China's Role in Supplying Critical Minerals for the Global Energy Transition

What Could the Future Hold?

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LTRC
Leveraging Transparency to Reduce Corruption

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The world faces major challenges in responsibly sourcing large quantities of minerals that are critical for the transition to low-carbon energy sources. Consumption of these critical minerals—most notably nickel, copper, lithium, and cobalt—is projected to rise, largely driven by their use in the renewable energy sector. Demand is expected to quadruple by 2040 under the International Energy Agency's Sustainable Development Scenario, in which global action would limit the global temperature rise to well below 2°C, and it is projected to rise by six times under a net-zero scenario.[1] Many governments, including the United States, European Union members, and China, seem to share the goal of increasing the supply and rate of production of the raw materials needed for the energy transition to address the challenge of global climate change. However, meeting this demand will be difficult—and producing these minerals in strict adherence to robust environmental, social, and governance criteria will be even more so.

China is the dominant player in global mineral processing. This report analyzes how its strategic position in regard to critical minerals may evolve, to shed light on current and emerging challenges for the energy transition, given the country's high level of engagement in global mineral supply chains.

Two major factors are likely to influence dynamics around responsible sourcing of critical minerals for the energy transition. This first factor is China's level of dominance across critical minerals supply chains. There is growing concern that a high level of dependence on China for these minerals and their derivative products may create energy security risks.[2,3] Other governments, notably in the U.S. and Europe, have moved to build out their own critical minerals supply chains, creating uncertainty about whether China will maintain its dominant position. The second factor is the level of enforcement of due diligence requirements in China's mineral sector and midstream and downstream industries (e.g., refiners or original equipment manufacturers) to make these supply chains "cleaner" and "greener." Comprehensive, globally aligned due diligence requirements are needed to ensure that the sourcing of minerals needed for the energy transition does not cause or contribute to adverse social and environmental impacts. These two factors will likely shape the future of critical minerals supply chains.

A best-case scenario would be characterized by geographic diversification of critical minerals supply chains, coupled with globally aligned statutory due diligence requirements to make these supply chains cleaner and greener. This would see the U.S. and Europe making considerable investments in and successfully building out their critical minerals supply chains, from mining to battery manufacturing. It would also entail China instituting mandatory due diligence requirements on critical minerals sourcing and global coordination among major players, including Beijing, Washington, and Brussels, to align these requirements. This would ensure a stable supply of cleaner and greener critical minerals for the energy transition and minimize the risk of the energy transition being disrupted due to price volatility, geopolitical tensions, or logistical issues in supply chains.

As things stand, this best-case scenario looks unlikely. Considerable investment would be needed to build out critical minerals supply chains in the U.S. and Europe. Current planning, including that undertaken by the Biden administration in the U.S., is a step in the right direction, but it is unclear whether it is commensurate with the scale of the challenge.

Moreover, China shows few signs of moving toward mandatory due diligence requirements for critical minerals and their derivative products. It has taken some steps to strengthen due diligence in the past decade, but key standards, many of which are voluntary, remain unenforced. This means that broad transparency across critical minerals supply chains globally will be difficult to achieve, given the critical role of Chinese actors, particularly in the midstream.

A worst-case scenario would see continued reliance on China for critical minerals and their derivative products. This would expose the energy transition to major geopolitical risks, as well as increase the risk that sourcing of critical minerals will cause or contribute to serious social or environmental harms.

1 Introduction

This report from the Leveraging Transparency to Reduce Corruption project (LTRC) explores four potential scenarios for China's role in critical minerals supply chains over the next 20 years, considering two key factors that are likely to influence dynamics around sourcing of critical minerals for the energy transition: 1) the extent to which China retains a dominant position in these supply chains and 2) whether China's mineral sector and midstream and downstream industries (e.g., refiners or original equipment manufacturers) move to make these supply chains "cleaner" and "greener" by tightening due diligence requirements. The report describes what each scenario could mean for the global energy transition, and specifically whether the world would have access to the stable and clean supply of critical minerals it would need to meet ambitious decarbonization goals.

Minerals undergo a complex, multi-stage transformation for use in applications such as rechargeable electric batteries. First, raw minerals are mined from deposits. This mining activity, known as **upstream operations**, is heavily concentrated in a set of resource-rich countries. The minerals are then sold to traders or directly to smelters or refiners, mostly located in China. Chemical refining and processing, known as **midstream operations**, transform the minerals into fine particles with high purity levels and make them suitable for use in battery-grade products. In the late midstream stage, manufacturers use these refined products to manufacture major battery cell components—namely cathodes, anodes, and collectors. These cell components are then assembled by **downstream** actors into modules within battery packs, which are used in applications such as electric vehicles (EVs). For simplicity, we broadly refer to the products at the various stages of the process from smelting to the manufacturing of battery cells and their components as **critical minerals products** in this paper.

As critical minerals move along the value chain, the companies that acquire them may undertake due diligence to assess whether they have been responsibly mined and processed. **Due diligence** refers to the process through which companies identify, prevent, mitigate, and account for how they address actual and potential adverse social and environmental impacts.[4] International organizations and industry associations have set out several different due diligence schemes. In some jurisdictions, notably in Europe, governments are instituting mandatory due diligence requirements for companies.

Effective due diligence across critical minerals supply chains serves two main purposes. First, it supports efforts to ensure that the extraction and trade of these minerals has positive impacts on society and contributes to sustainable development. Second, it reduces the risk that their extraction and trade will contribute to social and environmental harms, including labor abuses, corruption, and conflict. In this paper, we use the terms **cleaner** and **greener** to describe critical minerals that have been subject to due diligence processes and are therefore less likely to have caused, contributed to, or been linked to adverse impacts. It is important to note that there are no perfectly "clean" or "green" critical minerals or critical minerals products. Rather, there is a wide spectrum, with minerals that cause major and multiple adverse impacts on one end and minerals that have been responsibly and sustainably mined and processed on the other. Mandatory, rigorous, and widespread due diligence is critical to ensuring that the energy transition—which will require large volumes of critical minerals—does not cause adverse impacts globally.

China currently controls most global critical minerals refining, and its upstream control of raw commodities is also increasing. Crucially, it controls much of the world's EV battery manufacturing, as well as the manufacturing of wind turbines, solar panels, energy storage, and electric transmission, among other applications. As things stand, the world is highly dependent on sourcing from China to advance the energy transition and meet decarbonization goals. The sheer influence and impact of a single player calls for an assessment of the risks and challenges it may pose for the energy transition, as well as potential pathways to address them in the critical minerals supply chain.*

A consensus is growing about the risks to energy security posed by concentration of various stages of critical minerals supply chains. The International Energy Agency (IEA) has highlighted the high geographic concentration of production—including the high concentration of processing operations in China—as a key vulnerability for the energy transition.[5] Other international organizations have also identified concentration of producers as a source of risk for the energy transition "should investments in production capacity not meet demand, or in case of potential geopolitical risk inside or between producer nations."[6] Similarly, the European Union and the United States have recognized dependence on China for critical inputs and technologies as a major reason to increase their mineral supply chain resilience.[7]

The next section sets out China's role in critical minerals supply chains. Section 3 explores the West's bid to build out its own critical minerals supply chain to reduce Chinese dominance. Section 4 explores the question of whether China will tighten due diligence requirements on these supply chains. Section 5 undertakes a scenario analysis to consider how dynamics may evolve over the next 20 years.

