U.S.-NORWAY CRITICAL MINERALS MEMORANDUM OF COOPERATION REPORT ON NON-MARKET POLICIES AND PRACTICES IN THE CRITICAL MINERALS SECTOR

This report was written by the U.S. Department of Commerce's Industry and Analysis (I&A) business unit and the Ministry of Trade, Industry and Fisheries of Norway. The United States drafted the overview of mineral supply chains in the United States and the United States' mineral strategy in Section II, Sections III and IV, and the case studies of graphite, cobalt, and nickel in Section V. Norway drafted the overview of mineral supply chains in Norway and Norway's mineral strategy in Section II, and the case study of magnesium and the summary of its questionnaire responses in Section V.

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The U.S. Department of Commerce would like to thank and acknowledge contributions from the White House National Security Council, the U.S. Geological Survey of the U.S. Department of the Interior, the U.S. Department of State, the U.S. Department of Treasury, the U.S. Trade Representative, the U.S. Department of Defense, and the U.S. Department of Energy.

The Norwegian Ministry of Trade, Industry and Fisheries would like to thank and acknowledge contributions from the Norwegian Ministry of Foreign Affairs, Geological Survey of Norway, and the Research Council of Norway (Prosess21).

I. Introduction

Developing secure, transparent critical mineral supply chains is essential to the clean energy transition, manufacturing, and technologies of the future as well as national and economic security. While demand for critical minerals is expected to increase, the supply has become increasingly concentrated, making supply chains less resilient.

On September 30, 2024, the United States and Norway signed a Memorandum of Cooperation ("MOC") on High-Standard, Market-Oriented Trade of Critical Minerals to formalize the intent to advance high standards in global critical mineral supply chains while maintaining and identifying appropriate responses to non-market policies and practices ("NMPPs").[1] As part of this MOC, we expressed an intent to develop a shared understanding of NMPPs of certain third-party countries that may distort production or supply of, or trade in, critical minerals. This report presents the analysis and learnings shared by the two countries.

This report begins with a background on the critical minerals sectors in both Norway and the United States. It then provides an overview of NMPPs followed by an examination of how these NMPPs have been employed in the supply chains for graphite, cobalt, nickel, and magnesium. These minerals are important in terms of trade between Norway and the United States and are key to the energy transition. This section also looks at the negative impact NMPPs have had on the supply chains for these minerals. The report concludes by looking at future collaboration and the consequences of not addressing NMPPs.

II. Overview of Mineral Supply Chains in Norway and the United States

A. Norway Mineral Supply Chains

Norway has a mining and quarrying industry extracting metallic ore, industrial minerals, natural stone and aggregates. Current production includes iron ore and titanium minerals, as well as natural graphite, quartz and quartzite, nepheline syenite and other feldspar minerals, olivine, limestone/marble and dolomite.

Norway also has a processing industry with a substantial metal production, mainly based on imported feedstock. Main products are aluminum, nickel, zinc, silicon, ferro alloys, cobalt and platinum group metals ("PGMs"). For certain commodities, Norway plays a significant role in the European and U.S. raw materials supply chain. This section reviews Norway's mining and processing industries and employment and output of these industries.

Mining

The Norwegian extraction of titanium minerals makes up 4.7 percent of the world's production. Norway has a number of significant deposits of both ilmenite ($FeTiO_3$) and rutile (TiO_2), but

1 "NMPPs involve state-directed interventions, failures to act, or policy directives that undermine fair, competitive, and market-oriented economic conditions." U.S. Trade Representative, Adapting Trade Policy for Supply Chain Resilience: Responding to Today's Global Economic Challenge, January 2025, page 33, USTR Adapting Trade Policy for Supply Chain Resilience_0.pdf.

current production primarily takes place at the Tellnes mine in Southwest Norway. A new mine at Engebø in Western Norway initiated production in 2024 and is currently ramping up. In 2023, the Tellnes mine produced 670,000 metric tons ("t") of ilmenite concentrate as well as approximately 40,000 t of vanadium-bearing magnetite. The mine also produces a minor sulfide concentrate containing nickel, cobalt and copper. Ilmenite concentrates are refined in Norway and Germany, and a significant part is exported to the PRC.

The recently opened Engebø deposit is unique in extracting rutile from a hard rock deposit. The mine is operated by Nordic Mining AS, and Japanese Iwatani Corporation has a significant share in the company. The mined rutile is suited to produce titanium metal.

Norway has been mining natural graphite from deposits in Northern Norway for almost a century. The Trælen deposit on the island of Senja in Northern Norway is the world's highest-grade operating flake graphite mine with a current ore grade of 28 percent. The deposit contains a Joint Ore Reserves Committee ("JORC")-compliant resource of 1.79 million metric tons ("Mt") at 23.5 percent total graphitic carbon ("TGC") and a reserve base of 600,000 t at 24.5 percent TGC.[2] With a name plate capacity of 10,000 metric-tons-per-year ("t/yr"), Trælen is the most important producer of natural crystalline graphite in Europe, and the host region remains highly prospective. The Trælen mine is operated by Skaland Graphite AS.

Resources of rare earth elements ("REEs") have been identified in the Fen deposit south of Oslo, demonstrating that this carbonatitic deposit is continental Europe's largest known resource of light REEs. Two companies are developing the deposit. Rare Earths Norway controls most of the relevant area, whereas REE Minerals is investigating a smaller volume of the deposit. The reported inferred resources correspond to 10 Mt contained total rare earth oxides. Both projects are considered pre-feasibility stage projects.

Norway has a long history of copper mining, primarily through a string of volcanogenic deposits concentrated in central and northern Norway. Norway does not currently produce copper from national deposits, and the last operating copper mine at Joma in central Norway closed in 1998. Currently, a couple of mature copper projects are progressing, of which the Nussir project in northern Norway is the most advanced with a mining concession in place. With an 80 Mt JORC-compliant resource containing 754,000 t copper, Nussir remains the largest copper discovery in Norway. Brownfield projects include the seven Mt copper-zinc deposit at Joma in central Norway (74,000 t contained copper), which is currently in the feasibility stage, as well as the Sulitjelma deposit in northern Norway, with a historical resource estimate of 261,000 t contained copper and 100,000 t contained zinc. Both Nussir and Sulitjema have recently been acquired by Toronto-registered Blue Moon Metals.

Norway has been a nickel producer from the initial discovery of nickel ore in the 19th century. In total, approximately 70,000 t of nickel have been extracted in Norway. The last Norwegian

2 Mineral Commodities Ltd, Annual Report 2023, https://www.mineralcommodities.com/wp-content/uploads/2024/04/Annual-Report-2023.pdf

nickel mine at Bruvann in northern Norway closed in 2002. Currently, several companies are investing in exploration activities, including drilling and geophysical surveys. Targets include brownfield magmatic nickel-copper deposits in Råna (Bruvann) in northern Norway, as well as deposits in Espedalen and Ringerike in Southern Norway.

Cobalt is an accessory metal in many Norwegian copper and nickel deposits, and there is a known potential for cobalt associated with several of the old copper mining camps, including in the mining waste left behind. Recent exploration confirms that the Bruvann nickel deposit in Northern Norway contains 0.19 percent cobalt. The cobalt (and copper) mines at Modum in South Norway were the major source of cobalt blue pigment used in Europe during the late 18th and 19th centuries. The ore contains approximately 0.2 percent cobalt, and exploration is on-going in the area.

There are five quartz and quartzite mines in Norway producing a range of qualities for different applications. A major part of the production is processed and refined in Norway. High-purity quartz produced by the Quartz Corp is exported to the PRC.

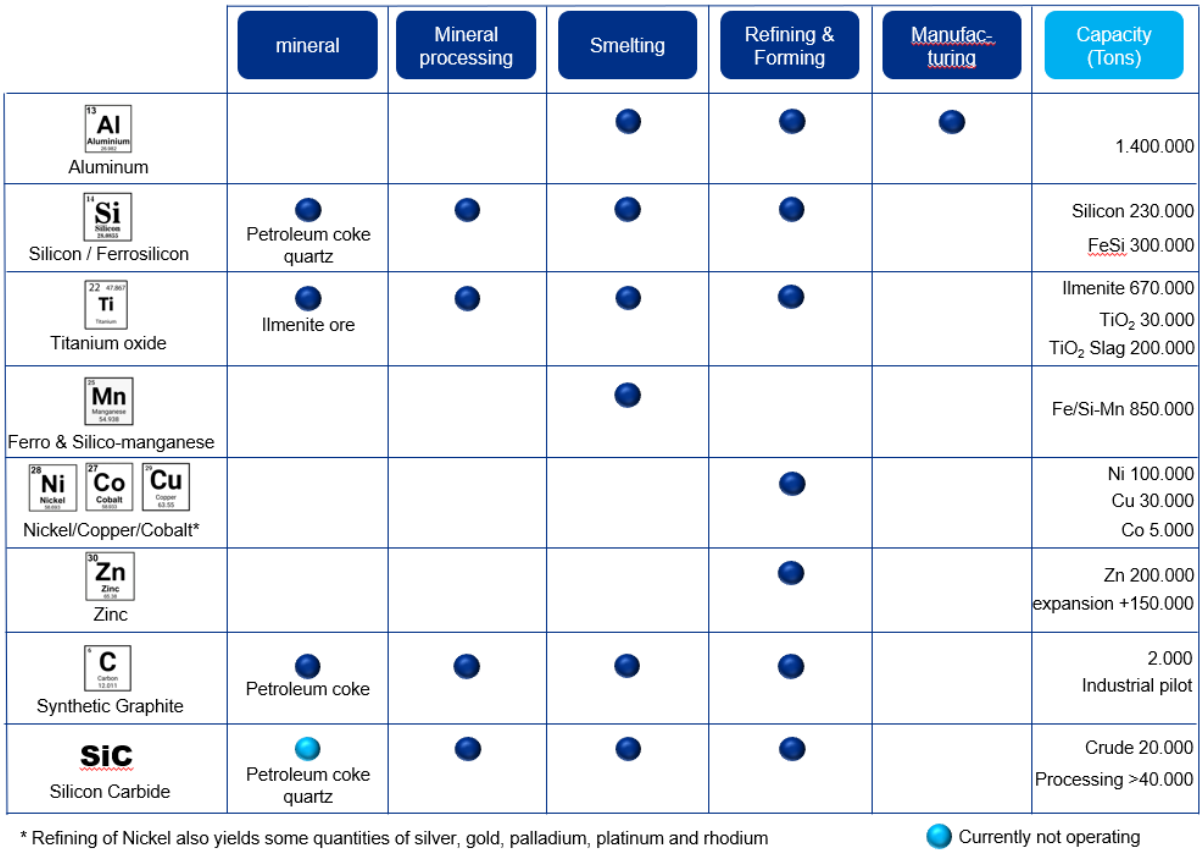
Processing

Norway has built a substantial processing industry for over a century. Much of the production consists of materials or semi-finished products such as aluminum ingots, silicon and ferro-alloys. Many of these products are building blocks in the green transition with a broad range of uses, including solar cells, batteries and wind turbines. Norway is Europe's largest producer of aluminum, silicon, ferro-alloys and certain refined materials such as zinc. Norway is also the second-largest European producer of refined nickel after Russia, and the second-largest cobalt refiner after Finland.

The processing industry is power-intensive, with an annual power consumption corresponding to approximately a quarter of Norway's normal annual power consumption. The Norwegian processing industry has streamlined its production processes over decades. Several Norwegian companies are recognized as global leaders in their respective industries when it comes to climate and resource efficiency, attributed to their advanced technology and utilization of renewable energy. The processing industry has reduced its emissions by more than 40 percent since 1990 while value creation has increased by 30 percent, adjusted for inflation.

Norwegian activities that include processing within the value chain are outlined in the table below. The materials processed in Norway include aluminum; cobalt; copper; nickel; silicon; silicon carbide; synthetic graphite; manganese; PGMs including palladium, platinum, and rhodium; titanium; and zinc. Norwegian activities do not include manganese or titanium metal production but do involve the processing of silico- and ferromanganese, as well as titanium oxide and titanium slags.

Figure 1. Summary of Mineral and Metal Processing Capabilities in Norway



Aluminum

Norway has seven aluminum smelters producing a total of 1.4 Mt with about 3,000 employees. Hydro is the largest producer, with five sites all located on the west coast of Norway. These sites include Karmøy, Husnes, Høyanger, Årdal, and Sunndal. Alcoa operates two sites in Lista and Mosjøen. Carbon anodes for smelters are produced at Hydro Årdal, Hydro Sunndal and Alcoa Mosjøen. Hydro is listed on Oslo stock exchange and the Norwegian state owns 34 percent. Alcoa is a U.S. based company.

All sites receive aluminum oxide as raw material and there is significant import of carbon anodes. Hydro sources all its aluminum oxide from Alunorte, a majority-owned subsidiary of Hydro in Brazil. The source of aluminum oxide for Alcoa's plants is not specified.

Hydro produces primary aluminum at all its plants and also manufactures wire rod at the Karmøy plant. The Vigeland plant produces highly refined aluminum with 99.99 percent purity, while the Magnor plant specializes in extrusions. Speira owns and operates a recycling facility and a rolling mill at Holmestrand, and a rolling mill at Karmøy. Alcoa produces ingots and alloys at the Mosjøen smelter and supplies molten metal to Aludyne for automotive aluminum casting at the Lista plant. Norwegian aluminum production is mainly focused on primary aluminum but

also includes refining for high purity, as well as forming through extrusion and casting, and recycling of production scrap and end-of-life scrap. Europe is the primary export market.

