Critical Mineral Chokepoints Could Threaten the US Nuclear Energy Renaissance

August 13, 2026
Tess Carter (tcarter@rhg.com), Laura Gormley (lgormley@rhg.com), John Larsen (jwlarsen@rhg.com); Rovjok authors: Simon Zieleniewski (simon.zieleniewski@rovjok.com), Tim Rose (tim.rose@rovjok.com), Tim O'Brien (tim.obrien@rovjok.com)

Nuclear energy capacity is poised to expand in the US if the government and industry can overcome supply chain and financial barriers. However, this energy renaissance will only be possible if key investments are made in precise segments of the critical mineral value chain. In this analysis, Rhodium Group and Rovjok calculate the mineral requirements for a US nuclear build-out of Generation 3+ reactors (e.g., the AP1000 and BWRX-300). We find that most minerals, with the exception of uranium, are available in sufficient quantities at an aggregate level to support a nuclear build-out, giving the appearance of supply chain security. However, a careful review of supply chains reveals potential chokepoints, especially if there is a surge in demand from a large number of nuclear projects.

Supply chain constraints affect specific forms and niche minerals, such as the zirconium used in fuel rods, where the US will face significant supply chain vulnerabilities if companies don't take action early. In particular, China dominates the mid-stage mineral and metal production required for critical downstream, end-product manufacturing, and has already adopted export controls for critical products. These potential bottlenecks can be resolved through targeted investments, but urgent action—and detailed analysis—is needed to prevent them from constraining a resurgence of new nuclear plants. The outlook for critical mineral vulnerabilities will also become more nuanced if the US pursues Generation 4 small modular reactor (SMRs) technologies at scale. This highlights the importance of detailed supply chain forecasts as a precondition for betting on a nuclear investment boom.

Barriers to nuclear energy scaling

Increasing energy demand from data centers, manufacturing, and electrification makes now the best time in a long time for new nuclear energy in the US. However, in addition to financial, policy, and supply chain constraints on broad nuclear fission energy deployment, nuclear energy also relies on critical mineral inputs that are often controlled by China. These constraints will become particularly apparent if a nuclear renaissance, defined by the development of 10 or more gigawatts (GW) of capacity, materializes in the next decade.

As the industry moves ever closer to making this scale-up a reality (for example, with the Department of Energy's announcement of lending for long-lead components of 10 large-scale light water reactor AP1000s), a granular accounting of component-level requirements and workforce needs is essential. Here, we capitalize on joint Rhodium Group-Rovjok capabilities to provide a granular, product-specific assessment of critical minerals needed for a US nuclear power plant build-out scenario through the mid-2030s and associated key supply chain vulnerabilities.

Nuclear energy has relatively low demand for critical mineral inputs compared to other clean energy sources, such as solar and wind power. However, processing minerals into nuclear-specific inputs is monopolized by a small set of firms with the necessary technical capabilities. While our projections for nuclear critical mineral requirements are less than 1% of global production on average across minerals, secure access to these inputs could still be the bottleneck to the success of a US nuclear energy renaissance. Without the growth of nuclear-specific mineral processing capabilities, US nuclear energy will compete for sourcing from a small set of predominantly Chinese suppliers and under a growing threat of China's weaponization of export controls.

Critical minerals requirements for a medium-term nuclear fleet build-out

Just like in nearly all modern technologies, critical minerals play integral roles across a nuclear power plant, from alloys in control rods and reactor pressure vessel ecosystems to uranium. According to Rhodium calculations, doubling the current US fleet capacity by 2050 would require 1.3 to 22 times the current US uranium fuel capacity, depending on the step in the process (e.g., fuel fabrication vs. mining and milling, respectively). Uranium often gets the spotlight, but numerous other components and materials are just as integral to nuclear power generation. Therefore, we focus on sourcing requirements for other critical minerals for the rest of this note.

Here, we evaluate two possible scenarios: 1) the current near-term goal of 10 reactors in the US, and 2) doubling the current fleet to ~200 GW (half the Trump administration goal of 400 GW by 2050, but more feasible given time, financing, and supply chain constraints). These scenarios assume that the currently operating nuclear fleet remains online during this timeframe, which is an approximation but reasonable given license extensions and investments by hyperscalers in bringing back recently shut-down nuclear plants and upgrading existing ones. We use mineral intensities from the literature that align with current leading generation 3+ nuclear fission technologies: 1) a large light-water reactor; 2) the AP1000, a pressurized water reactor; and 3) the BWRX-300, a small modular reactor (SMR) using an established boiling-water design. Generation four nuclear fission SMRs have some novel critical mineral needs that warrant close scrutiny of their specific critical mineral supply chains. We briefly discuss this at the end of this note.

