ensuring sufficient financing.

— **Primary supply innovation** — improving mining material yield through AI-enabled process optimization, innovative chemical processes like direct lithium extraction, and recovery of metals from mining tailings (i.e., residual resources from the processing of mined ore).

— **Secondary supply from recycling** — reusing materials, especially from end-of-life batteries, scrap, and waste electrical equipment.

Because the availability of CRMs is large in North America, new and expanded sites, coupled with tailing re-processing, as well as other primary supply innovation, would be particularly critical and could cover up to 59 percent, 35 percent, and 46 percent for lithium, nickel, and natural graphite domestic demand, respectively.

Given the long lead times and high capital requirements of these supply-side projects, these projects benefit immensely from a more localized downstream industry (i.e., industries using these CRMs in their production processes), as well as streamlined processes to improve access to resources. An abundance of stable downstream users of CRMs helps to significantly de-risk capital-intensive supply-side projects and R&D efforts. Companies also benefit from lower barriers to accessing new deposits, as well as overlooked, and often more environmentally friendly, resources like tailings. For example, permitting processes for new mines and resources in North America often create a critical bottleneck for unlocking new supply sources. Permitting of new mines in the United States often exceeds 10–15 years compared to 2 years in Australia and Canada.

These supply-side levers should be pursued in parallel with other technology-driven demand-side levers including:

— **Technology mix shift** — adopting alternative technologies, for example, using battery chemistries, such as sodium-ion batteries, that would require less CRMs than lithium-ion batteries with some types of sodium-ion technologies being uniquely suitable for large-scale battery storage applications due to high power densities and cycle life.

— **Material substitution** — leveraging alternative materials for common use cases, such as deploying alternative motor technologies that have lower demand for rare earth elements.

— **Efficiency improvements** — leveraging innovative technology to rely less on CRMs, without sacrificing performance, such as using silicone blending in battery anodes to reduce demand for graphite, while maintaining performance.

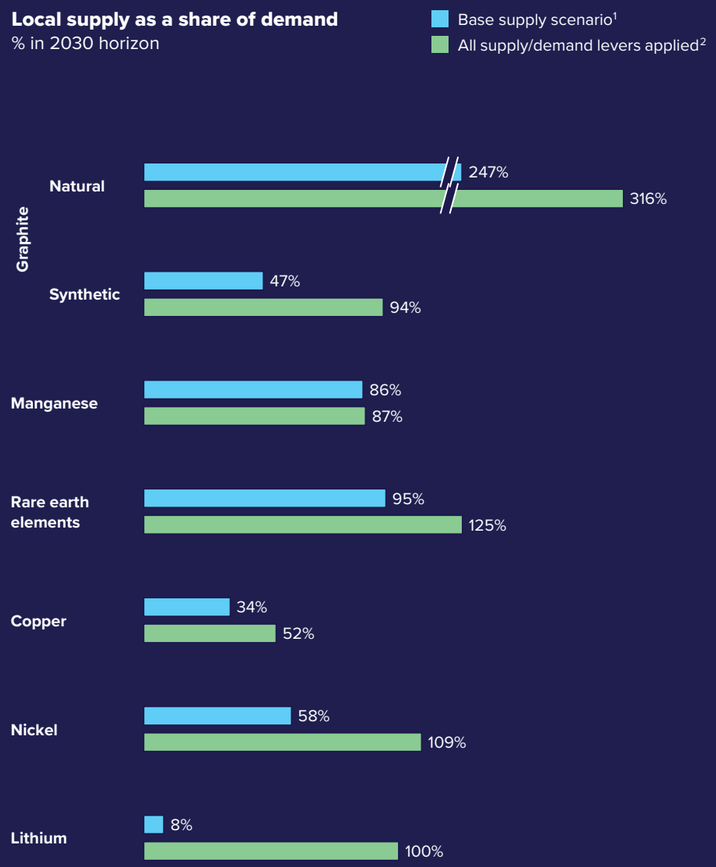
While some of the gaps between local supply and demand could remain by 2030, localization of the CRM supply would nevertheless create tremendous value across North America by significantly reducing long-term supply risks across all CRMs and putting both regions in a leadership position in the technologies critical to long-term CRM supply security.

The US has taken first steps through policy responses; further efforts in this area could significantly reduce long-term supply chain risks

The US has taken steps to reduce supply dependencies and disruptions by implementing policies to enhance domestic production of CRMs. These efforts aim to strengthen self-sufficiency, improve supply chain resilience, and make domestic industries competitive.

The US has enacted several measures, including the Bipartisan Infrastructure Law (BIL), securing more than USD 7 billion of financing for critical battery materials and R&D and production of rare earth elements. The BIL also seeks to reduce inefficiencies in the permitting process. However, the policy environment around CRMs

The gaps between demand and local supply could be significantly reduced in North America



1. Base supply scenario: Projects in construction or projects with feasibility confirmed
2. Implications after considering total impact of all examined levers on both supply and demand side

Source: MineSpans, McKinsey Battery Insights, IEA, Company announcements

in the US is constantly changing. An executive order issued in January by the US President states an ambition to pause funding from, for instance, the BIL targeting programs that discourage fossil fuel development or promote electric vehicles. At the same time, the US President's latest executive order, issued in March, aims to boost local mineral production, simplify permitting, and reduce reliance on foreign minerals. The administration has outlined an ambition to ensure the US becomes the leading producer and processor of minerals, and given greater power to agencies to finance, develop and approve mining sites. Additionally, as of April, it is expected that Trump administration will release another executive order allowing US to stockpile rare earth minerals, as well as other CRMs, extracted via deep-sea mining, thus boosting additional sources of supply.