* A nonpartisan consensus has emerged among the U.S., EU, and many international forums, such as the IEA, that the concentration of the critical minerals supply chain creates energy security risks in the context of the energy transition. We recognize that the Chinese government and the Chinese private sector may have a different perspective.

2 China's Role in Critical Minerals Supply Chains

China dominates the midstream and downstream of critical minerals supply chains but not upstream production.

China is the dominant global player in refining strategic minerals. It refines 68% of nickel globally, 40% of copper, 59% of lithium, and 73% of cobalt.[8,9] It is also a strategic player in later stages of the supply chain, such as manufacturing of battery cell components. It accounts for most of the global production of mineral-rich components for battery cells, including 70% of cathodes, which are the most important component and can account for half the cost of a manufactured cell, 85% of anodes, 66% of separators, and 62% of electrolytes[10,11] Most notably, China holds 78% of the world's cell manufacturing capacity for EV batteries, which are then assembled into modules that are used to form a battery pack. The country also hosts three-fourths of the world's lithium-ion battery megafactories.[12] This makes China the largest consumer of the minerals it refines.

Given tight mineral supplies, actors ranging from manufacturers to refiners are now targeting mining projects as part of their investment strategies to secure raw minerals. Foreign investments and agreements on future demand for minerals, often in the form of joint venture and strategic cooperation agreements, show the strong dependency on China's mineral processing operations and manufacturing capacities. For example, European and U.S. automakers have shown interest in collaborating with Chinese companies. Volkswagen recently announced that it will form a joint venture with Huayou Cobalt in southwestern Guangxi Province, China, and with Tsingshan Holding Group in Indonesia to secure nickel and cobalt supplies.[13] Similarly, Ganfeng Lithium signed a long-term supply agreement with BMW and strategic cooperation agreements with Tesla and Volkswagen.[14]

While China has a clear downstream competitive advantage, it does not dominate the upstream for critical minerals. Australia and Chile host more than 70% of global lithium extraction, and the Democratic Republic of the Congo (DRC) hosts nearly 70% of cobalt extraction. In the case of nickel extraction, Indonesia is the largest source, with more than 30% of the global share. For

copper extraction, Chile and Peru, the two largest players, account for more than 40% of the global share.[15] At a domestic level, China has recently invested in increasing its domestic mined lithium output, especially in Qinghai Province; but despite widespread government support and investments, the region has failed to significantly ramp up production, largely due to high waste-disposal costs.[16,17] While Chinese mining companies like Zijin Mining are trying to speed up construction of other domestic mine sites, such as the Xiangyuan Lithium Polymetallic Mine in Hunan Province,[18] China extracts less than 10% of the global market for both copper and lithium domestically.[19] (This does not account for Chinese companies or partly Chinese-owned companies overseas.) China is by far the world's leading producer and processor of rare earth elements (REEs), which are used in motor technologies for EVs and wind power technologies. (See Box 1.)

With demand for critical minerals rapidly increasing, Chinese companies are striking new deals for minerals globally to secure raw mineral inputs for refining and battery manufacturing. This includes direct investments in mining projects and companies, part-equity-stake deals, and extended supply sales agreements with mining companies. In January 2022, BYD, one of the largest automakers in China, was awarded a contract to extract 80,000 metric tons of lithium in Chile over 20 years, although the contract has been suspended by a Chilean court.[20] In 2018, China's Tianqi Lithium purchased a 24% stake in SQM, one of only two major lithium producers in Chile.[21] Huayou Cobalt, a Chinese company with smelters and refining facilities both inside and outside China, has vertically integrated by expanding into other stages of mineral supply chains, as evidenced by its recent purchase of a lithium mine in Zimbabwe.[22] Similarly, Ganfeng Lithium, one of the major lithium producers and refiners, has acquired stakes in mining projects in Argentina, Ireland, Chile, and Australia. CATL, the world's largest EV battery manufacturer, has acquired Canada-based Millennial Lithium, as well as stakes in an Australian lithium mining company and in copper-cobalt mines in the DRC. At the start of 2022, Suzhou CATH Energy Technologies entered into an agreement under which it will invest US$240 million in the Manono lithium and tin project in the DRC in a joint venture with AVZ Minerals, earning a 24% equity interest.[23] Chinese companies have remained the largest source of foreign investment in the nickel sector in Indonesia—the world's largest producer of nickel—and Chinese-backed companies own or have a financial stake in 15 of 19 cobalt-producing mines in the DRC.* [24]

* Chinese mining giants like Huayou Cobalt and China Molybdenum, which dominate cobalt mining in the DRC, have also increased investment in the nickel supply chain in Indonesia. See: Pattisson, P., & Firdaus, F. (2021, November 25). "Battery arms race": How China has monopolised the electric vehicle industry. *The Guardian*. https://www.theguardian.com/global-development/2021/nov/25/battery-arms-race-how-china-has-monopolised-the-electric-vehicle-industry

BOX 1. Rare Earth Elements

Rare earth elements are the only strategic sector over which China has a substantial hold over mining activity. REEs include 17 metallic elements, four of which—neodymium, dysprosium, praseodymium, and terbium—are of particular relevance to clean energy technologies. Demand for these four elements is expected to rise dramatically (e.g., neodymium is projected to triple under the IEA's Sustainable Development Scenario). They play a particularly important role in motor technologies for EVs and wind power technologies and can more easily be substituted in the case of supply concerns or disruptions, according to Wood Mackenzie.[25] The U.S. Department of Energy projects that "demand for rare earth elements for wind power alone could exceed the supply for all uses by 1.6 to 3.5 times over."[26] (REEs should not be mistaken for other strategic minerals, over which China has a significantly less dominant role across the entire supply chain.)

China's REE production increased at the beginning of this century and peaked at 95% of the global share by 2010. It has decreased in recent years, down to nearly 60% in 2019.[27] Other relevant producers include the U.S. and Myanmar, with just over 10% of global REE production each. Currently, MP Materials is the only significant REE producer in the U.S.[28] The company is minority owned by Shenghe Resources, a partly Chinese-state-owned company that is also the sole purchaser of its output.[29] Due to the level of concentration of REE production and the lack of recycling pathways, efforts are ongoing to reduce REE use in EV motors to reduce exposure to REE export control risks.* New discoveries—including a potentially relevant discovery in Turkey in June 2022—may further reduce dependence on China for REEs in the long term if these deposits can be successfully developed. However, REE processing capacity remains concentrated in China.[30]

* According to the IEA, pathways to reducing REE use in EV motors include: "(i) improving material efficiency in magnet production to obtain NdFeB magnets with less REE content but with similar performance; (ii) reducing the amount of NdFeB magnets in permanent-magnet synchronous motors; (iii) substituting permanent-magnet motors with REE-free motors." See: International Energy Agency. (2021). *The Role of Critical Minerals in Clean Energy Transitions*. https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions

3 Efforts to Reduce Dependence on China for Critical Minerals

Concern is growing about China's dominance in critical minerals supply chains, but efforts to reduce dependence on China face a range of challenges.

