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How Demand-Side Policies in Keystone Industries Can Help Revive the US Mineral Industry: A Case Study of the US Automotive Industry

Critical minerals are necessary in applications across core industries, from the defense industrial base to the automotive industry.[1] Nickel, for example, is used in the steel pressure hulls of attack submarines and the lithium-ion batteries of electric vehicles. Recognizing the importance of critical minerals to its national security and economic prosperity, the US government has mainly sought to increase US mineral production through supply-side policies like grants and loans for US mineral projects.[2] These policies should help increase US production of critical minerals. However, sustained production of domestic minerals requires sustained demand for domestic minerals, and demand for domestic minerals is currently lacking given lower-cost mineral options overseas. These foreign minerals often have lower costs due to state backing and lower labor and environmental standards, including for carbon emissions and waste management.

To sustain demand for domestic minerals, the US government should adopt demand-side policies targeting "keystone" industries—major downstream industries that consume significant volumes of upstream materials, including minerals.[3] Examples of keystone industries include the automotive, aerospace, and shipbuilding industries. Importantly, keystone industries impact national security and economic prosperity as they produce goods with military and civilian applications. Possible demand-side policies include domestic mineral content requirements for consumer tax credits and government acquisitions, as well as domestic mineral feedstock requirements for subsidies of downstream projects like battery factories. Such demand-side policies could increase demand for US-produced minerals and help revive the US mineral industry.

Keystone Industries

Keystone industries are generally in the manufacturing sector like the automotive, aerospace, and shipbuilding industries—all of which consume significant volumes of upstream minerals. For instance, the global automotive industry constitutes nearly 20 percent of global aluminum demand,[4] about 40 percent of global platinum demand,[5] and nearly 90 percent of global palladium demand.[6] Therefore, the demands of US keystone industries can significantly impact demands on the US mineral industry, which encompasses both mineral extraction and processing. For example, steel—an alloy of iron, carbon, and other elements—represents about 50 percent of the weight of light-duty vehicles like cars, pickups, and sports utility vehicles,[7] and the US automotive industry increasingly demands low-emissions steel.[8] Consequently, the US steel industry is building more capacity for low-emissions steel.[9] Therefore, the demands of the US automotive industry can markedly affect the production of the US mineral industry.

Notably, the US automotive industry is increasingly producing electric vehicles, which will further increase the industry's mineral demand.[10] Electric vehicles contain more aluminum than internal combustion engine vehicles,[11] which—as previously noted—use significant volumes of aluminum.[12] Already, electric vehicles represent 60 percent of global lithium demand,[13] 40 percent of global cobalt demand,[14] and 10 percent of global nickel demand.[15] Electric vehicles are projected to dominate the future demand for many minerals too, such as 95 percent of global lithium demand by 2030.[16] The Fraser Institute projects that almost four hundred new mines may be needed to meet countries' 2030 targets for electric vehicle adoption.[17] Thus, the US automotive industry, especially amid its electric vehicle transition, will bolster the US mineral industry *if* the US automotive industry demands US-produced minerals.