Silicon

Norway has seven silicon and ferrosilicon smelters producing 230,000 t of silicon metal and 300,000 t of ferrosilicon. The silicon metal production sites are Elkem Thamshavn, Elkem Salten, Elkem Bremanger and Wacker Holla. Ferrosilicon is produced at Finnsnes (Finnfjord), Bjølvefossen (Elkem), Rana (Elkem), and Bremanger (Elkem). In total, these companies employ about 1,400 people. All producers of silicon and ferrosilicon also produce fumed silica, which is collected from filter dust.

All sites use raw materials such as quartz, coal, coke, charcoal, and woodchips. Additionally, ferrosilicon producers include iron pellets and scrap in the smelting process. Quartz primarily comes from Norwegian sources, with Elkem's subsidiary, Elkem Tana, producing pure quartz. Quartz can also be imported. Producers are gradually increasing the use of charcoal to reduce carbon dioxide (CO_2) emissions.

Wacker Holla ships all its materials to Wacker in Germany, where polysilicon and different silicone products are produced. Elkem silicon and ferrosilicon sites sell their products worldwide, with the primary market being Europe. Elkem also operates sites in France that produce silicone products. Wacker Holla is a 100 percent subsidiary of the German multinational chemical company Wacker Chemie. Elkem is listed on the Oslo Stock Exchange and is 53 percent owned by China National Bluestar Group. The Finnfjord ferrosilicon producer is privately owned.

Titanium

Norway does not produce titanium metal but has processing capabilities. Titania AS, a subsidiary of Kronos Worldwide Inc., operates the Tellnes mine in Sokndal, Norway. This mine is one of the largest open-pit ilmenite mines in the world. Ilmenite, a titanium-iron oxide mineral with the formula $FeTiO_3$, is the most important ore of titanium and the main source of titanium dioxide (TiO_2), which is used in paints, printing inks, fabrics, cosmetics, and more. The Tellnes mine has an annual production capacity of approximately 670,000 t of ilmenite, making it a significant source of TiO_2 feedstock for various industrial applications.

Part of the ilmenite ore is sent to Kronos Titan AS which operates a TiO_2 production plant in Fredrikstad, Norway. This plant was the world's first factory for the production of TiO_2 using the sulfate process. The Fredrikstad plant produces TiO_2, which is used as a pigment in products such as paint, plastics, and paper. The plant has a production capacity of around 30,000 t/yr. Titanium metal can be produced from TiO2 by the Kroll process.

Ineos Tyssedal is a smelter equipped to produce TiO_2, which is used in the pigments industry. It also produces high-purity pig iron from ilmenite supplied by GCO in Senegal for sale to foundries in Europe.

Manganese

Norway does not produce manganese metal but has the upstream processing capabilities to produce silicomanganese and ferromanganese. Norway has four silico- and ferromanganese smelters producing 850,000 t. The silicomanganese is produced at Eramet Kvinesdal site. Ferromanganese is produced at Eramet Sauda and Ferroglobe Rana. Eramet Porsgrunn produces both silicomanganese and ferromanganese. The production of silico and ferromanganese generates slags that are typically disposed in landfills. This byproduct has, however, been approved for use in road construction, and Eramet is currently exploring additional applications. In total, these companies employ about 660 people.

All sites utilize raw materials that are rich in either manganese or iron, with all ore-based raw materials being imported. Eramet sources its ore from its own mine in Gabon. Additionally, coke is incorporated into the furnace mix, and Eramet is also working on developing biobased charcoal for use in their furnaces. The final products, which are alloys, are supplied to steel mills around the world for steel production. The manganese content in these alloys can be further refined to produce pure manganese metal through hydrometallurgical or electrolytic processes.

All Eramet sites in Norway are owned by Eramet, which is a French multinational mining and metallurgy company headquartered in Paris, France. Ferroglobe was formed in 2015 through the merger of the Spanish company Grupo FerroAtlántica and the U.S. company Globe Specialty Metals.

Nickel, Copper, Cobalt, and Magnesium

Glencore Nikkelverk in Kristiansand is a wholly owned subsidiary of the Swiss multinational commodity trading and mining company Glencore. The Kristiansand site receives nickel matte from Glencore operations in Raglan and Sudbury, Canada, with additional smaller amounts sourced from Finland and more recently minor volumes from Indonesia. Glencore Nikkelverk has a capacity of nearly 100,000 t/yr of refined nickel metal. Additionally, the plant produces copper and cobalt, with capacities of 30,000 t/yr and 5,000 t/yr respectively, depending on ore content. Smaller quantities of silver, gold, palladium, platinum, and rhodium are also produced.

The production process at Nikkelverk includes several stages: first, the material is crushed and milled into a fine powder. This is followed by chlorine-leaching, and then the material is refined through electrolysis and other processes. There are electrolysis lines for nickel, copper, and cobalt.

Glencore Nikkelverk is considering expansion within its existing premises. The site recently opened a new copper tank house, refining copper with 30 percent lower specific energy consumption. The plant employs approximately 550 people.

Zinc

Boliden Odda, a wholly owned subsidiary of the Swedish group Boliden, currently has a capacity of 200,000 t/yr of refined zinc and zinc alloy. The plant is undergoing a significant expansion to increase its capacity to 350,000 t/yr, with the new capacity expected to be operational in the first half of 2025. The primary raw materials for the Boliden Odda plant are zinc concentrates sourced from Boliden's mines in Garpenberg, Sweden, and Tara Mines in Ireland. Additionally, the plant uses recycled zinc as a secondary raw material.

Zinc concentrates are roasted in fluidized bed roasters to convert zinc sulfide (ZnS) into zinc oxide (ZnO) and sulfur dioxide (SO_2). The zinc oxide is then leached with sulfuric acid to produce a zinc sulfate solution. This purified solution undergoes electrolysis in large electrolytic cells, where zinc is deposited on aluminum cathodes and oxygen is released at the anodes. The zinc deposited on the cathodes is then stripped off, melted, and cast into various shapes and sizes, such as ingots or alloys, according to customer requirements. The plant employs approximately 500 people.

Synthetic Graphite

Vianode is an advanced battery materials company owned by Altor. Vianode focuses on producing sustainable anode graphite solutions for the battery and electric vehicle ("EV") value chains in North America and Europe. An industrial pilot with a capacity of 2,000 t/yr was recently inaugurated in Porsgrunn, Norway. Vianode sources petroleum coke to produce synthetic graphite. The production involves specialized high-temperature processes that create synthetic graphite with unique performance characteristics. These processes are conducted in closed production systems, ensuring lower energy consumption and reduced CO_2 emissions. A critical stage in the production is graphitization, where the graphite is processed in full-size furnaces to achieve the desired properties for high-performance anode materials. Vianode's proprietary technology aims to significantly reduce the CO_2 footprint, achieving a 90 percent reduction compared to conventional production methods.

Silicon Carbide

There are three production sites for silicon carbide in Norway. Two plants, located in Lillesand and Eydehavn, under the Fiven company were recently acquired by the Kymera Group (US), while the third site is operated by Washington Mills, a U.S. company. The Lillesand site has the capacity to produce 20,000 t/yr of silicon carbide crude but instead imports this material from a sister company in Brazil. Washington Mills imports its raw materials from the United States. All three plants focus on refining specialized silicon carbide through milling and crushing lines, chemical purification, and shaping. Applications include abrasive, ballistic, automotive and electronic applications.

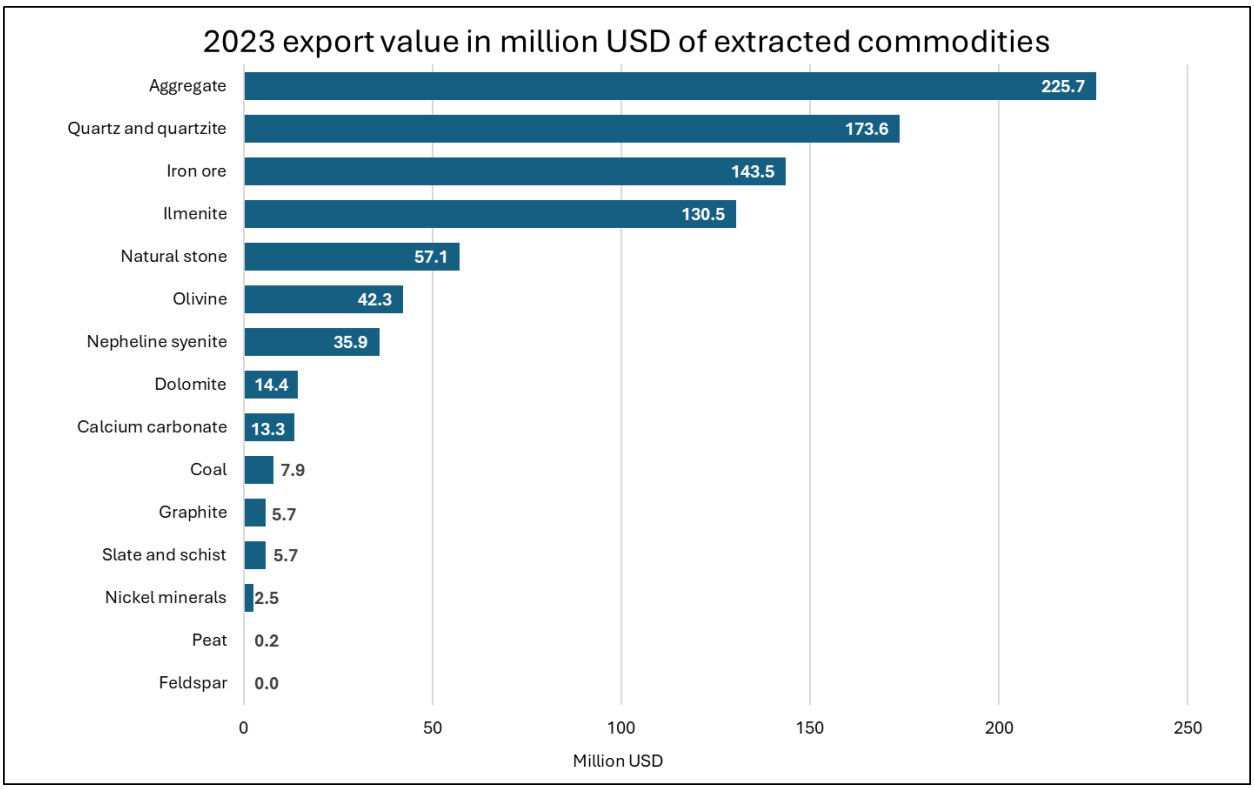
Employment and Output

According to data provided by the Directorate of Mining with Commissioner of Mines at Svalbard (DMF)[3], the sales value of minerals and rocks produced by the extractive industry in Norway amounted to 14.249 billion NOK in 2023 – roughly equivalent to 1.3 billion USD. Of the 1.3 billion USD, aggregates made up 51 percent, metallic ore 23 percent, industrial minerals 17 percent, and natural stone eight percent.

In 2023, the export value made up 54.6 percent of the total sales value. Almost all metals extracted (iron and titanium minerals) are exported, as are 62.4 percent of the industrial minerals. Figure 2 details the export values on a commodity basis.

In 2023, total manpower in the extractive industry consisted of 4,473 full time equivalents.

Figure 2. 2023 Export Value in million USD of Extracted Commodities



Source: Geological Survey of Norway (https://www.ngu.no/geologiske-ressurser/eksport-av-sand-grus-og-pukk)

Even though most of the metals and industrial minerals are exported, part of the Norwegian production of quartz and quartzite is used in the domestic processing industry.[4] As a result, Norway supplied the EU with 35 percent of all imported silicon in 2016-2020.[5] Also, the

3 Harde fakta 2023 (in Norwegian) https://dirmin.no/sites/default/files/harde_fakta_2023.pdf.

4 Prosess21: Norsk prosessindustri i 2024, p. 8-11, 241010-industribeskrivelse-2024-m-forside.pdf.

5 SCRREEN 2023. Updated fact sheets, 2023, https://scrreen.eu/crms-2023/.

Norwegian carbonate production (limestone, marble and dolomite) is supporting a Norwegian downstream industry producing fillers and other carbonate-based products.

Norway produces around five percent of the world's titanium mineral concentrate through hard-rock mining of ilmenite in Southwest Norway. Some of this production is processed into TiO_2 pigment in Norway, whereas the rest is exported, partly to the PRC. A minor byproduct of nickel, copper, and cobalt-containing sulfides is also exported. A new titanium mine (rutile) in Western Norway opened in late 2024. Norwegian production is therefore expected to increase from 2025.