Governments in the West, notably in the U.S. and Europe, are working to build out their own critical minerals supply chains to reduce dependence on China. This will be challenging and costly, however. They will need to significantly increase mineral production domestically or in allied countries, which will involve addressing conflicts over social and environmental impacts that have halted mining projects. The U.S., in particular, will likely have to update and amend its mining regulatory regime. Governments will also have to onshore or "friend-shore" smelting and refining capacity. The midstream part of the equation is likely to be the most challenging, complicated by high investment costs and market conditions. Finally, Western countries will need to build out cell component and battery manufacturing capacities.

Western governments have laid out plans to reduce vulnerabilities and increase mineral supply chain resilience.[31] Russia's February 2022 invasion of Ukraine has added to the salience and urgency of these plans, underscoring that dependence on strategic rivals for critical resources is a vulnerability. Organizations including the IEA are increasingly calling attention to the geopolitical and energy security dimensions of critical minerals supply chains.[32]

The Biden administration is focused on developing U.S. critical minerals supply chains and issued an executive order in February 2021 mandating a review of vulnerabilities in domestic supply chains. President Joe Biden invoked the Defense Production Act in April 2022 to fund the mining, processing, and recycling of lithium, nickel, cobalt, graphite, and manganese. The proposed Inflation Reduction Act of 2022 would incentivize investments across critical mineral supply chains.[33] It would require a certain percentage of batter components (by value) to be assembled in the US, as well as a certain percentage of the battery minerals to come from a country with which the US has a free trade agreement or to be recycled in North America. These requirements gradually ramp up through 2027. This is likely to benefit Canada (the major North American miner) and Australia (a key producer of lithium). The act increases funds available for the

midstream, including US$500 million to build critical minerals processing infrastructure as part the Defense Production Act, as well as additional tax credits for companies involved in critical minerals processing. It also provides grants and loans for new clean vehicle manufacturing facilities.[34] Similarly, the European Battery Alliance aims to expand mineral refining and battery production capacities in the EU to reduce dependence on China.[35]

Multilateral cooperation around critical minerals is also growing. In June 2022, the U.S. announced the Minerals Security Partnership (MSP), which has been dubbed "a metallic NATO." MSP partners include Australia, Canada, Finland, France, Germany, Japan, the Republic of Korea, Sweden, the United Kingdom, the U.S., and the European Commission.[36] It reflects a new strategic emphasis on friend-shoring, which U.S. Treasury Secretary Janet Yellen has described as a strategy in which a group of countries with shared values (e.g., liberal democracies) deploy policies that encourage companies to anchor supply chains within that group. The aim is to prevent strategic rivals from unfairly leveraging a market advantage in a key industry, such as critical minerals, to disrupt the economy of the U.S. or its allies. Japan and Korea are notable members because they have sizable capacities in the production of cell components outside of China and will likely be especially crucial to these friend-shoring efforts.

EV and car manufacturing companies, along with other downstream actors in the U.S. and the EU, also have an important role to play in diversifying supply chains. They are increasingly pursuing strategies to secure long-term supplies of processed minerals and reduce reliance on China. These include expanding their operations to other parts of the supply chain (in what is known as vertical integration). General Motors' deal with POSCO Chemical to establish a factory in Canada to process cathode active material is one example of this.[37] EV manufacturers have also established direct sourcing deals and association strategies. For example, Liontown Resources, an Australian lithium miner, recently agreed to direct sourcing deals with Tesla, Ford, and LG Energy.[38]

Reducing dependence on China for critical minerals is likely to be challenging. The following sections explore three key issues that will need to be addressed: political challenges and stakeholder opposition to onshore mining development (i.e., community opposition, institutional challenges, and government inertia), limited investment in mineral refining and smelting, and limited cell component and battery manufacturing capacities.

3.1 Political Challenges and Stakeholder Opposition to Onshore Mining Development

It is difficult to build out domestic critical minerals supply chains without domestic sources of raw minerals. In June 2022, the U.S. Department of the Interior announced that it would invest an estimated US$74 million across 30 states to better map areas with potential for critical minerals.[39] However, bringing new supplies online in the short term will be challenging. There is no single federal agency with authority over domestic mining, and the regulatory regime for mining in the U.S. is outdated. Moreover, existing projects in the pipeline face a range of political and stakeholder challenges.[40]

For example, the U.S. holds about 4% of global lithium reserves but has just one producing lithium mine and is struggling to bring additional projects online. Lithium Americas' Thacker Pass project in Humboldt County, Nevada, which would develop the largest known lithium resource in the U.S., reportedly faces staunch opposition from state environmental groups, Native American communities, and local ranchers.[41] Lithium Americas received a permit from the U.S. Bureau of Land Management to develop the mine in January 2022 but has faced multiple legal challenges due to alleged negative social and environmental impacts and inadequate consultation with project-affected Native American communities.[42] Similarly, ioneer's Rhyolite Ridge Lithium-Boron Project has faced intense opposition from environmentalists who allege that the project threatens Tiehm's buckwheat, a rare flowering plant listed by the Biden administration as endangered.[43]

Domestic copper and nickel development in the U.S. has faced similar challenges. In January 2022, the U.S. Department of the Interior canceled two mineral leases for Antofagasta's Twin Metals copper and nickel project in northern Minnesota.[44] President Barack Obama had moved to block the project, which is on the edge of the Boundary Waters (a large area of protected lakes and forests), but the mineral leases were reinstated by the Trump administration in 2019. The Interior Department determined that the leases were improperly reinstated and cited significant legal deficiencies in the renewal, including a violation of departmental regulations and an inadequate environmental analysis. In May 2022, the U.S. Environmental Protection Agency banned the disposal of mining waste in Alaska's Bristol Bay watershed, which is likely the final nail in the coffin for Northern Dynasty's controversial proposed Pebble copper project.[45] The Resolution Copper project in Arizona, a joint venture owned by Rio Tinto and BHP, has faced legal challenges from Apache Stronghold, a nonprofit group comprising members of the San Carlos Apache tribe.[46] The project sits on land that is of religious significance to the Apache, and the group argues that development of the mine would undermine their religious rights. The U.S. Court of Appeals for the Ninth Circuit ruled against Apache Stronghold in June 2022.[47] The group has signaled its intention to appeal to the Supreme Court.