Outside of concrete, steel, and uranium, the nuclear renaissance will require copper, chromium, nickel, and manganese in the largest quantities—several thousand tonnes (metric tons) (Table 1). Much smaller magnitudes of niche minerals like indium and hafnium are required as well.

TABLE 1

Total critical mineral requirements for 10 GW and 100 GW of additional nuclear capacity in the US by 2050

Metric tons (tonnes)

Mineral	Required for 10 AP1000s	Required for doubling of nuclear capacity to 200 GW by 2050
Copper	14,430	144,300
Chromium	12,987	129,870
Nickel	7,700	77,000
Manganese	5,717	57,165
Uranium	844	8,436
Molybdenum	786	7,859
Lead	444	4,400
Aluminum	330	3,300
Zirconium	330	3,300
Boron	111	1,110
Tungsten	56	555
Silver	28	278
Titanium	17	167
Vanadium	6.7	67
Yttrium	5.6	56
Indium	5.6	56
Hafnium	5.6	56
Cadmium	2.2	22
Lithium-7	0.0	0.4

Source: Rovjok calculations based on mineral intensities for LWR designs, AP1000 and Trojan (Westinghouse) reactors, from University of Texas (2023), Ashby (2021), Valero et al. (2018), European Commission, Institute for Energy and Transport (2011), World Nuclear Association (2024), Steinbruck et al. (2017), Advanced Nuclear Technology International (2014), US Nuclear Regulatory Commission (2011), and Roskill Zirconium Market Report (2014).
Note: The doubling scenario only includes the requirements for the additional 100 GW needed of new nuclear builds for initial fuel load. Hafnium is not used in the AP1000 control rod design but is a possible substitute.

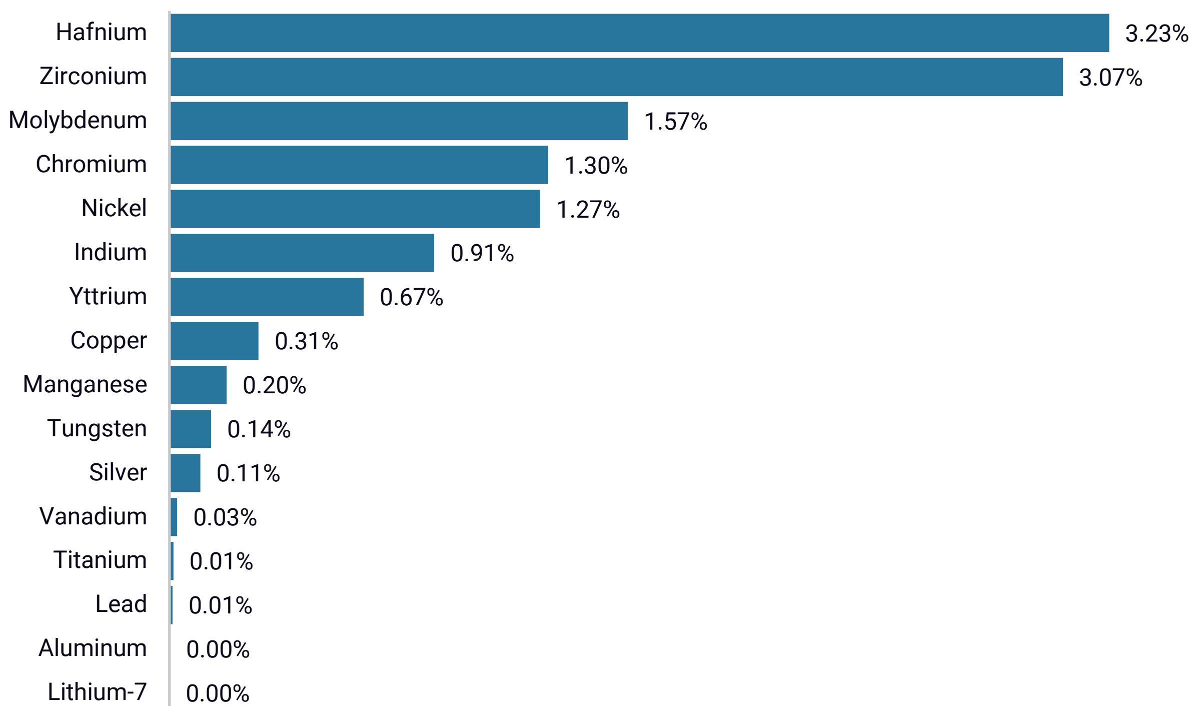
Outside of uranium fuel, mineral scale is generally not the issue