B. United States Mineral Supply Chains

Mining

Mining in the United States has a long history that predates the period of European colonization, with indigenous people utilizing turquoise, native copper, flint, obsidian, and other earth materials. The United States has diverse mineral resources, with 63 of the more than 100 mineral commodities tracked by the USGS having some domestic production in 2023. However, for many of these commodities domestic production covers only a fraction of the demand, and the United States is 100 percent import reliant on 12 of the 50 critical minerals,[6] despite the fact that a recent analysis identified 681 domestic mineral deposits which have documented critical mineral resources, including 244 which are not past or current producers. This subset is of particular interest as it represents possible untapped critical mineral potential.[7] In order to better assess domestic undiscovered critical mineral resource potential, in 2019, the United States Geological Survey ("USGS") launched the Earth Mapping Resources Initiative (Earth MRI),[8] a collaborative project between the USGS and the state geological surveys to collect and modernize the Nation's geologic mapping and data resources.

The text below focuses on domestic mining of graphite, REE, nickel, cobalt, molybdenum, PGMs, silver and zinc.

Despite its increasing importance to the world and national economy, large-scale graphite mining in the United States has been limited to two periods, 1900 to 1915 and 1941 to 1954, with mines in the Alabama Graphite Belt and the Seward Peninsula of Alaska. Areas with potential for graphite resources span 20 states,[9] with five companies exploring or developing graphite-mining projects—two in Alabama, one in Alaska, one in Montana, and one in New

6 U.S. Geological Survey, 2024, Mineral commodity summaries 2024: U.S. Geological Survey, 212 p., https://doi.org/10.3133/mcs2024.

7 Hammarstrom, J.M., Woodruff, L.G., and Dicken, C.L., 2023, Critical mineral deposits of the United States (ver. 2.0, April 2024): U.S. Geological Survey data release, https://doi.org/10.5066/P9K1HBNT.

8 U.S. Geological Survey, Earth Mapping Resources Initiative, https://www.usgs.gov/earth-mapping-resources-initiative-earth-mri.

9 Hammarstrom, J., Dicken, C., Day, W., Hofstra, A., Drenth, B., Shah, A., McCafferty, A., Woodruff, L., Foley, N., Ponce, D., Frost, T., and Stillings, L., 2020, Focus areas for data acquisition for potential domestic resources of 11 critical minerals in the conterminous United States, Hawaii, and Puerto Rico—Aluminum, cobalt, graphite, lithium, niobium, platinum-group elements, rare earth elements, tantalum, tin, titanium, and tungsten (ver. 1.1, July 2022), chap. B of U.S. Geological Survey, Focus areas for data acquisition for potential domestic sources of critical minerals: U.S. Geological Survey Open-File Report 2019–1023, 67 p., https://doi.org/10.3133/ofr20191023B.

York.[10] Only one of these projects, Graphite One in Alaska, has documented reserves, which are reported at 1.258 Mt of contained graphite.[11] Overall estimates of identified graphite resources in the United States total 22 Mt (G. Lederer, personal communication) compared to global resources which total more than 800 Mt.[12] Geological, geochemical, and geophysical mapping by the USGS and its partners of areas favorable for graphite deposits indicate that undiscovered resources in the United States may be significantly larger than identified.[13]

REE are mined in the United States at Mountain Pass, California. Production at this mine totaled approximately 43,000 t of mineral concentrates in 2023, representing approximately 12 percent of global REE production. In addition, multiple REE mine and exploration projects are being pursued in the United States, with complementary research on the potential extraction of REE from various mine and industrial waste streams. Total REE reserves in the United States are approximately 1.8 Mt with identified resources exceeding 3.6 Mt. These can be compared to global reserves of 110 Mt. However, more than 95 percent of the REE mineral concentrates produced in the United States are not processed domestically but exported to the PRC for processing into compounds and metals.[14] (See mineral processing section below).

The United States has one active nickel mine, the Eagle Mine in Michigan, which produced approximately 17,000 t of nickel in 2023. The ore is exported mostly to Canada for smelting. A small amount of nickel was also produced as a byproduct of PGM production at the Stillwater mine in Montana and from historic mine tailings in Missouri. In addition, there are several exploration and development projects in Michigan and Minnesota. Nickel resources in the United States are primarily found in magmatic sulfide deposits, typically also including cobalt, copper, and PGMs. There are also nickel-cobalt laterites in the Klamath Mountains region in California and Oregon, southwestern Puerto Rico, and parts of Alaska.[15] Nickel reserves in the United States total approximately 310,000 t with identified resources in excess of 450,000 t, and these figures compare to annual domestic consumption of approximately 110,000 t primary nickel (excluding the nickel content of stainless-steel and alloyed scrap). Global mine production of 3.6 Mt in 2023, reserves of more than 130 Mt, and identified resources in excess of 350 Mt highlight the relatively small, identified resource potential in the United States.[16]

Approximately 500 t of cobalt were produced from the Eagle Mine mentioned above as well as from historic mine tailings in Missouri.[17] The United States has 640,000 t of cobalt reserves and

10 U.S. Geological Survey, 2024, Mineral commodity summaries 2024: U.S. Geological Survey, 212 p., https://doi.org/10.3133/mcs2024.

11 JDS Energy & Mining Inc., Preliminary Feasibility Study Technical Report, Graphite One Project, 2022, https://www.graphiteoneinc.com/wp-content/uploads/2022/10/JDS-Graphite-One-NI-43-101-PFS-20221013-compressed.pdf.

12 U.S. Geological Survey, 2024, Mineral commodity summaries 2024: U.S. Geological Survey, 212 p., https://doi.org/10.3133/mcs2024.

13 Lederer, G., Jones, J., McPhee, D., Mauk, J., Seal, R., Campbell, K., Hammarstrom, J., Bedrosian, P., MacQueen, P., Graham, G. and Solano, F., 2024. USGS critical minerals review. Mining Engineering, 76(5).

14 U.S. Geological Survey, 2024, Mineral commodity summaries 2024: U.S. Geological Survey, 212 p., https://doi.org/10.3133/mcs2024.

15 Cornwall, H.R., 1966. Nickel Deposits of North America, USGS Bulletin 1223, https://doi.org/10.3133/b1223.

16 U.S. Geological Survey, 2024, Mineral commodity summaries 2024: U.S. Geological Survey, 212 p., https://doi.org/10.3133/mcs2024.

17 U.S. Geological Survey, 2024, Mineral commodity summaries 2024: U.S. Geological Survey, 212 p., https://doi.org/10.3133/mcs2024.

identified resources contained in several deposit types. The vast majority occurs within magmatic sulfide deposits of the Duluth Complex in northeastern Minnesota, and in metasedimentary-rock-hosted deposits of the Blackbird district in east-central Idaho. Smaller amounts of cobalt are present in western Montana and the Eagle mine deposit in northern Michigan. Resources are also present in the nickel-cobalt laterites of southern Oregon and northern California, although part of this area has been withdrawn from further exploration or development activity.[18] Compared with the estimated global identified terrestrial resources of approximately 25 Mt of cobalt, the United States has resources of approximately 1 Mt.

Molybdenum concentrate production at primary molybdenum mines continues at two U.S. operations in Colorado, and molybdenum concentrate production from mines where molybdenum is a byproduct continues at six U.S. operations (four in Arizona and one each in Montana and Utah).

In 2023, the Stillwater mine in Montana produced PGMs with an estimated value of about $510 million. Small quantities of primary PGMs also were recovered as byproducts of copper-nickel mining at the Eagle Mine in Michigan.

In 2023, U.S. mines produced approximately 1,000 of silver from four silver mines and as a byproduct or coproduct from 31 domestic base- and precious-metal operations. Silver was produced in 12 states, and Alaska continued as the country's leading silver-producing state, followed by Nevada.

In 2023, zinc was mined in five states at seven mining operations by five companies, with the largest quantity from the Red Dog mine in Alaska. The United States is a net exporter of zinc concentrate.

Processing

As noted above, the mining and mineral processing industry in the United States spans more than 60 mineral commodities, so the summary in this section is limited to the minerals and metals with significant domestic processing as well as those with significant byproduct recovery. The information in this section and the associated figures are derived from the 2024 USGS Mineral Commodity Summaries except where noted.[19]

- Aluminum (and bauxite) – In 2023, three companies operated five primary aluminum smelters in the United States. Two of these smelters operated at full capacity throughout the year, whereas three smelters operated at reduced capacity. Domestic smelter capacity decreased to 1.36 Mt/yr from 1.64 Mt per year in 2022. At present there are only two remaining domestic primary aluminum producers operating four

18 Schulz, K.J., DeYoung, J.H., Jr., Seal, R.R., II, and Bradley, D.C., eds., 2017, Critical mineral resources of the United States—Economic and environmental geology and prospects for future supply: U.S. Geological Survey Professional Paper 1802, 797 p., https://doi.org/10.3133/pp1802.

19 U.S. Geological Survey, 2024, Mineral commodity summaries 2024: U.S. Geological Survey, 212 p., https://doi.org/10.3133/mcs2024.

smelters located in New York, Indiana, Kentucky, and South Carolina. High energy costs, regulatory constraints, and aging infrastructure are some of the reasons driving this decline. Although metallurgical grade bauxite is not currently mined in the United States, there is one active alumina refinery in the United States located in Louisiana that produces both smelter and chemical grade alumina. Aluminum metal is further manufactured into castings, extrusions, forgings, etc. According to the Aluminum Association, the United States is the second largest producer of recycled (or secondary) aluminum in the world.[20]

- Antimony – Primary antimony metal and oxide were produced by one company in Montana using imported feedstock. Secondary antimony production was derived mostly from antimonial lead recovered from spent lead-acid batteries.
- Beryllium – One company in Utah mined bertrandite ore and converted it, along with imported beryl, into beryllium hydroxide. Some of the beryllium hydroxide was shipped to the company's plant in Ohio, where it was converted into metal, oxide, and downstream beryllium-copper master alloy, and some was sold.
- Cadmium – One company operating in Tennessee recovered primary cadmium metal as a byproduct of zinc leaching from roasted sulfide concentrates that would otherwise need to be disposed of as waste. One company operating in Ohio recovered secondary cadmium metal through the recycling of spent nickel-cadmium batteries.
- Copper – In 2023, copper was recovered or processed at 25 mines (17 of which accounted for more than 99 percent of mine production), two primary smelters, one secondary smelter, two primary electrolytic refineries, 14 electrowon refineries, and three secondary fire refineries. A new secondary copper refinery was expected to startup by yearend. Refined copper and scrap were consumed at about 30 brass mills, 14 rod mills, and 500 foundries and miscellaneous manufacturers. Copper recovered from scrap contributed 33 percent of the U.S. copper supply.
- Magnesium - In 2023, primary magnesium was produced by one company in Utah at an electrolytic process smelter that recovered magnesium from brines from the Great Salt Lake. Secondary magnesium was recovered from scrap at smelters that produced magnesium ingot and castings and from aluminum alloy scrap at secondary aluminum smelters.
- Molybdenum – The United States has three roasting plants that converted molybdenum concentrate to molybdic oxide, from which intermediate products, such as ferromolybdenum, metal powder, and various chemicals, were produced.
- Rhenium – Rhenium-containing products including ammonium perrhenate (APR), metal powder, and perrhenic acid were produced as byproducts from roasting molybdenum concentrates from porphyry copper-molybdenum deposits in Arizona and Montana. Total estimated U.S. primary production was approximately 9,100 kilograms in 2023.

20 The Aluminum Association, Aluminum Agenda: Recycling, https://www.aluminum.org/sites/default/files/2024-05/2024-Agenda_Recycling-Overview.pdf.

The United States continued to be a leading producer of secondary rhenium, recovering rhenium from nickel-base superalloy scrap, spent oil-refining catalysts, and foundry revert.

- Silver – There were 24 U.S. refiners that reported production of commercial-grade silver with an estimated total output of 3,000 t from domestic and foreign ores and concentrates and from new and old scrap.
- Tellurium – Tellurium is primarily recovered as a byproduct of the electrolytic refining of copper, where it accumulates in the residues of copper anodes. In 2023, two electrolytic copper refineries operated in the United States, one in Texas and one in Utah, and produced copper telluride from tellurium-bearing anode slimes. Copper telluride from both domestic facilities was exported for further processing. Downstream companies refined imported commercial-grade tellurium to produce high-purity tellurium, tellurium compounds for specialty applications, and tellurium dioxide.
- Titanium – In 2023, one company recovered ilmenite and rutile concentrates from its surface-mining operations near Nahunta, Georgia, and Starke, Florida. A second company processed existing mine tailings to recover a mixed heavy-mineral concentrate in California. Titanium sponge metal was produced by one operation in Utah.
- Vanadium – Energy Fuels has reconfigured its White Mesa Mill to be able to produce vanadium along with uranium and REE.[21] Secondary vanadium production continued in Arkansas, Ohio, and Pennsylvania where processed waste materials (petroleum residues, spent catalysts, utility ash) were used to produce ferrovanadium, vanadium-bearing chemicals or specialty alloys, and vanadium pentoxide.
- Zinc – Two smelter facilities, one primary and one secondary, operated by two companies, accounted for most of the commercial-grade zinc metal produced in the United States.