Simultaneously, Congress is pursuing reforms to the General Mining Act of 1872, although these efforts have consistently encountered political roadblocks. In April 2022, House Natural Resources Committee Chair Raúl M. Grijalva (D-AZ) and Senator Martin Heinrich (D-NM) introduced the Clean Energy Minerals Reform Act, which would update the 1872 act to strengthen environmental protections, require the government to consult with Native American groups before permitting mines near tribal communities, and institute a royalty on mining on public lands. The bill has faced opposition from environmental groups, which want even stronger protections, as well as from moderate Democratic and conservative lawmakers who are opposed to the introduction of a royalty. It may be difficult to build the political consensus needed for meaningful mining reform, particularly given internal divisions among Democrats.

The Biden administration is currently taking some steps to address these challenges related to political and stakeholder factors, but its efforts are not commensurate with the scale of the challenge. In February 2022, the Interior Department announced a new interagency working group on reforming hardrock mining laws, regulations, and permitting policies. The timeline for this reform and plans to successfully advance it through Congress, particularly in the context of Biden's ongoing failure to advance a legislative agenda, is unclear. Moreover, the administration

has been unwilling to advance controversial projects like Pebble and Twin Metals, which are likely needed to significantly increase domestic supply in the short term.

Europe also faces opposition as it pushes to bring critical minerals projects online. Savannah Resources' Mina do Barroso—which would be Europe's first significant producer of spodumene, a hardrock form of lithium—has faced red tape and political delays in its Environmental Impact Assessment approval process.[48] The project reportedly faces a high degree of local stakeholder opposition.[49] In January 2022, the Serbian government canceled Rio Tinto's Jadar lithium project amid protests over perceived environmental impacts.[50]

3.2 Limited Investment in Mineral Refining and Smelting

Even if the U.S. and EU were to dig more minerals out of the ground, many of these minerals would need to be shipped overseas for concentrating, refining, and smelting without significant increases in U.S. and European mineral refining and smelting capacity. The only notable mineral processing capacity outside of China is in Europe, but this is mostly limited to cobalt processing, mainly at plants in Finland. (Europe currently accounts for 20% of global cobalt processing.)

The solution would be to build new refiners and smelters in the U.S., Europe, or other allied nations, such as those in the MSP, as part of a combined onshoring and friend-shoring effort. Some progress has been made in this direction. The UK has recently announced plans to build up its lithium refining capacities. Green Lithium has plans to build a lithium refinery with production capacity of 50,000 tons per year in the North of England, through an investment from Trafigura, one of the world's biggest metal traders. Additionally, Livista Energy, another start-up, has secured funding to build a plant with an initial capacity of 30,000 tons per year, with the potential of increasing up to 60,000 tons per year. However, bringing new mineral refining and smelting capacity online is overall extremely difficult due to high investment costs and vulnerability to volatile or poor market outlooks.

China's domestic refining business has proven to be significantly more cost-competitive than refineries overseas, leading to refinery closures outside of China.51 Construction of refineries and smelters outside of China (many of which have been financed by Chinese investments) has proven costly and challenging. For example, China's Tianqi Lithium's lithium hydroxide plant in Kwinana, Australia, is only partly operational after US$700 million in investment and three years of construction.52 The plant was approved in 2016, but development was paused due to market conditions related to the low prices of lithium at the time, which were associated with high price volatility for battery metals.53 Chinese companies like Tianqi have benefited from financial support from China's state-owned banks, such as CITIC Bank, which can channel government support for industries deemed strategic in order to resolve debt problems stemming from large investments at a time of low commodity prices.

Smelters, refiners, and other types of processing infrastructure are susceptible to the same kinds of opposition as mining projects themselves, with stakeholders concerned about potential social and environmental impacts. This can create complications in permitting and approvals

processes. The industrial processes required for battery metals refining and recycling tend to generate a large carbon footprint and other toxic emissions (especially in the case of nickel). This has led to opposition from communities hosting these industrial facilities. One example is the case of a planned lithium-ion battery recycling facility in New York by SungEel MCC in New York, which canceled its plans because of community concerns regarding the facility's alleged toxic emissions.[54]

3.3 Limited Cell Component and Battery Manufacturing Capacities

The U.S has limited capacity to produce the cell components (cathodes, anodes, and collectors) needed for batteries and the batteries themselves. Europe hosts some manufacturers of cell components, crucially Germany's BASF, Belgium's Umicore, and Sweden's Northvolt, but capacity is limited. Moreover, another major obstacle is that the U.S., Europe, and other Western countries lack investment in overall battery manufacturing capacities compared to China. Indeed, China's heavy investment in EVs and battery storage has sometimes been characterized as overinvestment because it has generated significant excess capacity in some cases.[55]

China currently dominates global battery production, accounting for 77% (250 GWh) of lithium-ion battery production in 2020. The U.S. accounted for 9% (42 GWh), and the EU accounted for 6% (28 GWh).[56] One reason for China's dominance in the cell component markets is its low costs, which have been cited as a major reason behind offshoring of cell manufacturing to China.[57]

A June 2022 paper by the Coalition for a Prosperous America projected that U.S. battery production will increase to around 320 GWh by 2025 but that this will barely cover rising demand and will therefore not significantly increase the country's share of global production.[58] The outlook is somewhat more optimistic in Europe. This is in part due to strategies such as the European Battery Alliance, which aims to decrease reliance on batteries and other technologies from outside Europe and aspires to cover all of the industrial needs of car manufacturers in Europe by 2025 through an industrial plan that involves developing gigafactories across the continent. The EU is projected to account for 22% of global battery production by 2025.[59]

The Biden administration is taking steps to build out cell component and battery manufacturing capacity, including providing investment for this purpose. Coupled with global supply chain distress over the past two years, this has prompted the private sector (notably automakers) to make some moves to onshore this production. For example, Redwood Materials has entered into an agreement with Korean battery materials maker L&F to use a new L&F factory in the U.S. to produce battery cathodes for 1 million EVs per year by 2025 and more than 5 million per year by 2030.[60] In May 2022, the Hyundai Motor Group announced plans to invest US$5.5 billion to build an EV and battery manufacturing plant in the state of Georgia.[61] In July 2022, Panasonic announced plans for a US$4 billion EV battery plant in Kansas.[62] These efforts are relatively nascent, however, because automakers have been reluctant to invest until relatively recently (with the exception of Tesla). In the longer term, it is unclear whether this investment will be commensurate with the scale of the challenge. Development efforts also face other challenges. For example, the industry has cited attracting skilled workers as a key obstacle to ramping up production.

The extent to which the U.S. and Europe can address these challenges will determine their ability to develop competitive critical minerals supply chains. It is important to note, however, that future demand for critical minerals is highly uncertain. An analysis of the determining factors is beyond the scope of this paper, but technological developments (e.g., new batteries with significantly reduced critical minerals requirements) and improvements in recycling (e.g., major process improvements in the recycling of tailings from processing, scrap used in manufacturing, and scrap from end-of-life products) may reduce the need for new upstream and midstream investments. Such developments are unlikely to entirely eliminate the need for such new investments, however.

4 Will China Tighten Due Diligence on Critical Minerals Supply Chains?

Due diligence requirements on Chinese midstream actors—notably smelters and refiners—and downstream actors will be crucial to the development of responsible critical minerals supply chains globally.