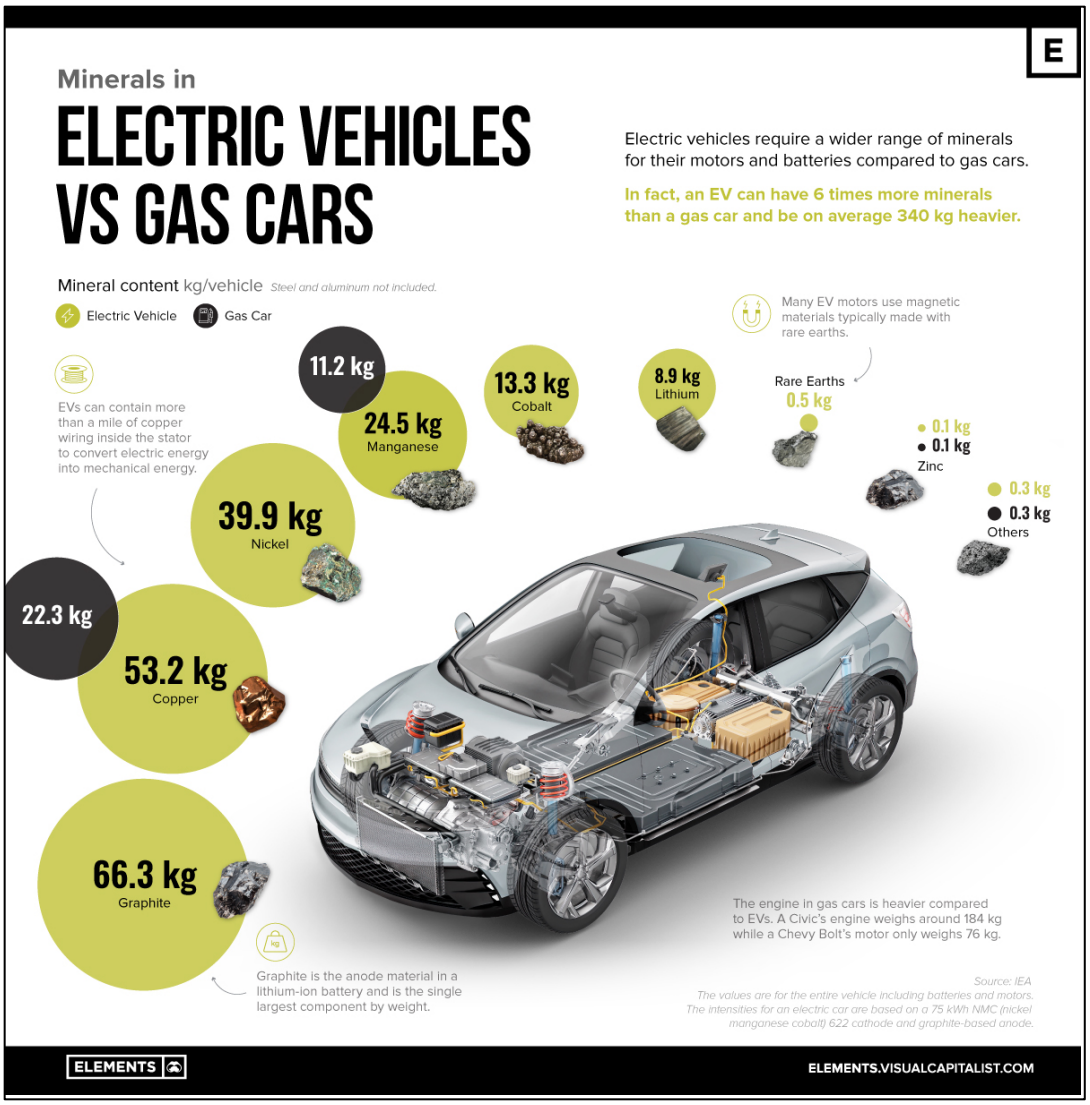

Figure 1: The mineral content of a battery electric vehicle versus an internal combustion engine vehicle. Source: Bruno Venditti and Rosey Eason, "EVs vs. Gas Vehicles: What Are Cars Made out of?" Visual Capitalist, May 30, 2022, https://elements.visualcapitalist.com/evs-vs-gas-vehicles-what-are-cars-made-out-of/.

America's Mineral Problem

However, the US automotive industry predominantly sources lower-cost minerals produced overseas instead of US-produced minerals.[18] For example, the US automaker Ford is directly investing in an Indonesian nickel plant partly owned by the Chinese company Zhejiang Huayou Cobalt.[19] While foreign countries may have larger mineral reserves and higher mineral grades, these foreign minerals are often cheaper due to lower environmental and labor standards. To illustrate, state-backed Chinese and Indonesian companies often clear-cut rainforests in Indonesia, the world's largest nickel producer, to build open-pit nickel laterite mines.[20] Given the energy intensity of mineral processing and many countries' heavy reliance on coal, these minerals are also carbon-intensive.[21] Overseas countries ordinarily have lower labor standards too. For instance, an explosion at a Chinese-owned nickel refinery in Indonesia killed twenty-one workers in December 2023.[22] Lastly, foreign mineral producers are commonly state-backed.[23] They sometimes receive

government grants and concessional loans that absorb some of their costs, allowing them to build capacity and operate at lower costs and thus offer lower mineral prices.