Employment and Output

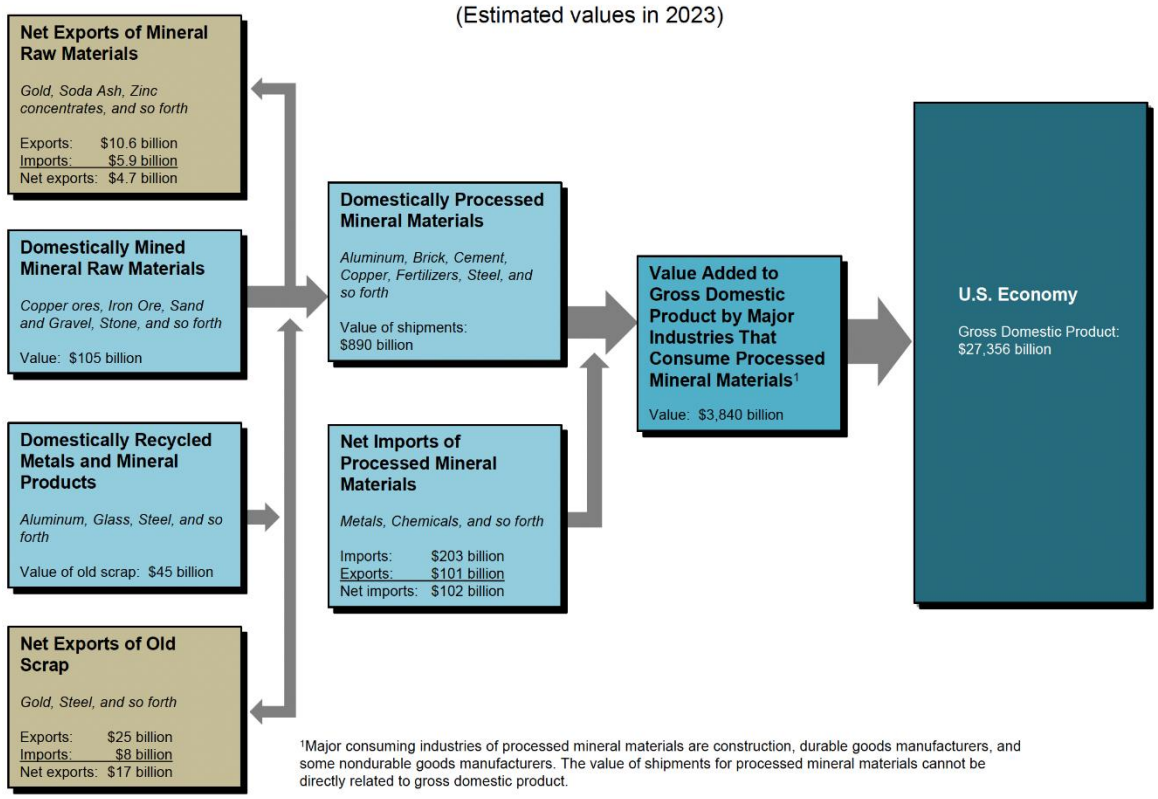
In 2023, the estimated total value of nonfuel mineral production in the United States was $105 billion, with $34.9 billion from metal production, $35.2 billion from construction aggregates production (construction sand and gravel and crushed stone), and $34.7 billion from other industrial minerals.[22] Figure 3 shows the role of primary and secondary mineral production, processed mineral materials, and imports and exports, to the United States economy, contributing to the real gross domestic product at several levels, including mining, processing, and manufacturing finished products. Domestic raw materials and domestically recycled materials were used to produce mineral materials worth $890 billion. These mineral materials as well as $102 billion of net imports of processed mineral materials were, in turn, consumed by

21 Energy Fuels, Vanadium Production, https://www.energyfuels.com/vanadium-production.

22 U.S. Geological Survey, 2024, Mineral commodity summaries 2024: U.S. Geological Survey, 212 p., https://doi.org/10.3133/mcs2024.

downstream industries creating an estimated value of $3.84 trillion in 2023 out of a national GDP of $27.36 trillion.

Figure 3. The Role of Nonfuel Mineral Commodities in the United States Economy.



Source: U.S. Geological Survey and U.S. Department of Commerce

In 2023, imports made up more than one-half of the U.S. apparent consumption for 49 nonfuel mineral commodities, and the United States was 100 percent net import reliant for 15 of those. In 2023, U.S. production of 14 mineral commodities was valued at more than $1 billion each. These commodities were, in decreasing order of value, crushed stone, construction sand and gravel, cement, gold, copper, iron ore, industrial sand and gravel, salt, lime, zinc, phosphate rock, soda ash, molybdenum, and helium. Principal contributors to the total value of metal mine production in 2023 were gold, 29 percent; copper, 28 percent; iron ore, 22 percent; zinc, seven percent; and molybdenum, six percent.

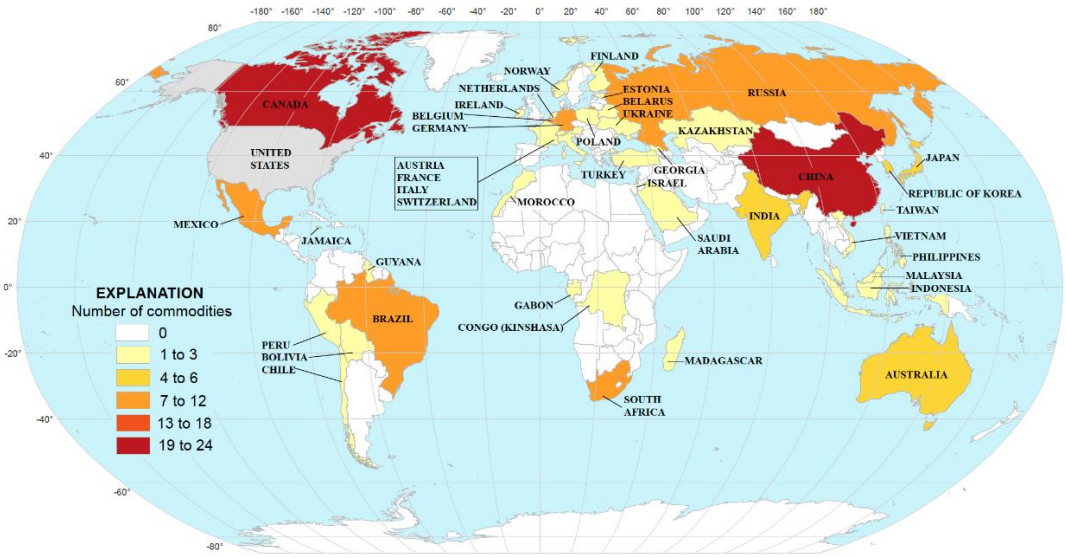
Mining across all sectors (nonfuel and coal mining) employed 191,000 people in 2023. Employment in allied industries, including chemicals; stone, clay, and glass products; and metal industries totaled 1,170,000 people.

In 2023, the value of domestic primary mine production of critical minerals was $4.1 billion. A total of 13 individual mineral commodities and the REEs (without specification of the specific REEs) had primary production in the United States. Zinc contributed the most to the total value of critical-mineral production (59 percent) followed by palladium (10 percent). The United

States had secondary production for 14 critical minerals, which resulted in net import reliance being less than 100 percent. Of the 50 mineral commodities identified in the 2022 List of Critical Minerals, the United States was 100 percent net import reliant for 12, and an additional 29 critical mineral commodities had a net import reliance greater than 50 percent. The total value of critical minerals domestically recycled in 2023 was $10 billion, 23 percent of the total value of domestically recycled old scrap. Recycling provided the only source of domestic supply for antimony, bismuth, chromium, germanium, tin, tungsten, and vanadium.

Since 2014, the People's Republic of China (PRC) has been a source of supply for up to 24 nonfuel mineral commodities or about half of the nonfuel mineral commodities for which the United States has a greater than 50 percent net import reliance.[23]

Figure 4. Leading Import Sources (2019–22) of Nonfuel Mineral Commodities for Which the United States was Greater than 50 Percent Net Import Reliant



Source: U.S. Geological Survey, 2024, Mineral commodity summaries 2024: U.S. Geological Survey, 212 p., https://doi.org/10.3133/mcs2024.

C. Norway's Mineral Strategy

Norway is actively working to expand its production of and maintain the commercial viability of the minerals sector. The government unveiled its comprehensive Norwegian Mineral Strategy[24]

23 Fortier, S.M., DeYoung, J.H., Jr., Sangine, E.S., and Schnebele, E.K., 2015, Comparison of U.S. net import reliance for nonfuel mineral commodities—A 60-year retrospective (1954–1984–2014): U.S. Geological Survey Fact Sheet 2015–3082, 4 p., http://dx.doi.org/10.3133/fs20153082.

24 Norwegian Ministry of Trade, Industry and Fisheries, Norwegian Minerals Strategy, https://www.regjeringen.no/contentassets/1614eb7b10cd4a7cb58fa6245159a547/norges-mineralstrategi_engelsk_uu.pdf.

in 2023 which aims to position Norway in the forefront of sustainable mineral extraction and processing, addressing both economic and environmental concerns.

One of the primary goals of the strategy is to expedite the implementation of mineral projects. The government plans to complete geophysical surveys and enhance the mapping of critical raw materials. This initiative includes the introduction of schemes designed to streamline permitting procedures, thereby reducing the time required to bring new projects into operation. This includes a revision of the Minerals Act.

In addition to accelerating project implementation, the strategy emphasizes the importance of contributing to the circular economy. This involves minimizing extractive waste and promoting the reuse and recycling of materials. This approach reduces environmental impact but also enhances the long-term viability of the mineral industry.

Sustainability is at the core of the strategy. This includes improving dialogue with communities affected by mining activities, including indigenous Sami communities, ensuring that their concerns are addressed, and that environmental and social impacts are minimized. Mobilizing private capital is another key aspect of the strategy. Private investment is key to developing profitable and sustainable mineral projects. To this end, the strategy outlines the plans to attract investment and foster innovation in the mineral industry.

International partnerships are also a key component of Norway's mineral strategy. The country seeks to strengthen its role as a stable supplier of raw materials for green value chains by enhancing cooperation with the European Union, the United States, and other international partners. These partnerships are intended to promote robust and sustainable supply of critical minerals essential for clean energy technologies and other strategic industries.

The Norwegian CO_2 compensation scheme

The CO_2 compensation scheme partially compensates undertakings active in certain energy-intensive industries for increased prices on electricity as a result of the EU Emissions Trading System. The objective and purpose of the scheme is to prevent a significant risk of carbon leakage due to European Union Allowance ("EUA") costs passed on in electricity prices.

The Norwegian government intends to make amendments in the Norwegian CO_2 compensation scheme, based on a political agreement between the Norwegian government and the Norwegian manufacturing industry. The proposed amendments consist of an implementation of an "annual compensation cap" of NOK 7 billion per year, removal of the current EUA price floor in the calculation of the aid and a new requirement in relation to 40 percent of the aid received. The manufacturing industry shall use at least 40 percent of the aid received (2024-2030) on climate mitigation measures or energy efficiency measures in Norway.

Other instruments

Projects in Norway have access to a broad set of grants, loans, guarantees and equity instruments to foster research, innovation, trade and the transition to a green economy. These instruments are financed nationally, on a Nordic level or through membership in relevant EU programs. The main national agencies involved are The Norwegian Research Council, Innovation Norway, Enova and Eksfin (Export Finance Norway). Additionally, projects have access to EU programs such as Horizon Europe, the Innovation Fund, and InvestEU.

The Norwegian Research Council supports research and innovation projects across various sectors, including critical minerals. It provides funding for both basic and applied research, as well as innovation projects. Innovation Norway offers financial support to businesses for innovation and development projects, including grants, loans, and guarantees to foster growth and competitiveness. Enova focuses on energy and climate projects, offering funding for initiatives that contribute to reducing greenhouse gas emissions and promoting energy efficiency. Eksfin provides loans, guarantees, and advisory services to Norwegian companies involved in international trade.

The Green Industry Finance Fund is specifically designed to support green industrial projects, including those in the critical minerals value chain. This fund aims to promote sustainable and environmentally friendly industrial practices.

On the EU level, Horizon Europe is the key funding program for research and innovation, with a strong focus on sustainability and green technologies. Projects in the critical minerals sector can apply for funding under various calls related to raw materials, circular economy, and green technologies. The Innovation Fund supports innovative low-carbon technologies and processes in energy-intensive industries, including the critical minerals sector, aiming to bring highly innovative technologies to the market. InvestEU provides funding for sustainable infrastructure, research and innovation, and small and medium-sized enterprises ("SMEs"), offering investment support to scale up and commercialize innovations in the critical minerals sector.

D. United States Mineral Strategy

A series of actions by the U.S. Federal Government in recent years addressed domestic supply chain vulnerabilities for critical minerals, beginning with Executive Order 13817, "A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals," which was issued on December 20, 2017, and initiated a whole-of-government call to action to identify critical

minerals and reduce U.S. critical-mineral supply-chain vulnerabilities. Subsequently, there have been additional actions including the following:

- Several Presidential determinations directed the use of Defense Production Act ("DPA") Title III authorities to strengthen the U.S. industrial base for REEs.[25]
- The USGS published the 2018 List of Critical Minerals.
- In 2019, the U.S. Department of Commerce with interagency input published, "A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals."[26]
- Executive Order 13953 was issued on September 30, 2020: "Addressing the Threat to the Domestic Supply Chain from Reliance on Critical Minerals from Foreign Adversaries and Supporting the Domestic Mining and Processing Industries."
- The Energy Act of 2020 (Public Law 116-260) was passed by Congress and signed into law.
- Executive Order 14017, "America's Supply Chains," was issued in February 2021. This mandated a 100-day interagency supply chain review, which was led by the White House and has guided Federal activities to improve the resilience of supply chains, including critical mineral supply chains, over the past four years.
- Congress passed, and the President signed, the $1.2 trillion Bipartisan Infrastructure Law (Infrastructure Investment and Jobs Act, H.R. 3684, Public Law 117–58) (BIL) in November 2021, which provides funding to support production of materials used in the energy transition.
- The USGS published the 2022 List of Critical Minerals in February 2022.
- A Presidential determination on March 31, 2022, authorized the use of DPA Title III authorities to strengthen the U.S. industrial base for large-capacity batteries and specifically increasing domestic mining and processing of critical materials for the large-capacity battery supply chain such as cobalt, graphite, lithium, manganese, and nickel.[27]
- The Additional Ukraine Supplemental Appropriations Act of 2022 (Public Law 117-128) provided $600 million for DPA Title III funds "to respond to the situation in Ukraine."