Awareness of responsible sourcing and compliance with environmental, social, and governance (ESG) standards has grown, and these factors are increasingly important and commercially material to actors across critical minerals supply chains globally.

However, compliance with best practices in critical minerals supply chains requires end-to-end coordination, from the mining of raw materials to cell and battery pack manufacturing. Smelting and refining constitute a key stage in the supply chain for companies to track the conditions under which the mineral they purchase is extracted, handled, transported, and traded from the mine site through to local suppliers. As a result, smelters and refiners are more strategically positioned to demand due diligence and compliance with responsible sourcing practices and impose greater scrutiny than are cell manufacturers, pack manufacturers, or EV automakers.

This section explores two key factors that may influence whether China moves to tighten due diligence requirements on critical minerals supply chains. The first is the evolving conversation in China about responsible business conduct. The second is external developments and expectations related to responsible sourcing among governments and private companies, particularly in the U.S. and Europe.

4.1 Responsible Business Developments in China

In the last two decades, China has introduced legislation and developed various industry guidelines for responsible business, such as the Company Law, which was first introduced in 2006 to endorse the idea that companies have a social responsibility. In addition, the three main stock exchanges in China, in Shanghai, Shenzhen, and Hong Kong, have issued guidelines for

responsible business reporting. As part of this effort, China has also taken important steps to tighten due diligence on mineral supply chains. These include:

- **CCCMC's Guidelines for Social Responsibility in Outbound Mining Investment.** The China Chamber of Commerce of Metals, Minerals & Chemicals Importers & Exporters (CCCMC), a unit within the Ministry of Commerce, issued its Guidelines for Social Responsibility in Outbound Mining Investment in October 2014. These called for Chinese mining companies undertaking outbound mining investment, cooperation, and trade to strictly "observe the UN Guiding Principles on Business and Human Rights during the entire life-cycle of the mining project" and to strengthen "the responsibility throughout the extractive industries value chain."[63] The Chinese government has also explicitly said that it expects Chinese mining companies to follow applicable local laws.[64]

- **CCCMC's Due Diligence Guidance.** In 2015, the CCCMC published its Chinese Due Diligence Guidelines for Responsible Mineral Supply Chains, which were based on the Organisation for Economic Co-operation and Development's guidelines for responsible mineral supply chains.[65] The CCCMC guidelines consist of five steps that companies must take to identify, address, prevent, and mitigate risks associated with their activities or sourcing decisions. They apply to all Chinese companies operating across mineral supply chains.[66] The guidelines lay out two risk categories: 1) risks of conflict and human rights abuses associated with extracting, trading, processing, and exporting resources from conflict-affected and high-risk areas and 2) risks associated with misconduct in environmental, social, and ethical issues (including but not limited to the fields of labor regulations, consultation mechanisms, and consent from Indigenous groups) throughout the supply chain.[67] The influence of this guidance is unclear, however, particularly given its nonmandatory nature. Moreover, the actual influence and leverage that CCCMC has over its members is unclear. CCCMC does not have the power to supervise or implement the due diligence measures as an industry association.

Despite having these standards, China's enforcement of due diligence standards appears to be limited, especially given that many of these guidelines are voluntary.[68] A 2021 report by Global Witness assessed due diligence by Chinese refiners and smelters for tin, tantalum, tungsten, and gold.[69] The report concluded that due diligence enforcement was scarce and that more transparency and proactive demonstration of responsible business were needed from Chinese refiners. It also found that China's participation in an industry-led program for responsible sourcing of minerals did not necessarily ensure that Chinese refiners would publish comprehensive due diligence information. The report recommends that China enact and enforce legislation that adapts and requires the application of these guidelines for refiners and smelters in order to prevent negative social, environmental, and governance impacts linked to Chinese companies in the mineral supply chain.

Moreover, Chinese mining companies, which feed minerals to downstream operations, are perceived by some governments in resource-rich countries (perhaps unfairly) to be less committed to international best practice than their Western counterparts. The most serious recent allegations are about Chinese companies' operations in the DRC, reportedly involving corruption[70] and violations of human rights, including forced evictions, child labor, and other labor and human rights abuses through subcontracting models.[71] In early 2022, a DRC court

ruling removed China Molybdenum from leadership at the Tenke Fungurume copper-cobalt mine for six months. While the company has reportedly regained control of the mine,[72] it stands accused of corruption and social and environmental performance issues, including underreporting of mineral reserves as a way to reduce annual payments, weak worker safety standards, and bribes to hide poor labor conditions.

These issues are not unique to Chinese mining companies; many mining companies operating in the DRC have been accused of corruption and poor social and environmental standards. Moreover, the Chinese government has at times been critical of the performance of some Chinese mining companies abroad. When the DRC ordered six Chinese and Sino-foreign joint venture mining companies to suspend operations in 2021, the Chinese Foreign Ministry expressed support for the local ruling and announced that the companies would be sanctioned by the governments of Zhejiang, Jiangsu, and Fujian provinces.[73] As of the publication of this paper, no public information was available about whether these companies were in fact sanctioned in this way or had any legal action taken against them.

4.2 Evolving Responsible Sourcing Expectations in the U.S. and EU

The evolution of responsible sourcing in the landscape in the U.S. and EU—in terms of emerging legal and regulatory standards, industry schemes, and downstream actors' tolerance for reputational risk—will also likely have knock-on effects in China. For example, if new regulation or pressure from downstream companies in the US and Europe create market access issues for Chinese companies, creating legal, regulatory, and logistical obstacles to exporting critical minerals products to major markets, those companies may be incentivized to implement tighter due diligence mechanisms.

Three key factors are at play here. First, due diligence requirements are rapidly evolving, particularly in Europe. In February 2022, the European Commission adopted a Proposal for a Directive on Corporate Sustainability Due Diligence. The directive requires large companies headquartered in the EU to conduct due diligence across their value chain, as well as to embed sustainability and human rights considerations into their business strategies, decision-making processes, and oversight mechanisms.[74] The forthcoming EU battery regulation will impose a due diligence obligation on battery manufacturers specifically, requiring them to address risks around the sourcing, processing, and trading of raw materials, chemicals, and secondary raw materials.[75] Moreover, several jurisdictions have proposed or adopted mandatory due diligence legislation requiring more stringent corporate responses to human rights risks and adverse impacts in their supply chains. This includes Switzerland's Conflict Minerals and Child Labor Due Diligence Legislation, France's Corporate Duty of Vigilance Law, Germany's Supply Chain Act, and Norway's Transparency Act.

Second, several industry schemes are focused on responsible sourcing. They include the London Metal Exchange's responsible sourcing requirements,[76] the Initiative for Responsible Mining Assurance,[77] the Responsible Minerals Initiative,[78] and the London Bullion Market Association

Responsible Sourcing Programme.[79] These initiatives, particularly the London Metal Exchange's responsible sourcing requirements, do have an extraterritorial reach in China, but it is unclear what kinds of levers they would be willing to employ when it comes to sanctioning China-based companies for noncompliance with the standards.