With greater demand for cheap foreign minerals than US minerals, the US mineral industry has declined. The United States increasingly relies on mineral imports to meet its domestic mineral consumption, indicating a relative decline in US mineral consumption versus US mineral production.[24] In 2023, the United States relied 100 percent on imports to meet its demand for twelve minerals on its Critical Minerals List, and it relied over 50 percent on imports to meet demand for another twenty-nine minerals on the list.[25] China is the leading import source of twenty-four mineral commodities in which the United States has more than 50 percent net import reliance.[26] In short, the United States lacks sufficient mineral production to support US keystone industries, which must then rely on mineral imports—including from China.[27]

The risks of continued US reliance on mineral imports include (1) mineral supply disruptions (e.g., export controls), (2) financial benefits to foreign, state-backed mineral companies that do not adhere to equivalent US environmental and labor standards, and (3) disincentives to develop US mineral production. These risks can undermine America's keystone industries, benefit companies and countries opposed to US interests, and stifle the development of the US mineral industry. For example, mineral supply disruptions affecting the defense industrial base during a war could weaken America's warfighting capabilities and ultimately result in lost American lives—and even losing the war.[28] Consequently, mineral import dependence poses risks to US national security and economic prosperity.

First, mineral supply disruptions can arise from various causes, such as export controls, mine issues, labor strikes, natural disasters, or pandemics.[29] For instance, gallium, germanium, natural graphite, and rare earth elements are used in vehicle components, such as semiconductors, lithium-ion batteries, and permanent magnets; however, China is the world's largest producer of gallium, germanium, natural graphite, and rare earth elements,[30] and it has imposed export controls on all of these elements.[31] Such upstream disruptions can impact keystone industries downstream. During the COVID-19 pandemic, shortages of semiconductors—which are usually made of silicon, germanium, or gallium arsenide[32]—resulted in 9.5 million units of lost global light-vehicle production[33] and an estimated $210 billion in lost revenue in 2021.[34]

Second, US mineral imports often financially benefit foreign, state-backed mineral companies that do not adhere to high environmental and labor standards. For example, state-owned or state-holding enterprises comprise the majority of mining and refining production in China,[35] and such enterprises, allegedly, damage the environment with impunity.[36] Chinese state-backed mineral companies operating overseas have also been accused of violating labor rights, including children working seven days a week at cobalt deposits owned or operated by Chinese companies in the Democratic Republic of the Congo.[37] This mined cobalt often enters the global supply chain for electric vehicle batteries.[38] Non-Chinese companies extracting minerals in other countries—such as lithium in Chile—have been accused of various abuses too, like excessive water extraction.[39]

Third, continued reliance on mineral imports disincentivizes US mineral production. If imported minerals remain cheaper—partly due to lower environmental and labor standards—than US minerals, keystone industries will likely prefer to purchase cheap imported minerals over US minerals, disincentivizing US mineral production. Without mineral production, other downstream segments are usually absent too: mining and processing activities have cost-saving incentives to co-locate. Technological advances in extraction and metallurgy are also frequently associated with

mineral production; thus, limited mineral production means limited technological development in the mineral sector. Lastly, continued import reliance versus domestic mineral production foregoes various national economic benefits, including jobs and tax revenue.

US Policy Options

To strengthen the US mineral industry, the US government has largely focused on increasing domestic mineral production, such as offering grants and loans to US mineral projects.[40] But reviving the US mineral industry requires more than increased production of domestic minerals; it also requires increased demand for domestic minerals. Without demand, domestic mineral production will likely cease to exist long-term. Demand-side policies like domestic mineral feedstock requirements for battery factory grants can help increase domestic mineral demand. Thus, a combination of supply-side policies targeting the mining industry and demand-side policies targeting keystone industries can help create a market of sustained mineral supply and demand.

To increase demand for minerals that are domestically produced—that is, domestically extracted and processed—the US government should enhance domestic mineral content requirements for government tax credits, financial support, and acquisitions affecting keystone industries. The US government should also impose import tariffs, coined here as environmental and labor (E&L) tariffs, to ensure minerals failing to meet US environmental and labor standards do not have unfair cost advantages versus US-produced minerals With demand-side policies targeting US keystone industries and affecting the US mineral industry, the US automotive industry—and electric vehicle production—can help revive the US mineral industry.