Given the mineral requirements of other demand sources (e.g., clean energy or digital technologies), projected nuclear mineral requirements amount to only a marginal share of current US mineral consumption (Figure 1). To double the current US nuclear capacity, the projected requirements for chromium, nickel, and indium would only amount to around 1% of total US annual demand for these minerals. Hafnium and zirconium stand out as the exceptions. Projected nuclear growth would account for a larger portion of total US annual average demand for these minerals relative to other uses, 3.2 and 3.1%, respectively, from now through 2050. The 3,300 tonnes of zirconium projected for a doubling of US capacity is a small share of the estimated 45,000 tonnes of zircon mined in the US in 2024 (which equates to around 22,000 tonnes of contained zirconium). However, while US capacity appears well-positioned based on these headline numbers, they do not show gaps in the manufacturing capabilities needed to produce nuclear-grade product forms or contextualize China's influence over these supply chains.

FIGURE 1

Projected annual average mineral requirements to double US nuclear capacity from 2026 to 2050

As a share of total US mineral consumption in 2025 (%)



Source: Rovjok analysis

Note: Values reflect the annual average amount of new demand from nuclear build out divided by the annual US consumption of each mineral in 2025.

Is there enough supply available from secure places?

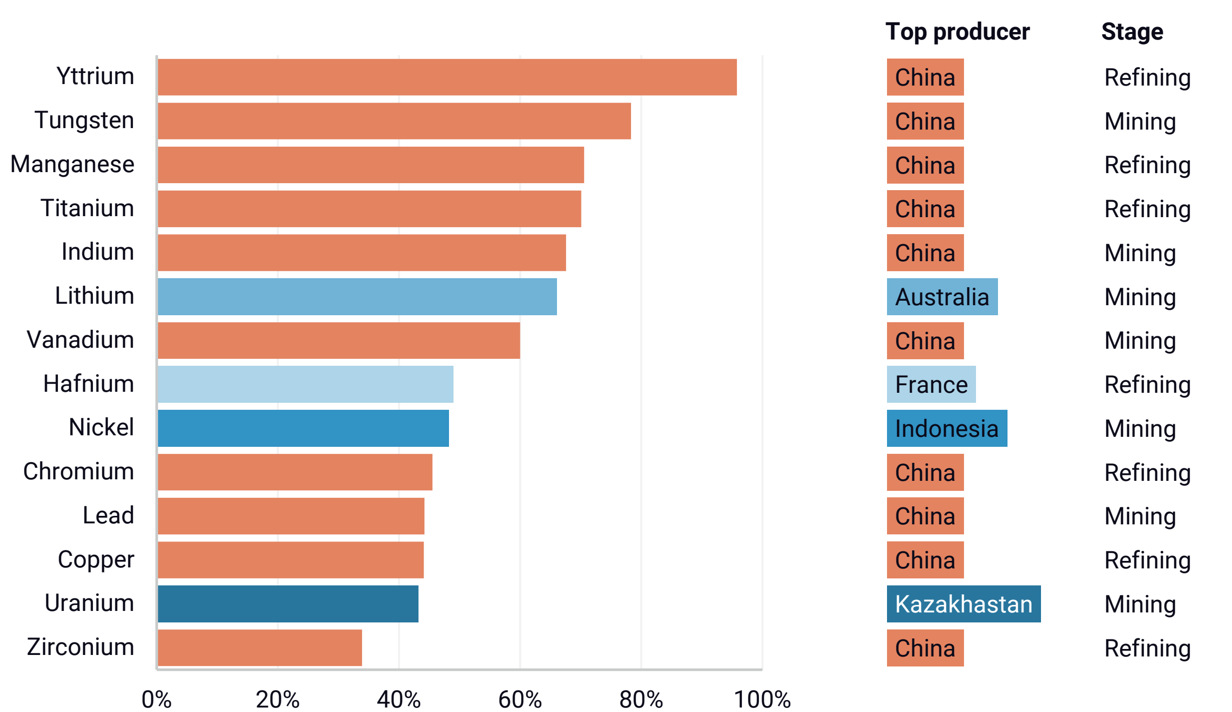
Quantifying the critical mineral requirements of a nuclear energy buildout in the US—whether 10 additional GW, 100 GW, or even the 300 GW of new nuclear that the Trump administration is proposing—all lead us to the same question. Does the US have access to enough critical mineral resources from secure places?