25 See e.g., Presidential Determination Pursuant to Section 303 of the Defense Production Act of 1950, as Amended, July 22, 2019, https://www.federalregister.gov/documents/2019/07/25/2019-15999/presidential-determination-pursuant-to-section-303-of-the-defense-production-act-of-1950-as-amended; Presidential Determination Pursuant to Section 303 of the Defense Production Act of 1950, as Amended, July 22, 2019, https://www.federalregister.gov/documents/2019/07/25/2019-16001/presidential-determination-pursuant-to-section-303-of-the-defense-production-act-of-1950-as-amended; Presidential Determination Pursuant to Section 303 of the Defense Production Act of 1950, as Amended, July 22, 2019, https://www.federalregister.gov/documents/2019/07/25/2019-16002/presidential-determination-pursuant-to-section-303-of-the-defense-production-act-of-1950-as-amended; Memorandum on Presidential Waiver of Statutory Requirements Pursuant to Section 303 of the Defense Production Act of 1950, as amended, on Department of Defense Supply Chains Resilience, February 27, 2023, https://www.whitehouse.gov/briefing-room/presidential-actions/2023/02/27/memorandum-on-presidential-waiver-of-statutory-requirements-pursuant-to-section-303-of-the-defense-production-act-of-1950-as-amended-on-department-of-defense-supply-chains-resilience/.

26 The U.S. Commerce Department, A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals, https://www.commerce.gov/sites/default/files/2020-01/Critical_Minerals_Strategy_Final.pdf.

27 Presidential Determination Pursuant to Section 303 of the Defense Production Act of 1950, as Amended, March 31, 2022, https://www.federalregister.gov/documents/2022/04/06/2022-07421/presidential-determination-pursuant-to-section-303-of-the-defense-production-act-of-1950-as-amended.

- The CHIPS and Science Act of 2022 (Public Law 117–167) provided the Department of Commerce with $52.7 billion in funding over five years to strengthen and revitalize the U.S. position in semiconductor research, development, and manufacturing. Section 10359 of the Act directs the National Science Foundation to fund "research that will accelerate innovation to advance critical minerals mining strategies and technologies for the purpose of making better use of domestic resources and eliminating national reliance on minerals and mineral materials that are subject to supply disruptions."
- The Inflation Reduction Act of 2022 (Public Law 117–169) ("IRA") was signed into law. Specifically related to critical minerals, it authorized $391 billion in funding for climate change and domestic energy production including targeted tax incentives aimed at manufacturing U.S.-sourced materials such as batteries, electric vehicles, solar, and wind parts and technologies. Section 13401 of the IRA provides a $3,750 tax credit to purchasers of "clean vehicles" whose batteries contain a certain percentage of critical minerals extracted or processed in the U.S. or a U.S. free trade agreement country or recycled in North America.
- In October 2022, the White House launched the "American Battery Materials Initiative" to "leverage and maximize ongoing efforts throughout the U.S. Government to meet resource requirements and bolster energy security."
- Section 7233 of the $847.3 billion James M. Inhofe National Defense Authorization Act for Fiscal Year 2023, which was signed into law in December 2022, included a provision requiring that a Federal strategic plan be developed to, among other things, guide the recycling and reuse of batteries used in the Federal electric vehicle fleet.

The 100-day Supply Chain Review and a subsequent one-year review mandated by Executive Order 14017 identified three thematic areas for federal investments in critical mineral supply chain resilience: (1) building capacity for domestic production of critical minerals and strengthening U.S. stockpiles; (2) fostering sustainable and transparent critical mineral supply chains, including by expanding options for recycling and recapture of minerals waste, as well as manufacturing scrap and end-of-life products, and promoting high sustainability standards with allies; and (3) identifying supply chain vulnerabilities and working with industry, allies, and partners to reduce supply risk.

As reviewed in detail in the White House's 2021–2024 Quadrennial Supply Chain Review, since 2021, significant progress has been made towards increasing critical mineral supply chain resilience.[28] Particular progress has been made in:

- USGS mapping of the nation's critical mineral potential, which was accelerated by BIL funding.

28 The White House, 2021-2024 Quadrennial Supply Chain Review, December 2024, 20212024-Quadrennial-Supply-Chain-Review.pdf at 124-130.

- Expanding domestic production and processing capacities through the IRA's Advanced Manufacturing Production Credit (45X), which is available to domestic producers of a variety of critical minerals produced in the United States; Department of Defense funding under the Defense Production Act and Industrial Base Analysis and Sustainment fund, including Defense Production Act funds authorized for the supply chains identified in the Supply Chain Waiver signed by the President in 2023;[29] foreign investments in mining and processing projects in the United States facilitated by the Department of Commerce; and funding, support, or commitments by the Department of Energy, under the BIL and IRA, and the Import-Export Bank of the United States to support the U.S. battery and mineral supply chains.
- Fostering sustainable and transparent critical mineral supply chains, including through funding to domestic facilities to demonstrate recycling, develop technologies that reduce the need for scarce and critical minerals in clean energy technologies and R&D for critical minerals production (including from unconventional sources); novel decision-making tools and methods developed by the National Institute of Standards and Technology ("NIST") to support the transition to a circular economy; public-private partnerships to advance waste reprocessing for critical minerals; and work with trade partners to advance capacity and experience in recycling critical minerals and advance global information sharing and common standards for waste management and recycling.
- Identifying supply chain vulnerabilities and working with industry, allies, and partners to reduce risk including through the Department of Commerce Industry and Analysis ("I&A") Business Unit's mineral-by-mineral supply chain assessments, which identify chokepoints and vulnerabilities across the supply chain, describe each mineral's importance to downstream applications and uses, and identify current and potential alternative sources and mid-to-long-term policy solutions. In making these assessments, I&A draws on its sectoral expertise; the SCALE tool, which weighs structural supply chain risks; and the Supply Chain Exposure Tool, which assesses direct and indirect supply chain vulnerabilities of international partners. These assessments are used to drive engagement with industry and international partners. Also, USGS developed a new model to quantify the potential economic impacts of mineral commodity supply disruptions both to individual sectors and to the overall U.S. gross domestic product and enhance data sharing with allies and partners, and the Department of Energy conducted new Supply Chain Readiness assessments that characterize global supply-demand balance, cost curves and economic competitiveness of the U.S. and allied operations for energy minerals.

29 Memorandum on Presidential Waiver of Statutory Requirements Pursuant to Section 303 of the Defense Production Act of 1950, as amended, on Department of Defense Supply Chains Resilience, February 27, 2023, https://www.whitehouse.gov/briefing-room/presidential-actions/2023/02/27/memorandum-on-presidential-waiver-of-statutory-requirements-pursuant-to-section-303-of-the-defense-production-act-of-1950-as-amended-on-department-of-defense-supply-chains-resilience/.

- Diversifying global supply chains in allied and partner countries by supporting or facilitating projects including under authorities of the Department of Defense, U.S. International Development Finance Corporation, the Export-Import Bank of the United States; initiatives such as the Department of State's Minerals Security Partnership, the Partnership for Global Infrastructure and Investment (which is a G7 initiative mobilizing infrastructure investment in emerging markets which support sectors including critical minerals), and the Partnership for Resilient and Inclusive Supply-Chain Enhancement ("RISE") (which is a multi-donor initiative at the World Bank focused on building out the capacity of low and middle-income countries to engage in midstream and downstream activities in the clean energy sector); and convenings by the Department of Commerce to bring together producing and consuming industry stakeholders as well as investors to foster private sector connections and increase deal flow targeting chokepoints in the supply chain.
- Decreasing the challenges of mine permitting and development. The White House has led inter-agency working groups to track critical minerals projects permitting efficiencies related to federal reviews and approvals and improve tribal consultation, engagement, and outcomes related to critical mineral projects.

However, more work remains to be done. There are still vulnerabilities to be addressed in areas such as trade concentration, supplier diversity, modernization of aging domestic processing plants, and development of new mining and processing facilities to reduce overall net import reliance across a range of commodities. As reviewed in detail in the following sections of this report, the United States, Norway, and other market-oriented economies face significant challenges from non-market economies that have a large role in mineral supply chains. To help address vulnerabilities facing critical mineral supply chains resulting from NMPPs, the United States, Norway, and other market-oriented economies will need to work together.

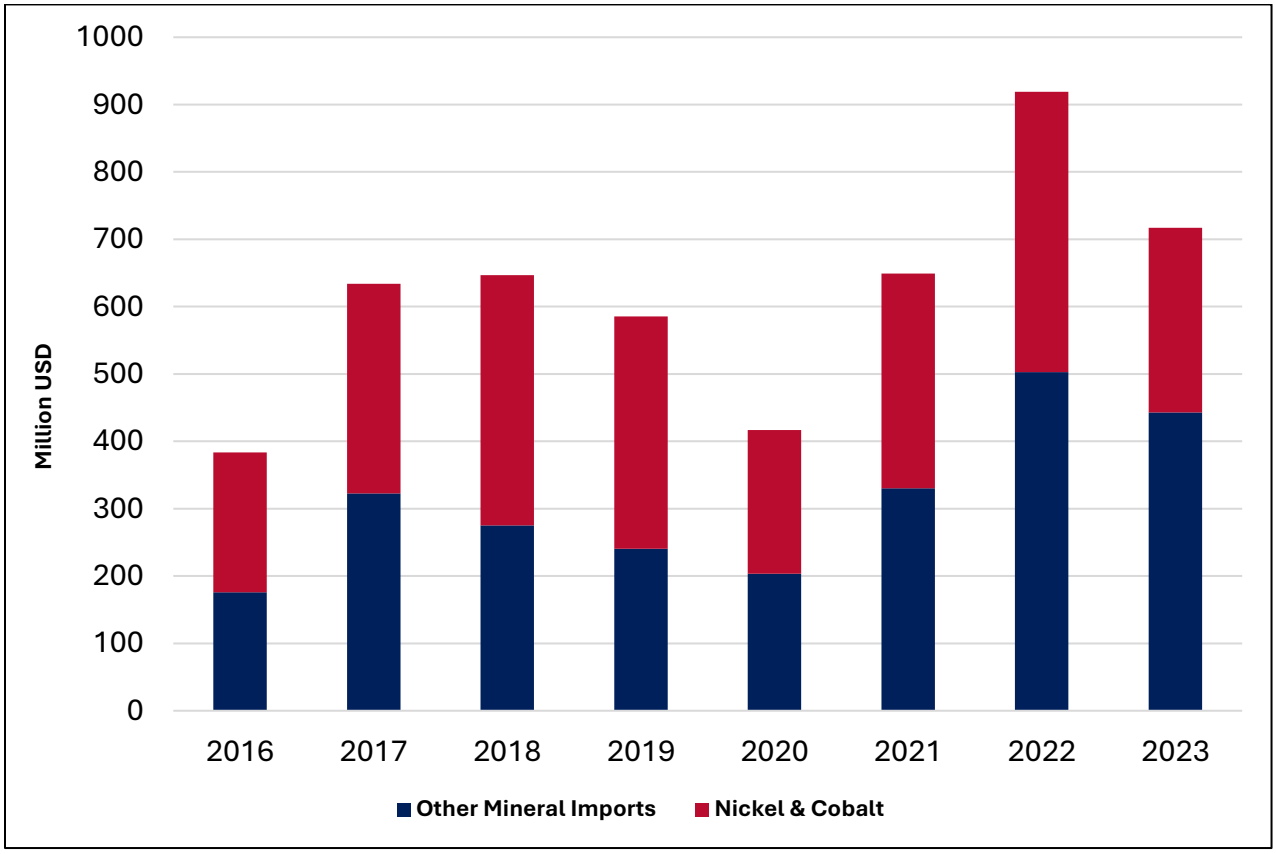
III. U.S.-Norway Trade in Critical Minerals

There has been strong trade in minerals between Norway and the United States. In the last 10 years, the United States has imported on average $608 million of minerals per year from Norway.[30] During this period, nickel and cobalt metal accounted for around half of all mineral