Third, the reputational risks for downstream actors relating to responsible sourcing are increasing. Several automakers (including Mercedes-Benz and Volkswagen) and technology companies recently came under fire after a report by Amnesty International revealed that their products were linked to cobalt mines in the DRC accused of serious human rights violations. In June 2022, *The New York Times* reported that the Xinjiang Nonferrous Metal Industry Group may have used coercive labor practices in its mines, smelters, and factories in Xinjiang (a region in the far west of China where leading human rights groups, including Amnesty International and Human Rights Watch, have accused China of crimes against humanity against Uyghur Muslims and other ethnic groups, including through forced labor transfer programs).[80] Metals produced by the company have been exported to the U.S. and Europe, while some have gone to large Chinese battery makers, who then supply major U.S. entities downstream. If downstream actors become more sensitive to the reputational risks of being perceived as sourcing "tainted" minerals, they may put pressure on their Chinese suppliers to tighten due diligence requirements.

5 What Could the Future Look Like?

The following scenarios illustrate how dynamics around critical minerals supply chains could evolve over the next 10 to 20 years.

These scenarios consider the extent to which the U.S. and Europe might be able build out their own critical minerals supply chains to rival those of China and whether Beijing moves to "green" and "clean" these supply chains and tighten due diligence requirements. They also consider the extent to which the world might have supplies of cleaner and greener minerals to fuel the energy transition. Figure 1 presents a high-level overview of the scenarios.

High vs. Low Supply Chain Due Diligence by China

The horizontal axis considers the level of due diligence enforcement in China's critical minerals supply chains. Particularly important will be the enforcement of due diligence standards for smelters and refiners, given their strategic point in the supply chain.

A high-enforcement scenario assumes that China has clear statutory requirements for due diligence, with mechanisms to monitor and sanction smelting and refining companies for noncompliance. Specifically, this means that the Chinese government has enacted and enforces legislation mandating mineral supply chain due diligence that aligns with the CCCMC guidelines, including requiring companies to disclose a due diligence policy, undertake independent third-party audits, and publish annual reports detailing implementation of due diligence measures and steps taken to mitigate risks in the supply chain. This also means that other key stakeholders in China, such as the Shanghai Gold Exchange and major stock exchanges such as Shanghai, Shenzhen, and Hong Kong (government ministry of the state council and Securities and Futures Commission for Hong Kong), have instituted mineral supply due diligence guidelines that are mandatory for all their members.*[81]

* It should be noted that the Shenzhen Stock Exchange and Shanghai Stock Exchange have issued guidelines for responsible business reporting and ESG impact information disclosure (in the case of Shanghai and Hong Kong). The stock market regulator in China also issued rules in 2017 requiring all listed companies to disclose ESG risks associated with their operations and in 2018 added a chapter on responsible business to its Code of Corporate Governance for Listed Companies.

Conversely, a low-enforcement scenario assumes a continuation of the status quo, with most smelters and refiners falling short of standards for mineral supply chain due diligence.

High vs. Low Control of Supply Chains by China

The vertical axis considers the global share of upstream, midstream, and downstream critical minerals activities dominated by China. A low-concentration scenario assumes a substantial scale-up of capacity across the supply chain by other jurisdictions, including the U.S. and Europe. A high-concentration scenario assumes that China maintains a high level of control over critical minerals supply chains.

FIGURE 1. Potential Scenarios for Critical Minerals Supply Chains*

* Several factors outside the scope of this scenario analysis will materially affect how things evolve, of course, including overall levels of demand for critical minerals and their prices, and technological breakthroughs that reduce mineral requirements for key energy transition applications.

SCENARIO 1:

Geopolitical and Sustainability Risks Imperil the Transition

1 Geopolitical and sustainability risks imperil the energy transition

High Control / Low Enforcement

- Global critical minerals supply chains are dominated end to end by China, and the world is highly dependent on China for the inputs needed for decarbonization.

Implications for the energy transition

- Premiums for a small supply of "cleaner" and "greener" critical minerals and derivative products, leading to price volatility
- Likely supply chain disruptions due to geopolitical tensions or logistical issues
- Higher risk of social and political conflict around decarbonization efforts

In this scenario, global critical minerals supply chains are dominated end to end by China. Mineral smelting and refining and battery cell manufacturing are highly concentrated in China, while Chinese mining companies have expanded upstream control over critical minerals to feed downstream operations. The Chinese government has not made any moves to implement legally binding due diligence requirements on actors across the supply chain.

This scenario assumes that efforts in the U.S. and Europe to build out domestic critical minerals supply chains have largely faltered, stymied by social and political opposition to mining developments and insufficient midstream and downstream investment. Companies and governments globally remain highly dependent on Chinese companies for the inputs needed to achieve climate commitments involving decarbonization, especially rechargeable batteries.

What would this mean for the energy transition?

This scenario would be clearly negative for the energy transition. The global supply of "green" and "clean" critical minerals for the energy transition would be insufficient, forcing difficult decisions and tradeoffs. Key challenges in this scenario would include:

- **Premium prices for a small supply of clean critical minerals.** This scenario would make responsible sourcing challenging for companies across the supply chain, particularly downstream actors. Automakers and other companies could struggle to source enough "clean" and "green" critical minerals to bring enough product to market to meet demand, particularly if their sourcing were under greater scrutiny from regulators, civil society organizations, or consumers and it were challenging to source from China with a high degree of confidence that minerals and/or mineral products were not linked to abuses. This would likely be an acute risk for companies operating in jurisdictions with binding due diligence laws; they could face significant fines or other adverse regulatory action for abuses in their supply chains. Companies could therefore be willing to pay premiums for critical minerals sourced transparently in accordance with strict due diligence standards, leading to competition for a small share of the world's clean critical minerals supplies. This could theoretically drive up the cost of the energy transition significantly.
- **Likely supply chain disruptions due to geopolitical tensions or logistical issues.** This scenario presents a risk that exports of critical minerals products could be interrupted in the context of rising geopolitical tensions. The ongoing trade war between China and the U.S. underscores the potential for trade controls. Moving forward, geopolitical disputes—

such as disputes stemming from China's historic tensions with Taiwan and Hong Kong—could trigger disruptions in the form of sanctions, disrupted maritime transport, or, in an extreme scenario, military conflict. If China were to shut off the flow of mineral products to the U.S. and Europe, this would likely slow the pace of the energy transition and make key inputs, such as EV batteries, more costly.

There is reason to be concerned. China has, for example, implemented export controls on REEs, in violation of international trade rules. In recent years, China has signaled new efforts to attain full control over these exports due to their use in the manufacture of military aircraft such as F-35 fighter jets. In October 2020, China passed a bill to allow export controls on items considered to be critical to the state's interest and security, which it could apply to resources crucial to the energy transition. In 2021, China's Ministry of Industry and Information Technology proposed draft controls on exports of REEs. In a worst-case version of this scenario, if China were to deem any or all critical minerals relevant to national security, this could spark a rapid implementation of export bans of raw and refined commodities in the event of trade disputes or geopolitical conflicts.