Although nuclear energy reactors, in this case the AP1000 and BWRX-300, have relatively low mineral-intensity requirements (Table 1; Figure 1), they require a large number of different mineral products, at least 18 on the USGS critical mineral list. These inputs are exposed to a range of vulnerabilities, and US nuclear supply chains currently depend on a small number of Chinese producers capable of producing nuclear-specific refined mineral forms to procure essential mineral inputs.

Vulnerabilities to US mineral sourcing for nuclear energy

Some nuclear-relevant product forms are typically produced alongside mineral products for nuclear weapons program development or only in small quantities sufficient for domestic nuclear energy producers. For example, according to industry reports, lithium-7, used in fission, is only produced in tradeable (but still small) quantities by a Russian weapons program supplier and unknown producers in China. Likewise, nearly all the US's zirconium oxychloride comes from two Chinese suppliers.[1]

FIGURE 2
Global production concentration of nuclear-relevant minerals (2025)
Share of global production held by top producer, at the most concentrated stage (mining or refining)



Source: Rovjok analysis based off data from USGS and BGS.
Note: Both mined and refined production were considered, with the highest chokepoint stage presented.

[1] Rovjok analysis of bill-of-materials data.

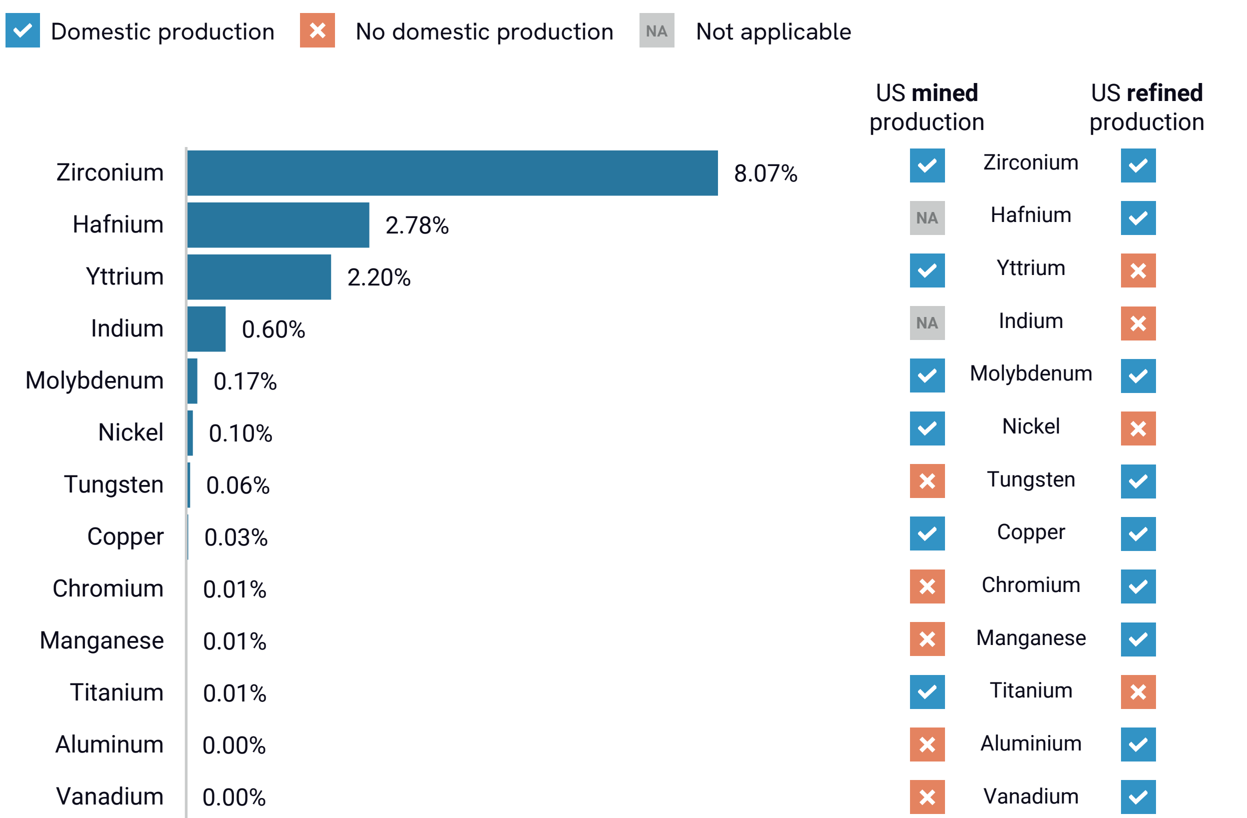
Many nuclear minerals are also niche, informal markets, with high upstream supply concentration (Figure 2); these structural characteristics increase US sourcing risk on their own. For instance, the US can produce the nuclear-grade zirconium and hafnium metal for fuel- and control-rods used in power plants. However, China dominates mid-stage zirconium and hafnium intermediate production feeding into this downstream production of nuclear-grade metal (Figure 2). These and other nuclear minerals are already covered by China's dual-use export regulations, and China has also passed restrictions on broader commercial forms of nuclear-relevant minerals like tungsten, yttrium, and indium. Cutting off access to these intermediary mineral products may hurt downstream manufacturers without alternative supply sources.