30 Trade data for U.S. imports is sourced from S&P's Global Trade Analytics for 2014 to 2023 for minerals imported under the following U.S. HTS codes: 2501000000, 2503000010, 2503000090, 2504101000, 2504105000, 2504900000, 2505101000, 2506100050, 2508600000, 2512000000, 2519905000, 2525100050, 2525200000, 2526200000, 2529100000, 2529300010, 2530908050, 2605000000, 2614006020, 2614006040, 2620995000, 2703000000, 2802000000, 2804290010, 2804610000, 2804691000, 2804695000, 2804900000, 2805199000, 2807000000, 2815200090, 2816402000, 2817000000, 2818200000, 2820900000, 2822000000, 2823000000, 2825200000, 2825400000, 2825909000, 2826120000, 2826300000, 2834210000, 2834292000, 2834295100, 2836200000, 2844301000, 2846100010, 2846100050, 2846902005, 2846902040, 2846908070, 2846908090, 2849201000, 2849202000, 2849901000, 2849902000, 2849905000, 3104300000, 3206110000, 3801101000, 3801105000, 3801900000, 3818000010, 6806200000, 6815992000, 7104100000, 7110110020, 7110110050, 7110190000, 7110210000, 7110290000, 7110310000, 7112920000, 7112920100, 7202111000, 7202115000, 7202191000, 7202195000, 7202211000, 7202215000, 7202290010, 7202290050, 7202300000, 7202910000, 7224100005, 7224900005, 7402000000, 7409901030, 7409909030, 7501200000, 7502100000, 7503000000, 7801910000, 7901200000, 7903100000, 7903903000, 7903906000, 8001100000, 8103200090, 8104900000, 8105203000, 8105206000, 8105209000, 8105300000, 8105900000, 8108300000, 8108906075, 8111004700, 8112925000.

imports from Norway in terms of value.[31] Norway's Nikkelverk refinery is a leading source of U.S. refined cobalt imports, accounting for 25 percent of domestic imports in terms of quantity, and the second-leading supplier of nickel to the United States, accounting for nine percent of primary nickel imports in terms of quantity.[32]

Figure 5. Annual U.S. Mineral Imports from Norway



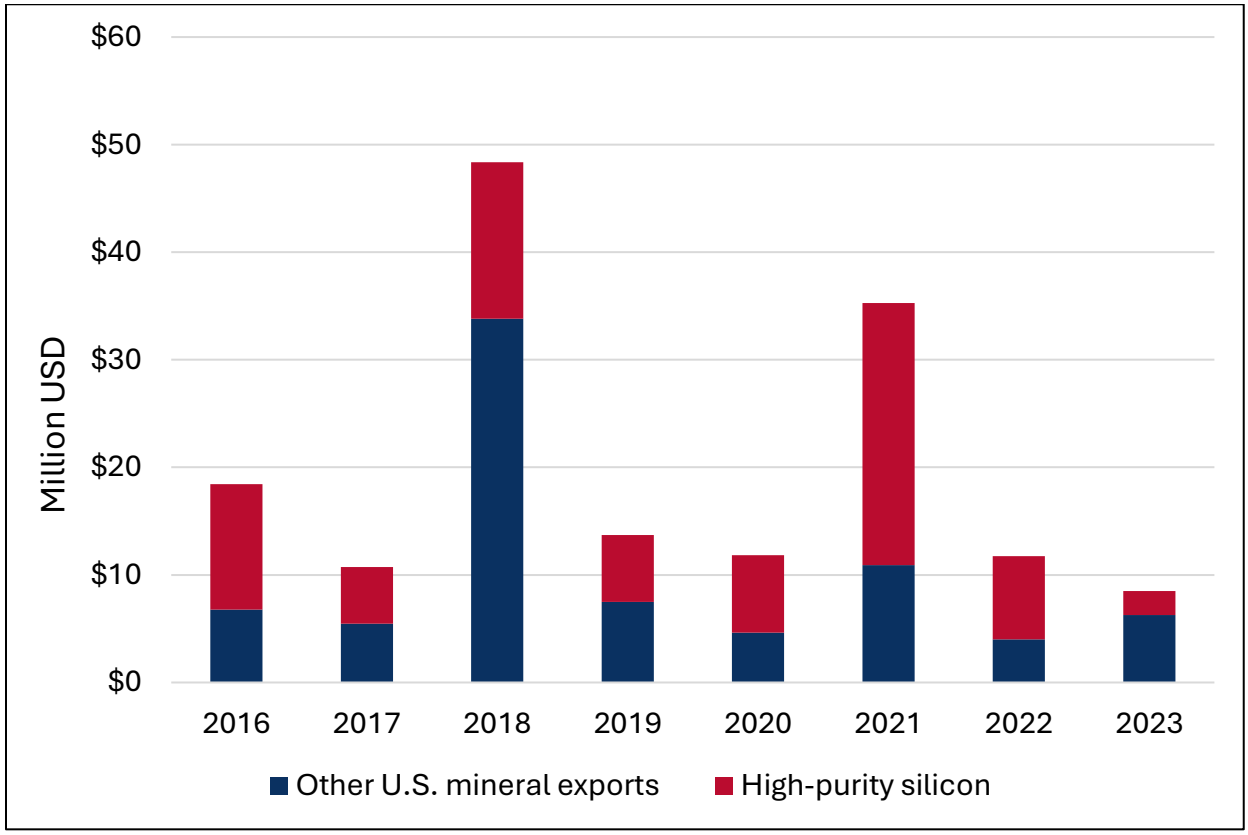
Source: S&P Global Trade Analytics

31 The nickel and cobalt import codes cover 7502100000: Nickel, Unwrought, Not Alloyed and 8105206000: Unwrought Cobalt Exc Alloys, Incl Powders.

32 U.S. Geological Survey, 2024, Mineral commodity summaries 2024: U.S. Geological Survey, 212 p., https://doi.org/10.3133/mcs2024.

In contrast, the United States exported around $48.6 million of minerals to Norway.[33] High-purity silicon is the largest in terms of value, accounting for around 33 percent of mineral exports to Norway.[34]

Figure 6. Annual U.S. Mineral Exports to Norway



Source: S&P Global Trade Analytics

33 Trade data for U.S. exports is sourced from S&P's Global Trade Analytics for 2014 to 2023 for non-fuel minerals imported under the following U.S. HTS codes: 2501000000, 2503000090, 2504900000, 2508600000, 2510100000, 2512000000, 2513100010, 2513100080, 2517100020, 2519100000, 2519901000, 2519902000, 2520100000, 2521000000, 2525200000, 2529100000, 2608000030, 2615100000, 2616100040, 2801200000, 2804290010, 2804300000, 2804610000, 2804691000, 2804695000, 2805199000, 2805300000, 2816401000, 2816402000, 2818200000, 2818300000, 2822000000, 2825200000, 2827310000, 2827510000, 2833210000, 2843300000, 2843900000, 2844301000, 2846100000, 2846902040, 2849201000, 2849202000, 2849901000, 2849903000, 3102100000, 3102210000, 3102900100, 3104900100, 3206190000, 3801900000, 6806200000, 6901000000, 7106911010, 7106911020, 7108121010, 7108125000, 7108135000, 7109000000, 7110190000, 7110210000, 7110290000, 7110390000, 7111000000, 7112910000, 7114190000, 7502100000, 7902000000, 8001100000, 8101100000, 8102950000, 8102990000, 8104110000, 8104190000, 8104300000, 8104900000, 8105900000, 8106000000, 8109200000, 8109210000, 8109900000, 8109990000, 8112190000, 8112290000, 8112927000, 8112991000, 8112992000, 8112999100, 8505110070.

34 The export code for high-purity silicon is 2804610000: Silicon Containing By Weight Not Less Than 99.99 Percent Of Silicon.

IV. Description Of NMPPs in Global Critical Mineral Supply Chains

A. Types of Market-Distorting Policies

This section reviews the PRC's NMPPs. Given the often non-transparent nature of NMPPs, it is difficult to quantify the extent to which they are used. Further, unlike transparent industrial policies employed by market economies, the PRC deploys NMPPs non-transparently, at scale, and in combination with each other.[35] Even conservative estimates of readily quantifiable industrial policies can serve as an indicator of the scale at which the PRC employs NMPPs. For example, in terms of scale, in 2019 alone,[36] the PRC government spent, by a conservative estimate given the lack of transparency, according to the study's authors, $248 billion at nominal exchange rates (1.48 percent of its GDP) in readily quantifiable NMPPs (e.g., direct spending, loan guarantees, subsidized rent) amid a much broader range of NMPPs for which quantification was not attempted (e.g., state direction of firms' commercial decisions, state-sponsored cybertheft).[37] In comparison, the United States spent $84 billion (0.39 percent of its GDP) on industrial policies, around one-third of the PRC's total, while Germany spent $19 billion (0.41 percent), and France spent $15 billion (0.55 percent).[38] While PRC NMPPs cover all sectors, the PRC's mineral markets have particularly benefitted from many of these NMPPs. NMPPs focused on mineral markets are discussed in the following sections, beginning with a review of the relevant legal and policy frameworks that guide the NMPPs. This is followed by an examination of several common (but non-exhaustive) NMPPs related to: capital/financing, state-owned enterprise ("SOE") subsidies, export restraints, and overseas market access and firm-level cooperation strategies. As described below, the PRC has identified certain industries in mineral supply chains for government support through numerous measures on both the supply and demand side to promote industry growth. These industries grow or maintain capacity without regard to market signals, and so structural overcapacity regularly leads to sustained low global prices and below-cost exports, hurting overseas competitors.[39] This can also lead to overconcentration of production in a particular market by discouraging investments elsewhere.

Legal and policy frameworks

The PRC government reinforces its targeted NMPPs through its legal frameworks and interconnected system of overlapping national and provincial policies, such as its national

35 U.S. Trade Representative, Adapting Trade Policy for Supply Chain Resilience: Responding to Today's Global Economic Challenge, January 2025, page 33, USTR Adapting Trade Policy for Supply Chain Resilience_0.pdf.

36 2019 is the only year this difficult-to-extract information was collected for comparison with other countries in the report cited, but this does not indicate that it was the only year this broader trend could have occurred.

37 Gerard DiPippo, Ilaria Mazzocco, and Scott Kennedy, Red Ink: Estimating Chinese Industrial Policy Spending in Comparative Perspective ed. Scott Kennedy and Matthew P. Goodman (Center for Strategic and International Studies, May 2022), 9-11, https://csis-website-prod.s3.amazonaws.com/s3fs-public/publication/220523_DiPippo_Red_Ink.pdf?VersionId=LH8ILLKWz4o.bjrwNS7csuX_C04FyEre.

38 Id. at 29-31.

39 See, e.g., OECD, 96th Session of the Steel Committee: Statement by the Chair, November 13, 2024, https://www.oecd.org/en/about/news/speech-statements/2024/11/96th-session-of-the-steel-committee-statement-by-the-chair.html.

economic five-year plans, the Made in China 2025 policy (MIC2025), the Belt and Road Initiative, the Outline of National Medium- and Long-term Science and Technology Development Plan (2006-2020), the PRC's outward foreign direct investment (FDI) policies, often referred to as The PRC's "Going Out" strategy, and various sector specific plans. These plans and strategies often operate without regard to changes in market conditions, thereby imposing the will of the government over profit-seeking and arbitrage opportunities that are central to a market-based approach to economics.

In its 12th Five-Year Plan[40] (covering 2011-2015),[41] the PRC government identified EVs, solar panels (clean energy) as strategic emerging industries. These sectors subsequently received significant subsidies such as low-cost loans, discounted energy and inputs, and tax incentives to encourage the industries' growth.[42] In 2022, the PRC released its 14th Five-Year Plan (covering 2021-2025), which includes an energy resource security section that includes "[s]trengthen[ing] the management and control of strategic mineral resources planning, improve the reserve security capability, and implement a new round of breakthrough strategic actions for prospecting."[43]

One of the mechanisms that has been instrumental in effectuating PRC government policy has been the *Catalogue for Industry Restructuring*, a government publication that shapes investments and government projects. This catalogue classifies three categories: encouraged, restricted, and obsolete where industries not listed are considered permitted.[44] It serves as a reference for the central and sub-national levels (e.g., provincial, local) of government for tax policy, investment, financing and market regulation among other things. According to Chinese reports, the 2019 catalogue placed mining in the "obsolete" category while emphasizing investment in strategic industries that process and use minerals and metals, like artificial intelligence, by classifying them as "encouraged."[45] The 2024 update to the *Catalogue for Industry Restructuring* placed more emphasis on high-tech industries and sustainability with

40 Outline of the Twelfth Five-Year Plan for National Economic and Social Development, March 15, 2011, https://www.gov.cn/2011lh/content_1825838_2.htm; The People's Republic of China, the State Council, 12th Five-Year Plan achievements a milestone for centenary goal, October 26, 2015, https://english.www.gov.cn/news/top_news/2015/10/26/content_281475220413367.htm; The People's Republic of China, the State Council, Major Achievements During 12th Five-Year Plan (2011-2015), https://english.www.gov.cn/12thFiveYearPlan/.

41 Outline of the Twelfth Five-Year Plan for National Economic and Social Development, March 15, 2011, https://www.gov.cn/2011lh/content_1825838_2.htm.

42 Matthew McMullan, SHOCKWAVES: The Ripple Effect of China's Industrial Overcapacity on American Manufacturing and Factory Workers (Alliance for American Manufacturing, June 2024), https://www.americanmanufacturing.org/wp-content/uploads/2024/06/Shockwaves-Chinese-Overcapacity-Report.pdf.