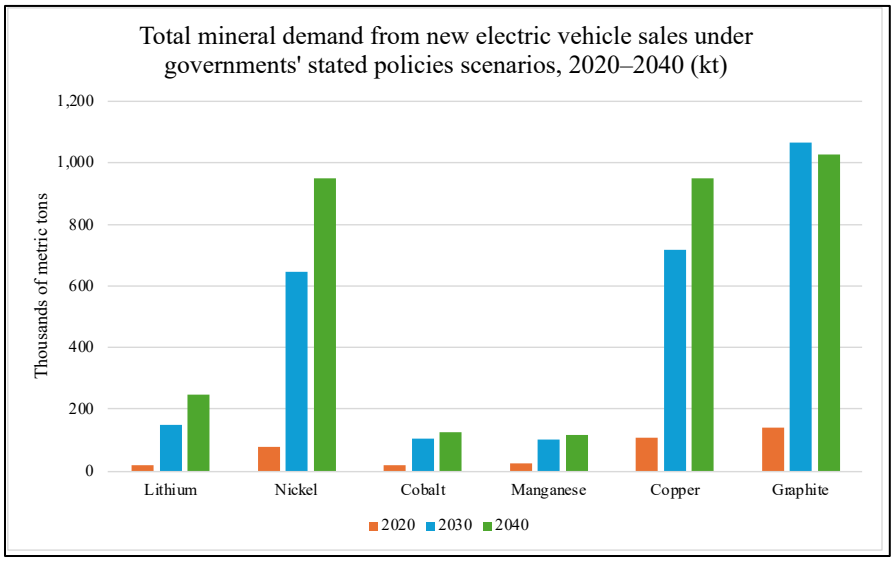

Figure 2: Total mineral demand from new electric vehicle sales under governments' stated policies scenario, 2020–2040 (kt). Source: International Energy Agency, "Total Mineral Demand from New EV Sales by Scenario, 2020–2040," updated May 5, 2021, https://www.iea.org/data-and-statistics/charts/total-mineral-demand-from-new-ev-sales-by-scenario-2020-2040.

First, the US government should enhance domestic mineral content requirements for government tax credits—including consumer, investment, and production tax credits—affecting keystone industries. The Inflation Reduction Act currently offers a $3,750 consumer tax credit to electric vehicles with batteries containing a certain percentage of minerals extracted or processed in the United States, free trade partners, and countries with whom the United States has critical mineral agreements (e.g., Japan).[41] To be eligible for this tax credit, the content of the

value of the battery's critical minerals from these eligible sources must be at least 50 percent in 2024, 60 percent in 2025, 70 percent in 2026, and 80 percent in 2027 and onwards.[42]

Thus, minerals extracted or processed in eligible foreign countries receive the same treatment as minerals extracted or processed in the United States. Yet, eligible foreign mineral producers, such as those in Chile, often have lower capital and operating costs than US mineral producers due to state support and lower environmental and labor standards, enabling the foreign producers to offer lower mineral prices.[43] Since automakers in the United States will seek the cheapest minerals that qualify their electric vehicles for the critical minerals tax credit, the tax credit effectively increases demand for foreign-produced minerals, not US-produced minerals.

To encourage demand for minerals extracted in the United States versus overseas, the US government should disqualify extracted foreign minerals from contributing to the content requirements for the critical minerals tax credit *if* those minerals have reserves in the United States. To illustrate, the United States has nickel reserves, which means all nickel extracted outside the United States would be disqualified from contributing to the content requirement for the minerals tax credit. Otherwise, cheaper nickel from eligible foreign countries will likely satisfy the US automotive industry's nickel demand, displacing demand for US-produced nickel. Under this proposed policy, Americans can still purchase electric vehicles with batteries without US-extracted minerals, but these foreign minerals would not contribute to the critical minerals tax credit.