Even in the absence of an escalation in geopolitical tensions, more benign logistical disruptions could affect the flow of mineral products from China to other markets. Port closures and container ship congestion at Chinese ports have unleashed waves of global supply chain shocks across commodities during the COVID-19 pandemic, leading to severe delays in export shipping and rising costs of containers.

- **Higher risk of social and political conflict around decarbonization efforts.** In the absence of a sufficient supply of "clean" and "green" critical minerals to power the energy transition, the risk of social and political conflict around decarbonization efforts is much higher. The push for "degrowth"—the idea that the only way to address the climate crisis is to dramatically reduce levels of economic activity and significantly reduce the use of raw materials—is increasingly working its way into conversations about the energy transition. For example, the EU's European Green Deal has faced intense criticism from civil society organizations along those lines. In June 2021, a global coalition of 180 community platforms, human rights and environmental organizations, and academics called on Brussels to abandon plans to expand what it termed "dirty mining" as part of its Green Deal and Green Recovery plans; Friends of the Earth Europe described the policy plans as a "desperate plunder for raw materials seemingly at any cost." In the context of growing concern about the perceived negative environmental, social, and corruption impacts of mining large quantities of minerals, this idea will likely gain traction.

SCENARIO 2:

Beijing's Clean and Green Monopoly

2 Beijing's clean and green monopoly

High Control / High Enforcement

- Global critical minerals supply chains are dominated end to end by China, but the country has instituted rigorous and legally binding due diligence requirements.

Implications for the energy transition

- Potentially less price volatility, due to a robust supply of "cleaner" and "greener" critical minerals and derivative products
- Positive effects for natural resource governance in resource-rich countries, helping to bring more minerals to market
- Higher risk of supply chain disruptions due to geopolitical tensions or logistical issues

In this scenario, as in scenario 1, global critical minerals supply chains are dominated end to end by China. It assumes that the U.S. and Europe have not succeeded in building out domestic critical minerals supply chains and that the world remains highly dependent on China for critical minerals products. However, in this scenario Beijing has made concerted efforts to ensure that actors across the supply chain—including mining companies, smelters, refiners, and manufacturers—are subject to rigorous and legally binding due diligence requirements that are aligned with CCCMC standards. The government also holds private and state-owned Chinese mining companies operating abroad to high operating standards in this scenario. As things stand, this scenario is the least likely of the four, because if China remains the dominant player across critical mineral supply chains, it will have less incentive to tighten due diligence.

What would this mean for the energy transition?

This scenario would have mixed implications for the energy transition. They include:

- **Potentially less price volatility.** Theoretically, there would be a robust supply of "clean" and "green" critical minerals, or minerals mined and processed in accordance with robust ESG standards, coupled with high transparency and traceability for transactions, responsible sourcing, and destinations of raw and refined materials. This would be positive for the entire supply chain, likely with at least some positive knock-on effects for natural resource governance in resource-rich countries; it would improve environmental and social performance and reduce risks of corruption, and, in turn, help bring more minerals to market. These dynamics could reduce the risk of price volatility.
- **Higher risk of supply chain disruptions due to geopolitical tensions or logistical issues.** As in scenario 1, this scenario includes a risk that exports of critical minerals products could be interrupted in the context of rising geopolitical tensions or logistical challenges. This would potentially slow the pace of the energy transition and create price shocks.

SCENARIO 3:

A Virtuous Circle of Competition and Sustainability

3 A virtuous circle of competition and sustainability

Low Control / High Enforcement

- The U.S. and Europe have successfully built out critical minerals supply chains to rival China.
- All players have instituted rigorous due diligence standards across the supply chain.

Implications for the energy transition

- The clear best-case scenario
- Lower risk of price volatility, due to an abundance of cleaner and greener minerals and derivative products
- Lower risk of supply chain disruptions due to geopolitical tensions or logistical issues

In this scenario, U.S. and European efforts to build out domestic critical minerals supply chains have been largely successful. China remains a key player, but Europe and the U.S. are both strong competitors, having addressed the challenges set out in section 3 and having made significant investments across critical minerals supply chains from mining to manufacturing.

The U.S. and Europe have achieved four key things in this scenario. First, they have significantly increased domestic mining. The U.S. has achieved broad, bipartisan political consensus that dramatically and urgently increasing domestic critical minerals output is a major national security priority. The Biden administration has permitted controversial projects—including the Pebble and Twin Metals projects—because it has deemed the potential costs of not bolstering critical minerals supplies to be too high. Bipartisan consensus has led to a coordinated effort between Congress and the executive branch to simplify and streamline the permitting process. Congress has meaningfully updated the General Mining Act of 1872, strengthening social and environmental protections and levying a royalty, which is lessening stakeholder conflict around mining. This has allowed subsequent administrations to more easily bring additional domestic mines online. Europe and MSP partners have also brought many new mines into production.

Second, the U.S., Europe, and other MSP partners have made significant and highly coordinated investments in refining and smelting capacity domestically and within countries in the MSP. Tens of billions of dollars of capital have been deployed to build new smelters and refiners and thereby reduce dependence on China. The U.S. has been particularly crucial to this effort, deploying capital through a variety of mechanisms domestically and abroad (such as the Partnership for Global Infrastructure and Investment or the U.S. International Development Finance Corporation).

Third, the U.S. and Europe have successfully developed thriving cell component and battery manufacturing sectors. These sectors have seen considerable investment, with EV makers onshoring this activity. This has been achieved through a combination of tax credits and other economic incentives to the private sector, clear regulation to streamline permitting and construction, and a national workforce development strategy. Direct cooperation and collaborations with MSP partners, including Korean and Japanese companies in the case of cathode and anode production, has also contributed to the success of this.

Fourth, the U.S. and Europe have continued to invest in innovation to develop a clear advantage in mineral and battery recycling. This has provided an additional stream of critical minerals, further bolstering supply chains in the U.S. and Europe.

Against this backdrop, the world has continued to evolve toward mandatory due diligence and responsible sourcing requirements, with global coordination. Individual jurisdictions have aligned their regulatory regimes with these requirements to a high degree. The U.S. and Europe have developed supply chains in line with extremely robust ESG standards, with statutory requirements mandating supply chain due diligence that is aligned with the OECD Guidance. This, in turn, has motivated China to also implement due diligence to remain a competitive player.

What would this mean for the energy transition?

This is clearly the best-case scenario for the energy transition. Specifically, it would mean:

- **Lower risk of price volatility due to an abundant supply of cleaner and greener critical minerals.** With several different major players in critical minerals supply chains, global coordination around regulatory regimes for responsible sourcing is more likely, as is alignment on statutory requirements between major jurisdictions, including the U.S., the EU, China, and potentially others. This would be positive for the sustainability aspects of the energy transition, generating a diverse supply of cleaner and greener minerals that could be sourced by downstream actors globally. With multiple major players mining and refining minerals in accordance with strict ESG standards, dirtier minerals could trade at steep discounts. This would create a clear commercial motive for all players to adhere to high standards. Moreover, responsible sourcing would lead to improved social license to operate, which would then lead to improved mining conditions and increased mineral supplies to international markets.
- **Lower risk of supply chain disruptions due to geopolitical tensions or logistical issues.** With less concentration of critical minerals supply chains, Beijing would not be able to easily turn off the flow of critical minerals. In the event of escalating geopolitical tensions or logistical challenges, the U.S. and Europe would be much more resilient and would be able to easily draw on their own supplies of critical minerals and critical minerals products.