43 See 14th Five-Year Plan for National Economic and Social Development of the People's Republic of China and the Long-Term Objectives for 2035, Chapter 53, http://www.xinhuanet.com/2021-03/13/c_1127205564.htm; see also https://fingfx.thomsonreuters.com/gfx/ce/gjnpwolekpw/CHINA's%2014TH%20FIVE-YEAR%20PLAN.pdf.

44 Zoey Zhang, China's 2019 Catalogue for Guiding Industry Restructuring, China Briefing (Dezan Shira and Associates, November 26, 2019) https://www.china-briefing.com/news/chinas-2019-catalogue-guiding-industry-restructuring/.

45 Zoey Zhang, China's 2019 Catalogue for Guiding Industry Restructuring, China Briefing (Dezan Shira and Associates, November 26, 2019) https://www.china-briefing.com/news/chinas-2019-catalogue-guiding-industry-restructuring/.

industries like solar cells being included in the encouraged category.[46] Guidance like this influences how the government uses its NMPPs.

Capital/Financing

The PRC employs numerous non-market tools to finance its policies. The vast majority of PRC banks are state-owned or controlled, which allows the PRC government to decide who has access to capital. This can make it more difficult for new PRC domestic and foreign private companies to enter the market as the government directs substantial capital and financing to support industries focused on relevant PRC policies.[47] Support mechanisms that provide disproportionate credit to SOEs and other firms that meet the government's objectives lowers the overall costs for those firms in these industries. Market distortions can then appear when market signals like low prices are ignored, and money continues to flow to these industries which in turn can lead overcapacity, which, as described by the Treasury Undersecretary for International Affairs, involves production capacity untethered from global demand," among other measures.[48]

Regulations, policy guidance, and the ability to appoint top executives all provide additional ways for the PRC government to influence state-owned and controlled banks to favor government-identified strategic industries through different NMPPs, among other channels. Examples include:

- SOE's debt-equity swaps, which can act as implicit subsidies. These allow companies to provide equity to debtholders, often state-owned banks, investors or companies, in exchange for offloading their debt and thereby reducing their debt burdens and redirecting financing. When this occurs under the influence of the government, this can allow failing companies that are considered strategically important to continue operating and promoting the conditions that ultimately lead and continue to lead to overcapacity and other sector-specific inefficiencies.
- The usage of below-market interest rates. While many governments use below-market credit, the PRC is particularly reliant on this tool, which accounted for 0.52 percent of PRC GDP in 2019 as compared to other countries surveyed who used 0.22 percent of their GDP or less.[49] Below-market credit provides debt financing on favorable terms

46 National Development and Reform Commission, Decree of the National Development an Reform Commission of the People's Republic of China, No. 7, December 27, 2023, https://www.ndrc.gov.cn/xxgk/zcfb/fzggwl/202312/t20231229_1362999.html; Giulia Interesse, China's 2024 Catalogue for Guiding Industry Restructuring, China Briefing (Dezan Shira and Associates, January 9, 2024), https://www.china-briefing.com/news/chinas-2024-catalogue-for-guiding-industry-restructuring/.

47 Congressional Research Service, China's Mineral Industry and U.S. Access to Strategic and Critical Minerals: Issues for Congress (March 20, 2015), 8-9, https://crsreports.congress.gov/product/pdf/R/R43864; Rodrigo Castillo and Caitlin Purdy, China's Role in Supplying Critical Minerals for the Global Energy Transition (Leveraging Transparency to Reduce Corruption, Brookings Institution, July 2022), https://www.brookings.edu/wp-content/uploads/2022/08/LTRC_ChinaSupplyChain.pdf.

48 Remarks by Under Secretary for International Affairs Jay Shambaugh on Chinese Overcapacity and the Global Economy, U.S. Department of the Treasury, July 10, 2014, https://home.treasury.gov/news/press-releases/jy2455.

49 Gerard DiPippo, Ilaria Mazzocco, and Scott Kennedy, Red Ink: Estimating Chinese Industrial Policy Spending in Comparative Perspective ed. Scott Kennedy and Matthew P. Goodman (Center for Strategic and International Studies, May 2022), 17, https://csis-website-prod.s3.amazonaws.com/s3fs-public/publication/220523_DiPippo_Red_Ink.pdf?VersionId=LH8ILLKWz4o.bjrwNS7csuX_C04FyEre.

such as longer repayment requirements, longer grace periods, or more favorable interest rates than risk-based market-driven lenders would impose. Even if the initial investment may have been market-driven, the PRC government often maintains or provides additional support to companies in strategic sectors where market-driven investors would have divested or put pressure on the company to resume profitability.

- Government guidance funds ("GGFs"). GGFs were first established in the mid-2000s as a partnership between the government (central or local) and the PRC's private sector to invest in targeted sectors and accelerate technological catch-up. Unlike the industrial investment funds used before that typically financed projects through SOEs, GGFs emphasized partnering with private sector investors to increase overall funding and benefit from their expertise. While the funds were intended to be market-responsive and not direct venture investment activities; however, the government did intervene. According to researchers, many of the sectors in which these funds invested overlapped with the sectors enumerated in MIC2025 and have provided subsidized capital to strategic industries.[50] These investments have allowed the PRC to gain significant market share that can greatly influence global prices.

Taken together, these policies and practices have reduced the cost of capital for certain types of companies (often those whose actions align with government policy direction) and often lead to overinvestment in the targeted industries. In the minerals sector, "patient" capital is important for companies to grow given the time it takes to stand up production and in the case of the PRC, the reduced capital cost has allowed companies to expand production even during prolonged periods of low prices.

State Owned Enterprises

In the PRC, SOEs conduct most of the mining and mineral-processing activities. According to the National Bureau of Statistics of China, in 2021, SOEs owned 29 percent of mining and mineral-processing enterprises and 77 percent of the assets for the extraction of nonferrous metal ores. Regarding nonmetal ores, SOEs represent 11 percent of the enterprises and own 53 percent of the assets of the nonmetal ores.[51] The PRC has used SOEs, both at the national and local level, as government policy instruments expected to funnel state capital into key sectors.[52] Through the State-owned Assets Supervision and Administration Commission ("SASAC"), the PRC government has merged underperforming SOE's with other SOE's so that over time, the

50 Yifan Wei, Yuen Yuen Ang and Nan Jia, The Promise and Pitfalls of Government Guidance Funds in China, The China Quarterly, Volume 256, (Cambridge University Press, December 2023) 939-959, https://doi.org/10.1017/S0305741023000280.

51 Ji Won Moon, China [Advance Release], 2020-2021 Minerals Yearbook (U.S. Geological Survey, Department of Interior, May 2024), 9.3, https://pubs.usgs.gov/myb/vol3/2020-21/myb3-2020-21-china.pdf.

52 "Government officials say that [funders of SOEs] should not seek to make money in their investments; rather, they are meant to be more like 'policy funds', seeding firms and industries with government cash or money raised from SOE dividends without worrying about profit." Reform of China's ailing state-owned firms is emboldening them, The Economist, July 22, 2017.

number of SOEs has decreased, but the size of SOEs has increased greatly, giving them large market shares and turning some into "national champions."[53]

Subsidies

Based on data from firms listed on public exchanges, direct subsidies from the PRC government grew as a share of GDP since the global financial crisis in 2008 before stabilizing in 2015.[54] Such subsidies include direct cash grants, tax incentives, below-market borrowing (including lending to entities that could never acquire financing on commercial markets), export subsidies, and other schemes. Significant, long-term subsidies lead to excess production that, when combined with low PRC consumption levels, results in dumping of products onto global markets. In the absence of trade measures or other relief, PRC-subsidized goods are then sold at below-average manufacturing costs in countries that do not subsidize production, at least to a comparable degree. The excess global capacity and market concentration affect a wide range of products, including steel, chemicals, critical minerals, and others.

Initially, as exemplified in the nickel section that follows, the PRC directed many of its subsidies to upstream materials like minerals to quickly advance domestic manufacturing. The subsidization of raw materials led to below-market input prices that flow down the value chain, distorting markets both domestically and globally wherever the PRC is a large market participant. In addition to lowering costs along the value chain, PRC subsidies allow beneficiary producers to continue operations even when they are not profitable, including purchasing major assets or investing in new or upgraded production facilities without having to respond to market pressures.[55]

The OECD has documented the PRC's history of providing the aluminum industry with beneficial subsidies. This includes SOEs providing inputs (raw material and energy) below the market price. Energy subsidies are particularly crucial for the smelting node of the aluminum value chains since energy costs can account for up to 40 percent of the total cost of production.[56]

Export Restraints

The PRC has used export restraints, including bans, quota systems, and export controls to manage exports, particularly for resources needed in strategic industries. In the case of mineral markets, the PRC controls a significant market share that enables the PRC government to manipulate global prices, potentially undercutting U.S. and allied competitor producers.

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53 Congressional Research Service, China's Mineral Industry and U.S. Access to Strategic and Critical Minerals: Issues for Congress, March 20, 2015, 8-9, https://crsreports.congress.gov/product/pdf/R/R43864.

54 Gerard DiPippo, Ilaria Mazzocco, and Scott Kennedy, Red Ink: Estimating Chinese Industrial Policy Spending in Comparative Perspective ed. Scott Kennedy and Matthew P. Goodman (Center for Strategic and International Studies, May 2022), 39, https://csis-website-prod.s3.amazonaws.com/s3fs-public/publication/220523_DiPippo_Red_Ink.pdf?VersionId=LH8ILLKWz4o.bjrwNS7csuX_C04FyEre.

55 Dr. Markus Taube, Analysis of Market-Distortions in the Chinese Non-Ferrous Metals Industry (April 24, 2017), 69-71, https://www.eurometaux.eu/media/1624/study_-analysis-of-market-distortions-in-china.pdf.

56 OECD (2019), Measuring distortions in international markets: The aluminium value chain, OECD Trade Policy Papers, No. 218, OECD Publishing, Paris, https://doi.org/10.1787/c82911ab-en.

Additionally, when exports are controlled by export restraints (versus determined by the market), market-oriented manufacturers are at risk of supply disruptions, which in turn increase costs, further reducing their ability to compete on the global market.[57]

In some cases, export restraints encourage downstream producers to set up new manufacturing or maintain existing manufacturing in the PRC in order to maintain access to the necessary raw materials.[58] This further concentrates production in the PRC, reducing supply chain resiliency and putting advanced technologies held by downstream producers at additional risk.

Overseas Market Access and Firm-Level Cooperation Strategies

Leveraging state-owned or controlled capital, the PRC government has been able to make significant investments in overseas mineral projects to secure access to these resources as well as increase their global market share. For example:

- In the late 1980s and early 1990s, PRC's early investments in overseas mineral production were made by state-owned steel companies in order to secure iron ore for the country's nascent steel industry.
- In the early 2000s, the PRC introduced the Going Out strategy, which established mining and mineral development as a key pillar. The Export-Import Bank of China and the National Development and Reform Commissioned developed guidance reportedly encouraging foreign investment in:

  > 1) resource exploration projects to mitigate the domestic shortage of natural resources; 2) projects that promote the export of domestic technologies, products, equipment and labor, 3) overseas R&D [research and development] centers to utilize internationally advanced technologies, managerial skills and professionals, and 4) [mergers and acquisitions] that could enhance the international competitiveness of PRC enterprises and accelerate their entry into foreign markets.[59]

  PRC interest in overseas resource investments was subsequently fueled by The PRC's rapid economic growth, which has driven demand for metals.[60] Numerous studies have observed that the Going Out strategy is "resource-seeking," with outbound investment

57 Department of Homeland Security, Public-Private Analytic Exchange Program, Threat of Limited U.S. Access to Critical Raw Materials (2024), https://www.dhs.gov/sites/default/files/2024-09/2024aepthreatoflimitedusaccesstocriticalrawmaterials.pdf.

58 FTI Consulting, China's Export Controls on Critical Minerals – Gallium, Germanium and Graphite (December 19, 2023), https://www.fticonsulting.com/insights/articles/chinas-export-controls-critical-minerals-gallium-germanium-graphite.

59 Salidjanova, Nargiza, Going Out: An Overview of China's Outward Foreign Direct Investment, U.S.-China Economic & Security Review Commission Staff Report, March 30, 2011, https://www.uscc.gov/sites/default/files/Research/GoingOut.pdf at 5.

60 Ericsson, M., Löf, O. & Löf, A. Chinese control over African and global mining—past, present and future. Miner Econ 33, 153–181 (2020) https://doi.org/10.1007/s13563-020-00233-4;Salidjanova, Nargiza, Going Out: An Overview of China's Outward Foreign Direct Investment, U.S.-China Economic & Security Review Commission Staff Report, March 30, 2011, https://www.uscc.gov/sites/default/files/Research/GoingOut.pdf.

frequently focused on assets and infrastructure that support development of mineral resources that underpin the PRC's strategic development plans.[61]

- In 2011, the Bank of China issued $70 billion in loans to acquire minerals from overseas,[62] although one criticism is that the true scale of foreign investments can be difficult to track given that many are directed through tax havens.[63]
- In 2015, the first private equity fund focusing on mineral resources and related industries – Belt and Road Mining Industry Development Fund – was officially launched in Beijing.[64] The fund mainly invests in high-quality mineral resources, infrastructure and related industrial chains in Belt and Road target countries.[65]
- In its 13th Five-Year Plan (2016-2020), the PRC government encouraged foreign investment in sectors such as advanced manufacturing and new technologies where previously the focus was limited to obtaining raw materials and selling finished goods.
- Currently, PRC programming focuses on R&D cooperation, standardization, and other areas to advance the PRC's technological capabilities.[66] The government has also encouraged companies to set up overseas operations through targeted M&As or greenfield investments which may also ensure access to critical materials that it cannot obtain domestically.[67]

Through these efforts, the PRC government has been able to gain equity stakes in important overseas mining and processing companies as well as finance junior miners (typically defined as companies with relatively lower market capitalization and that tend to focus on the early stages of a mine's creation) to acquire strategic materials. This can be seen in the lithium sector where nearly 60 percent of lithium resources have come under PRC control or influence as a result of investments made in Chile, Argentina and Australia in the mid- to late-2010s.[68]

61 Gulley, McCullough, and Shedd,China's domestic and foreign influence in the global cobalt supply chain https://doi.org/10.1016/j.resourpol.2019.03.015.