For example, when doubling US nuclear energy capacity, zirconium, hafnium, yttrium, and indium supply would face the greatest exposure to price shocks if China restricts exports of upstream supply. Supply of these minerals would put the most strain on and require a large demand share of ex-China production, with zirconium the highest at 8.1% (Figure 3).

FIGURE 3

US nuclear demand's share of average annual metal ex-China production (scenario 2: doubling US capacity)

Percentage



Source: Rovjok analysis

Notes: "NA" denotes metals recovered only as a by-product, with no stand-alone US figure. Values reflect the annual average amount of new demand from nuclear build out from 2026 to 2050 divided by the 2025 annual ex-China production of each mineral.

Many more critical minerals needed for this renaissance

This research note only scratches the surface of understanding the critical mineral supplies needed to support a nuclear renaissance. Here, we just focus on increased US demand, but many European (e.g., UK, Sweden, Poland, etc.) and Asian countries are also looking to expand their nuclear fleets with associated critical mineral needs. Additional work must unravel how to ensure appropriate uranium for the current fleet (one of the largest suppliers of enriched uranium to the US nuclear fleet recently questioned if there was enough supply for current demand), with an eye to future enrichment needs and newer fuel types like high-assay low-enriched uranium (HALEU) and Tri-structural ISOtropic (TRISO) for some SMRs. A Canadian reactor design that does not require enriched uranium fuel could change this calculation, and while it already operates commercially in Canada and elsewhere, recently submitted a license application to the US regulator.

Some new SMR designs, if they catch on, will require additional critical minerals not discussed in depth here. For example, molten salt reactors and high-temperature gas reactors require nuclear-grade graphite and much larger quantities of enriched lithium than discussed here, further straining the supply chain. Additional emerging electric power sector technologies, such as enhanced geothermal, long-duration energy storage, fusion power, space-based solar and new transmission and distribution technologies, all have unique critical mineral needs. This note demonstrates our capabilities in quantifying the risks and challenges as the US and world build new infrastructure to meet surging electric demand.

For nuclear, the key to unlocking mineral chokepoints and securing the supply needed to achieve scale will be adapting tailored solutions for the unique vulnerabilities across the many mineral inputs required to produce a reactor. Policy interventions may be necessary for certain minerals, yet generating more reliable and sustained demand reduces risk in any mineral market. While a US nuclear renaissance will have its mineral supply complications, it will also help generate a large source of demand across many niche mineral products essential to national security and defense applications.

ABOUT RHODIUM GROUP

Rhodium Group is an independent research provider with deep expertise in policy and economic analysis. We help decision-makers in both the public and private sectors navigate global challenges through objective, original, and data-driven research and insights. Our key areas of expertise are China's economy and policy dynamics, and global climate change and energy systems. More information is available at www.rhg.com.

ACKNOWLEDGMENTS

The authors would like to thank Jaspreet Sohal and Maggie Young from Rhodium Group for their review and contributions.

DISCLOSURES

Rhodium Group's publications are intended to provide clients with general background research on important global developments and a framework for making informed decisions. Our research is based on current public information that we consider reliable, but we do not represent it as accurate or complete. The information in this publication is not intended as investment advice, and it should not be relied on as such.

New York | California | Washington, DC | Paris

Website: **www.rhg.com**

Rhodium Group