To stimulate demand for minerals processed in the United States versus overseas, the US government should disqualify all foreign-processed battery materials (e.g., nickel sulfate) from contributing to the content requirements for the critical minerals tax credit. Processing is not geologically constrained, while mining is; consequently, the United States can become a processing powerhouse regardless of its mineral reserves by securing overseas mineral reserves and developing domestic processing capacity. For example, in 2022, China only had 1.7 percent of global cobalt reserves;[44] yet, China had 75 percent of global cobalt refining.[45] Again, under this policy, Americans can still purchase electric vehicles with batteries not containing US-processed minerals, but these foreign minerals would not contribute to the critical minerals tax credit.

For minerals lacking reserves in the United States (e.g., manganese), the US government should allow extracted minerals from certain foreign countries to contribute to the critical minerals tax credit content requirements. For these foreign minerals, however, the US government should incentivize the most resilient mineral supply chains by only deeming minerals eligible from certain countries, based on countries' order of supply chain resilience. Supply chain resilience rankings would consider factors like a country's proximity to the United States, size of mineral reserves, and political risks. For example, manganese reserves are located in both Australia and Mexico, but given Australia's larger reserves and lower political risks, manganese extracted in Australia, not Mexico, would be eligible to contribute to the content requirements for the critical minerals tax credit.[46] Sometimes extracted minerals from multiple foreign countries would be eligible to contribute to the content requirements for the tax credit. For instance, the United States has no production and lacks appreciable reserves of natural graphite, while both Canada and Norway have relatively small natural graphite production.[47] In this case, natural graphite produced from both Canada and Norway would be eligible to contribute to the tax credit content requirements.

While the assessment of countries' supply chain resilience varies by element, the order of countries with the most resilient to the least resilient supply chains to the United States is generally the following: Canada, Australia, free trade partners in the Western Hemisphere, Morocco, Japan,

South Korea, and other eligible countries. The reason why US supply chains with Australia are more resilient than US supply chains with Mexico and other Western Hemisphere countries (excluding Canada) is greater political risks in these other countries, such as forced government shutdowns and nationalization of mining assets.[48] Additionally, US supply chains with Morocco are more resilient than US supply chains with Japan and South Korea because US sea lanes with East Asia face high disruption risks in a potential US-China conflict.[49]

Importantly, electric vehicles with batteries containing *any* content extracted or processed by foreign entities of concern, which includes Chinese companies, should disqualify those vehicles from the critical minerals tax credit.[50] The ownership threshold for an entity to be deemed a foreign entity of concern is currently 25 percent ownership by a foreign entity of concern. This threshold means US-made electric vehicles with batteries containing minerals produced by entities with less than 25 percent ownership by foreign entities of concern can qualify for the critical minerals tax credit, benefitting foreign entities of concern. The ownership threshold to be deemed a foreign entity of concern should be *any* ownership held by a foreign entity of concern. Under this proposed policy, Americans could still purchase vehicles containing minerals produced by foreign entities of concern, but those vehicles would be ineligible for the minerals tax credit.

The US government should enhance domestic mineral content requirements for other tax credits too, including investment and production tax credits. To receive these tax credits, US projects should be required to use certain levels of domestic mineral feedstock in their operations. For instance, nickel sulfate projects should be required to use US-produced nickel feedstock to receive either investment or production tax credits. Tax credits should also be conditioned on the credit claimant using no feedstock from foreign entities of concern, meaning nickel sulfate projects seeking tax credits could not source nickel feedstock from Chinese or Russian companies.

Second, the US government should enhance the domestic mineral feedstock requirements for government financial support affecting keystone industries. The Department of Energy offers grants and loans for projects in the battery supply chain, from cathode production facilities to battery cell factories.[51] To increase demand for domestically produced minerals, the US government should only offer grants and loans to projects that source minerals meeting the three following criteria: domestically extracted minerals for those minerals with domestic reserves, only domestically processed minerals, and no minerals produced by foreign entities of concern.

For example, a prospective production facility for precursor cathode active material would be eligible to receive US government funding if the facility sources US-processed nickel sulfate produced from US-mined nickel, US-processed cobalt sulfate produced from US-mined cobalt, and US-processed manganese sulfate produced from Australian-mined manganese. Such sourcing requirements for US government grants and loans would encourage automakers in the United States to invest in the upstream supply chain, as many automakers are already doing.[52] US projects in the battery supply chain that do not source minerals meeting the criteria could still build production facilities, but they would be ineligible for government grants and loans.