SCENARIO 4:

Bifurcation of Critical Minerals Supply Chains

4 Bifurcation of critical minerals supply chains

Low Control / Low Enforcement

- Governments are able to monetize resources despite lower-than-anticipated demand and less mining activity globally, due to perceived low levels of political and stakeholder risk.

Implications for the energy transition

- Higher risk of price volatility for critical minerals and derivative products
- Potential for aggressive moves by Western governments to limit the flow of Chinese critical minerals and derivative products

In this scenario, as in scenario 3, U.S. and European efforts to build out domestic critical mineral supply chains have been largely successful. In practical terms, this means significantly increased domestic mining, a highly coordinated effort to make substantial investments in refining and smelting capacity domestically and within countries in the MSP, major expansion of domestic cell component and battery manufacturing sectors, and continuous investment in R&D to remain competitive.

However, in this scenario, the U.S. and EU have tight due diligence requirements on critical minerals, but China does not. The result is two different streams of critical minerals globally: one sourced and then refined and processed in the U.S. and EU in accordance with strict due diligence regulations, and one sourced and then refined and processed in China without strict due diligence. This means critical minerals supplies that are bifurcated into "cleaner" and "dirtier."

What would this mean for the energy transition?

This scenario would be negative for the energy transition, although not as bad as scenario 1. The key implications include:

- **Higher risk of price volatility for critical minerals and critical minerals products.** The bifurcation of critical minerals supply chains would likely have price implications, with one potentially trading at a premium and the other at a discount. Depending on the percentage of the supply chain that the U.S. and EU ultimately control, this could force companies to choose between more expensive "cleaner" minerals and cheaper "dirtier" ones. This could drive up the cost of the energy transition, although the situation is unlikely to be as dire as that set out in scenario 1.
- **Aggressive moves by Western governments to limit the flow of Chinese critical minerals and critical minerals products.** Governments in the U.S., Europe, and other countries could move to limit the flow of Chinese critical minerals, either due to significant geopolitical tensions (analogous to attempts to limit the flow of Russian oil and gas following its invasion of Ukraine) or due to growing concerns about social, environmental, or human rights abuses in the supply chain. This would likely exacerbate price volatility.

  The exact dynamics—and, specifically, how aggressively governments might move to force companies to use "cleaner" and "greener" critical minerals—would likely depend on the geopolitical climate and the extent of concerns about abuses in critical minerals supply chains. The U.S. and Europe could potentially move to institute stricter mandatory

ESG requirements for critical minerals and critical minerals products specifically, along the lines of the Dodd-Frank legislation in the U.S.*

In a more extreme version of this scenario, the U.S. and Europe could seek to take aggressive regulatory action to ban imports of critical minerals products. This would create a much more challenging legal and regulatory environment for companies that are crucial to the energy transition, including automakers. There is already some precedent for this. The Uyghur Forced Labor Prevention Act, signed into law by President Biden in December 2021, assumes that goods made in whole or in part in the Xinjiang region of China are produced with forced labor and therefore prohibited from importation into the U.S.[82] The U.S. and Europe could also seek to target bad actors—including Chinese companies and individuals and their proxies—through targeted sanctions and prosecutions, potentially making it more difficult for Western companies to do business with Chinese actors along the value chain. There is also precedent for this. Israeli billionaire Dan Gertler was sanctioned by the Trump administration in 2017 under the U.S. government's Global Magnitsky Sanctions program for his alleged involvement in large-scale corruption in the DRC's mining sector.[83] In December 2022, The U.S. Treasury sanctioned a DRC national, Alain Mukonda, and 12 entities linked to him for allegedly providing support to Gertler, including opening bank accounts for him and making payments into proxy bank accounts for him.[84]

Chinese government authorities could institute their own sanctions on restrictions on companies or individuals in the Europe and US in response. These kinds of actions would likely create turbulence across critical minerals markets.

* Section 1502 of the Dodd-Frank Wall Street Reform and Consumer Protection Act requires that companies with tin, tantalum, tungsten, or gold in their products report to the Securities and Exchange Commission on their due diligence processes for these minerals.

6 Conclusion

The clear best-case scenario for the energy transition is scenario 3, in which critical minerals supply chains are no longer concentrated in China and due diligence requirements on critical minerals and their derivative products are globally harmonized. The second-best, albeit suboptimal, scenario would be scenario 4, in which the U.S. and Europe have built out their own critical minerals supply chains but, given a lack of movement on due diligence requirements in China, global supplies are split into "cleaner" and "dirtier" minerals. Scenario 1, in which China retains a clear dominance but does not strengthen due diligence is the clear worst-case scenario. This would present a serious risk of disruption to the energy transition if rising geopolitical tensions or more benign logistical issues limit the flow of critical minerals products out of China. It would also increase the risk that the energy transition could cause or contribute to social and environmental harms through the mining and processing of critical minerals. In our view, scenario 2, in which China retains a clear dominance but makes moves to institute mandatory due diligence on critical minerals, is highly unlikely.

To achieve either the best-case or second-best-case outcome, governments in the U.S. and Europe will need to build substantially on their existing commitments to build out their critical minerals supply chain. This would likely entail significant additional financial capital, ongoing innovation, and improvements to regulatory and permitting regimes. This by itself would be challenging, but especially given the current global context. In the wake of the COVID-19 pandemic and Russia's invasion of Ukraine, governments globally are facing myriad economic challenges, including high inflation, a commodity price shock and global energy crisis, and the looming threat of recession. Governments are not in the best position to be writing large checks, particularly for mining and smelting projects that may be tough sells to voters who are concerned about social and environmental impacts. Competing pressures may take time and attention away from the critical minerals agenda. Political polarization, especially in the U.S., could make it difficult to achieve political consensus around how to most effectively build out these supply chains—especially where difficult tradeoffs may be required.

As discussed in section 3, there is some reason for optimism. The Biden administration's planning efforts around critical minerals supply chains are encouraging, and recent private-sector investments in battery manufacturing are a promising sign. However, this will be a long-term endeavor, and only time will tell if there is enough political will and financial backing to build on this momentum.

To achieve the best-case outcome, continued global engagement around due diligence and responsible sourcing would also be needed. China is unlikely to institute mandatory due diligence requirements, but this is not beyond the realm of possibility. A number of industry associations, including the Responsible Minerals Initiative, have been active in China for some time. Continued pressure and evolving due diligence requirements elsewhere globally, especially in Europe, could move the needle, especially if failure to do so creates market access issues.

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