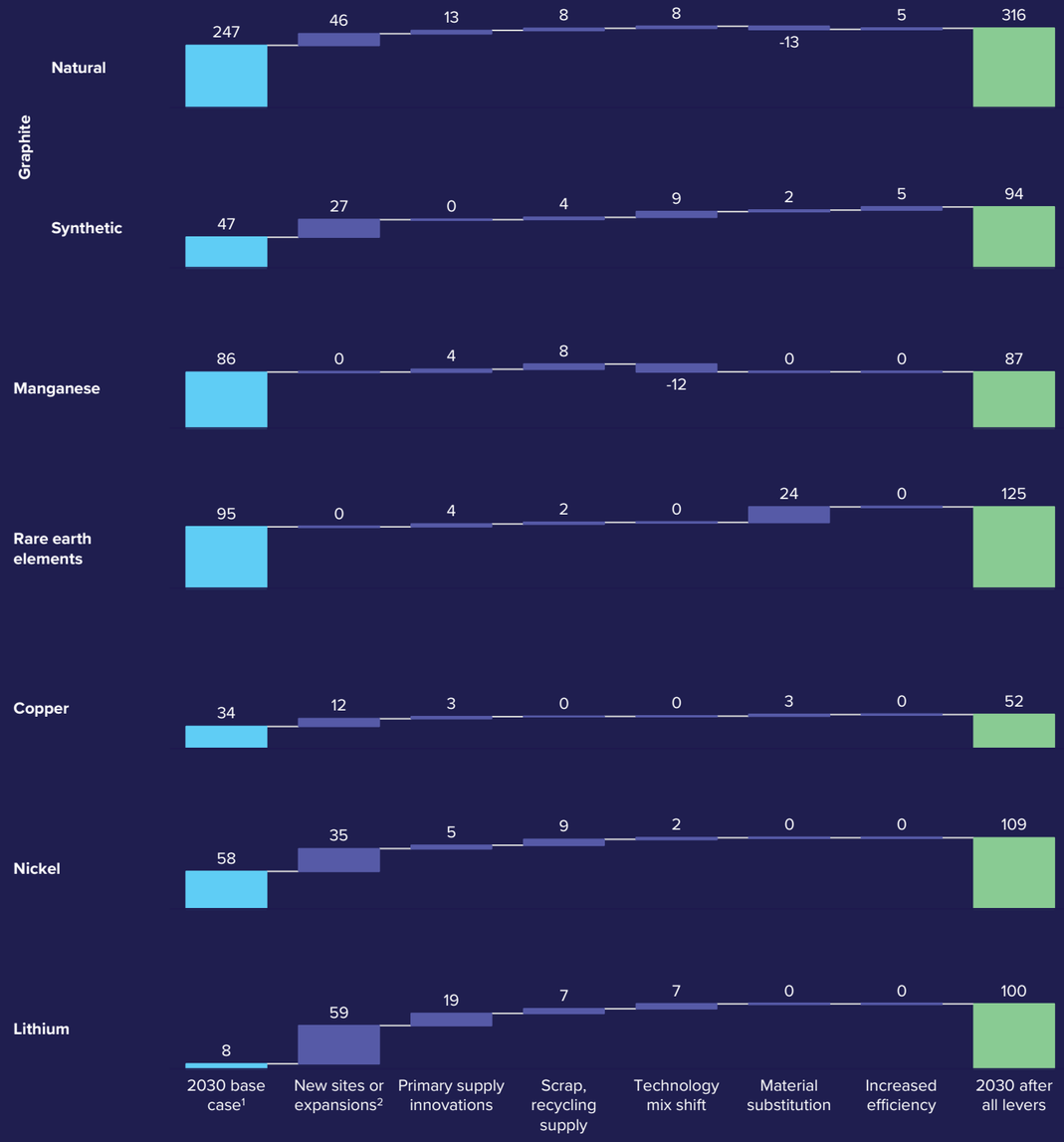
Overall, the US provides substantial investment in CRM projects, with 0.2 percent of nominal 2023 GDP allocated via direct financing and tax breaks, though significantly more would be needed to fully capture the potential of the levers outlined above.

Path forward: guidelines and recommendations

Success in securing a stable, diversified, and predictable supply of CRMs depends on an interplay of multiple enablers rather than any single factor. It requires a combination of policy making decisions that encourage innovation, timely permitting reviews, active participation and risk-taking by private players, availability of sufficient financing capital, and development of local innovation ecosystems. It also requires parallel action by different stakeholder groups including policy experts , large-scale incumbents, innovative start-ups, academia, investors, and public organizations working towards a common goal.

Closing the gap between local supply and demand requires an "all of the above" approach to innovation but also presents an opportunity — to build new regional innovation ecosystems and national champions in areas like battery technology, chemical processing, and resource recycling, to increase the competitiveness of North American business, and to significantly reduce the long-term supply chain risks.

Innovations can materially reduce the gaps between demand and local supply



1. Base case
2. Under high case supply scenario

Source: MineSpans, press research, expert interviews, McKinsey Battery Insights

Active mines and processing plants in North America

	Mine	Plant
Copper	●	▲
Graphite	●	▲
Lithium	●	▲
Nickel	●	▲
REE	●	▲