Third, the US government should enhance the domestic mineral content requirements for government acquisitions affecting keystone industries. As the world's largest purchaser,[53] the US government can dramatically impact the automotive and mineral industries through domestic content requirements. For example, if the US Army proceeds with fielding an entirely electric non-tactical light-duty vehicle fleet by 2027,[54] the US Army should procure vehicles with batteries containing high domestic mineral content, driving demand for US-produced minerals. Similarly,

the US Postal Service intends to purchase 66,000 electric vehicles from 2024 through 2028,[55] and it should also purchase vehicles with batteries containing a high percentage of domestically produced minerals. Without such requirements, US government acquisitions of electric vehicles could increase demand for foreign-produced minerals, including from China.

For US government departments and agencies purchasing electric vehicles, their acquisition rules should require batteries containing 80 percent domestically extracted minerals and 100 percent domestically processed minerals. The 80 percent extraction target is from the Inflation Reduction Act's critical minerals tax credit, which requires that 80 percent of the content of the value of the battery's critical minerals be from eligible sources (e.g., the United States, free trade partners, and countries with whom the United States has critical mineral agreements) in 2027 to qualify for the tax credit. Such a high content threshold for tax credit eligibility would help spur demand for US-extracted minerals. To grow demand for US-processed minerals, the US government should require 100 percent domestic content for processed minerals since processing is dictated more by capital and technical expertise than geological reserves.

The US government should also impose environmental and labor (E&L) tariffs to ensure minerals failing to meet US environmental and labor standards do not have unfair cost advantages versus US-produced minerals. Overseas sources of US mineral imports generally have far lower environmental and labor standards. As previously noted, state-backed Chinese and Indonesian companies often clear-cut rainforests in Indonesia to build open-pit nickel laterite mines.[56] These companies then produce mixed hydroxide precipitate that is converted into nickel sulfate, which is necessary in certain electric vehicle batteries. Imports of these nickel products should face substantial US import tariffs given their environmental costs, and the use of these nickel products by any US products or projects should disqualify them from government tax credits. Regarding the automotive industry, the US government should increase import tariffs on minerals with US reserves (e.g., nickel), all processed battery materials (e.g., nickel sulfate), all battery components (e.g., cathode material), all battery cells and packs, and all electric vehicles.

Increasing tariffs across the battery supply chain should help ensure that US-produced goods with high domestic content, not foreign content, meet US demand for these goods. For instance, if Americans can import cheap electric vehicles with batteries containing foreign-produced minerals, those imported vehicles—instead of US-made electric vehicles with batteries containing US-produced minerals—will satisfy US demand for electric vehicles. Thus, protecting the US automotive industry from cheap imports should protect the US mineral industry too. As Tesla CEO Elon Musk warned in January 2024, "If there are no trade barriers established, [Chinese electric vehicle companies] will pretty much demolish most other car companies in the world."[57]

Conclusion

The US automotive industry is a keystone industry that consumes significant volumes of minerals. The mineral demands of the US automotive industry, therefore, can markedly impact the production of the US mineral industry. But, instead of sourcing US-produced minerals, the US automotive industry often sources foreign minerals, which are cheaper given state backing and lower labor and environmental standards. To sustain the US mineral industry long-term, the mineral industry needs sustained demand, and to sustain demand, the US government should adopt demand-side policies—like enhanced domestic mineral content requirements for mineral tax credits—targeting keystone industries like the automotive industry. Such demand-side policies could increase demand for US-produced minerals—and help revive the US mineral industry.

[1] The US government defines critical minerals as a non-fuel mineral or mineral material "essential to the economic or national security of the United States; the supply chain of which is vulnerable to disruption; and serve an essential function in the manufacturing of a product, the absence of which would have significant consequences for the economic or national security of the United States." See 30 USC 1606 (c)(4)(A)(i–iii), accessed November 10, 2023, https://uscode.house.gov/view.xhtml?req=(title:30%20section:1606%20edition:prelim).

[2] US Department of Defense, "Defense Production Act Investments," November 15, 2023, https://www.linkedin.com/posts/ousd-as_defense-production-act-investments-activity-7132757979564539904-l7QB; and "Critical Materials Projects," Loan Programs Office, US Department of Energy, accessed March 1, 2024, https://www.energy.gov/lpo/critical-materials-projects. The US government has also pursued "friendshoring" of mineral supply chains. According to US Treasury Secretary Janet Yellen, "Friend-shoring is about deepening relationships and diversifying our supply chains with a greater number of trusted partners to lower risks for our economy and theirs." See Christopher Condon, Heejin Kim, and Sam Kim, "Yellen Touts 'Friend-Shoring' as Global Supply Chain Fix," *Bloomberg*, July 18, 2022, https://www.bloomberg.com/news/articles/2022-07-18/yellen-touts-friend-shoring-as-fix-for-global-supply-chains. See also Ana Swanson, "The US Needs Minerals for Electric Cars. Everyone Else Wants Them Too." *New York Times*, May 21, 2023, https://www.nytimes.com/2023/05/21/business/economy/minerals-electric-cars-batteries.html; and Samantha DeCarlo and Anna Perry, "Why Can't We be Friends? Friendshoring the REE Supply Chain," US International Trade Commission, April 2023, https://www.usitc.gov/publications/332/executive_briefings/ebot_friendshoring_ree.pdf. The US government's friendshoring efforts include, for example, investing in an investment firm to invest in a nickel project in Brazil and a rare earths project in South Africa, as well as financing a railway project that will connect mineral-rich central Africa to the Lobito port in Angola. See "Sourcing Critical Minerals to Support the Global Clean Energy Transition," US International Development Finance Corporation, accessed March 1, 2024, https://www.dfc.gov/investment-story/sourcing-critical-minerals-support-global-clean-energy-transition; US International Development Finance Corporation, "DFC Delivers on US Climate Finance Commitments at COP28, Announces More than $3.7 Billion in Climate Finance in FY2023," December 8, 2023, https://www.dfc.gov/media/press-releases/dfc-delivers-us-climate-finance-commitments-cop28-announces-more-37-billion; and US International Development Finance Corporation, "DFC Announces New U.S. Financing for Africa's Lobito Corridor," February 8, 2024, https://www.dfc.gov/media/press-releases/dfc-announces-new-us-financing-africas-lobito-corridor.

[3] The term "keystone industry" is based on the term "keystone species," which Robert T. Paine defined as a "single species of high trophic status" whose activities "disproportionately" affect "the patterns of species occurrence, distribution and density" in "natural communities." In other words, the keystone species is an apex predator in an ecosystem. Paine also defined keystone species in the following manner: "Within both these fairly or very complex systems the species composition and physical appearance were greatly modified by the activities of a single native species high in the food web. These individual populations are the keystone of the community's structure, and the integrity of the community and its unaltered persistence through time, that is, stability, are determined by their activities and abundances." Stephen Wagner offers a concise interpretation of Paine's definition: "Keystone species are species that play a disproportionately large role in the prevalence and population levels of other species within their ecosystem or community." See Robert T. Paine, "The Pisaster-Tegula Interaction: Prey Patches, Predator Food Preference, and Intertidal Community Structure," *Ecology* 50, no. 6 (1969): 950, https://doi.org/10.2307/1936888; Robert T. Paine, "A Note on Trophic Complexity and Community Stability," *The American Naturalist* 103, no. 929 (1969): 92, http://www.jstor.org/stable/2459472; and Stephen C. Wagner, "Keystone Species," *Nature Education Knowledge* 3, no. 10 (2010):51, https://www.nature.com/scitable/knowledge/library/keystone-species-15786127.

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(China Development Bank and Export-Import Bank of China) and Chinese state-owned commercial banks (Industrial and Commercial Bank of China and Bank of China, based in Sydney)." See Gregory Wischer and Juan Pablo Villasmil, "China's Critical Mineral Model in Latin America," *New Security Beat*, Wilson Center, July 24, 2023, https://www.newsecuritybeat.org/2023/07/chinas-critical-mineral-model-latin-america/.

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