62 Congressional Research Service, China's Mineral Industry and U.S. Access to Strategic and Critical Minerals: Issues for Congress (March 20, 2015), at 9, https://crsreports.congress.gov/product/pdf/R/R43864.

63 Salidjanova, Nargiza, Going Out: An Overview of China's Outward Foreign Direct Investment, U.S.-China Economic & Security Review Commission Staff Report (March 30, 2011), https://www.uscc.gov/sites/default/files/Research/GoingOut.pdf.

64 People's Daily Online, The Belt and Road Mining Development Fund was launched, June 11, 2015, http://finance.people.com.cn/fund/n/2015/0611/c201329-27135487.html.

65 International Energy Agency, Launch of "One Belt One Road" Mining Industry Development Fund, October 30, 2022, https://www.iea.org/policies/15527-launch-of-one-belt-one-road-mining-industry-development-fund.

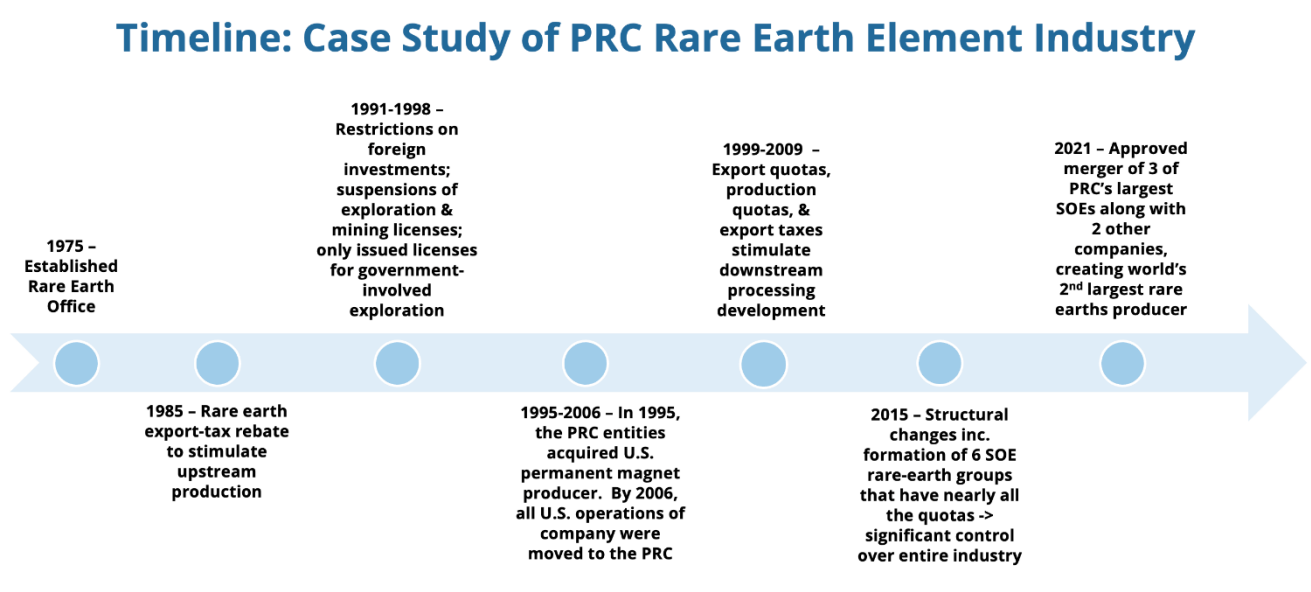
66 See, for example, Ministry of Science and Technology of the People's Republic of China, https://en.most.gov.cn/.

67 Dr. Markus Taube, Analysis of Market-Distortions in the Chinese Non-Ferrous Metals Industry, April 24, 2017, 30, https://www.eurometaux.eu/media/1624/study_-analysis-of-market-distortions-in-china.pdf.

68 FP Analytics, "Mining The Future: How China is set to dominate the next Industrial Revolution," May 1, 2019, https://foreignpolicy.com/2019/05/01/mining-the-future-china-critical-minerals-metals/.

Implementation of NMPPs: REEs

In critical minerals supply chains, the PRC government has used NMPPs to secure monopolistic advantages over certain raw materials and advance downstream manufacturing. NMPPs may target specific industries or be applied economy-wide with both national and local governments involved. The following highlights some of the NMPPs the PRC has employed to develop its REE industry.



- In 1975, the PRC started to regulate the REE industry when it established the National Rare Earth Development and Application Leading Group, which focused on developing the fledgling REE mining industry.[69]
- REE exports became eligible for export-tax reimbursement in 1985. From 1985 to 1990, PRC's production of rare earth oxides doubled from 8,500 t to 16,500 t, growing at an average annual rate of 14 percent.[70]
- Between 1991-1998, foreign investors had restricted access to REE exploration, mining, beneficiation, smelting, and separation. Also, exploration and mining licenses were frequently suspended. During most of that time, the PRC only renewed licenses for qualified firms and only issued licenses for government-involved exploration. This period experienced the fastest growth in REE production. The total production increased from 16,150 t in 1991 to 65,000 tin 1998, an annual growth rate of 22 percent

69 Shen, Y., Moomy, R. & Eggert, R.G. China's public policies toward rare earths, 1975–2018. Miner Econ 33, 127–151, January 7, 2020, https://doi.org/10.1007/s13563-019-00214-2.

70 Id.

and the PRC's REE minerals market share went from 33 to 85 percent.[71] In 1995, two PRC companies and a U.S. investment firm sought to acquire U.S. rare earth magnet company and industry leader, Magnequench. The acquisition was approved by Committee on Foreign Investment in the U.S. on the condition that the company would be in the United States for at least five years.[72] In 2003, the U.S. plant was closed and equipment moved to the PRC.[73] In the years since, the rest of the industry has moved operations to the PRC where the needed raw materials are more easily accessible.

- From 1999 to 2009, the PRC central government introduced export and production quotas and export taxes on REE products and further tightened the restrictions on foreign investment. Those policies encouraged domestic downstream development by giving PRC firms the advantage of cheaper raw materials and driving foreign firms to move processing to the PRC.[74]
- In 2015, the PRC government announced a consolidation plan under which six SOEs (either owned by state or local governments) would be formed and would obtain nearly all the mining and separation quotas. This was in furtherance of a policy announced in 2011 on rare earths that, among other things, called for accelerating the process of merging and creating an industrial structure led by dominant firms, including the goal that the industrial concentration of the largest three southern ionic clay REE firms should be 80 percent and for coordinating the REE industry with the local economies and the interests between different entities (central government and local government, SOEs and private firms, local government and local firms, SOEs owned by the central government and local governments).[75]
- In 2021, in the largest move of its kind, the PRC established the China Rare Earth Group Co., Ltd., merging three of the PRC's six largest SOEs and two research entities.[76] China Rare Earth Group Co., Ltd. is estimated to account for around 62 percent of the PRC's heavy rare earth supplies. This firm's significant market share can significantly impact pricing for an industry that the PRC government considered undervalued. This megafirm will also be able to gain efficiencies and share technologies.[77]

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71 Id.

72 How China came to dominate the supply chain of rare earths and critical minerals, The Graduate Press-La Gazette de la Paix, April 1, 2022, https://thegraduatepress.org/2022/04/01/how-china-came-to-dominate-the-supply-chain-of-rare-earths-and-critical-minerals/.

73 "America's Rare Earth Ultimatum: Made in China", Capital Research Center, May 28, 2019, https://capitalresearch.org/article/americas-rare-earth-ultimatum-part-2/.

74 Shen, Y., Moomy, R. & Eggert, R.G. China's public policies toward rare earths, 1975–2018. Miner Econ 33, 127–151, January 7, 2020, https://doi.org/10.1007/s13563-019-00214-2.

75 Id.

76 State-owned Assets Supervision and Administration Commission of the State Council, State-Owned Enterprise Seen Changing Rare Earth Market, December 24, 2021, http://en.sasac.gov.cn/2021/12/24/c_11053.htm; Qian Zhou and Sofia Brooke, "China Merges Three Rare Earths State-Owned Entities to Increase Pricing Power and Efficiency", China Daily Briefing, January 12, 2022, https://www.china-briefing.com/news/china-merges-three-rare-earths-state-owned-entities-to-increase-pricing-power-and-efficiency/.

77 Qian Zhou and Sofia Brooke, China Merges Three Rare Earths State-Owned Entities to Increase Pricing Power and Efficiency, China Daily Briefing, January 12, 2022, https://www.china-briefing.com/news/china-merges-three-rare-earths-state-owned-entities-to-increase-pricing-power-and-efficiency/.

V. Current Market Dynamics and Impact of NMPPs on the Markets

This section reviews the current market dynamics and impact of NMPPs, including relevant NMPPs, evolution of the market share, pricing trends, and impact on market-oriented economies for the following minerals: graphite, cobalt, nickel, and magnesium; and provides a summary of questionnaire responses pertaining to the impact of NMPPs.

A. Mineral Markets

Graphite

Graphite, a form of pure carbon, has two source types: 1) natural graphite mined from ores and 2) synthetic graphite produced from heating carbonaceous materials like petroleum coke to high temperatures. Traditionally, the steel industry has been the main end use for graphite, accounting for over half of graphite consumption in 2023.[78] However, lithium-ion batteries are expected to be the main demand driver in the next decade as graphite (natural and synthetic), used for the anode material, is the largest component by weight in these batteries. The downstream steel and later the battery market has influenced the global graphite market and the PRC's policies have been aligned with developing these industries.

The PRC is the world's largest producer of natural graphite with output estimated at 1.23 Mt in 2023 (78 percent of global production), as well as having reserves of 78 Mt.[79] This is followed by Madagascar, which is estimated to have produced 100,000 t (six percent), Mozambique at 96,000 t (six percent), and Brazil at 73,000 t (five percent).[80] The United States currently does not produce natural graphite though there are several exploration and development projects underway, and Norway has a high-grade graphite mine with a nameplate capacity of 10,000 t/yr. The PRC is also the largest producer of synthetic graphite accounting for 69 percent of global production in 2023 while India accounted for eight percent and the U.S. accounted for five percent. Although current synthetic graphite production is also highly concentrated, it is not limited to a particular location like with mined minerals that are tied to the location of mineral deposits because it is manufactured in a plant.

The PRC has been the largest graphite producer since at least the 1990s as low prices and the PRC's policies have allowed it to capture a large share of the global market. One such policy was refund for value-added tax ("VAT") on most goods which began in 1994.[81] Until the policy was changed in 2003,[82] VAT refunds on graphite encouraged graphite exports by reducing costs and accelerating exploration and development of natural graphite mines. By the end of the

78 Oxford Economics, Enabling North American Graphite Growth A Report For The North American Graphite Alliance, March 2024, Enabling-North-American-Graphite-Growth.pdf

79 U.S. Geological Survey: National Minerals Information Center, Mineral commodity summaries 2024, (2024), pubs.usgs.gov/periodicals/mcs2024/mcs2024.pdf.

80 Id.

81 Mui, M., & Lee, K. (2004). The VAT refund effect. The China Business Review, 31(1), 32-35, https://www.proquest.com/trade-journals/vat-refund-effect/docview/202710245/se-2

82 Id.

1990s, due to its conductivity and high thermal stability, new applications such as brushes for electrical motors increased demand for graphite, particularly crystalline flake graphite.[83] There was also demand for higher-purity graphite for use in batteries and fuel cells.[84] However, reportedly in an effort to curb overcapacity and to meet demand from its growing steel industry as well as the new applications, VAT refund program for graphite was eliminated in 2003.[85] Then in January 2008, the PRC reportedly implemented an export duty of 20 percent on natural graphite.[86] This export duty was seen as keeping prices low for PRC producers of value-added products that used graphite as an input while increasing costs for overseas manufacturers of the same value-added products. This change in export duties aligned with the perceived PRC goal to shift the graphite value chain from a focus on exporting the raw material to value-added graphite products like specialty refractories and battery materials. As part of this push towards value-added products, in 2011, Heilongjiang, the largest graphite-producing province in the PRC, formed a technology alliance to develop new graphite applications as well as asking the central government to shut down illegal mines to stabilize prices.[87]

As PRC managed its natural graphite industry, it simultaneously encouraged expanding capacity for synthetic graphite production. Initially, synthetic graphite was primarily used to produce graphite electrodes used in producing steel in electric arc furnaces ("EAFs").[88] The ability to obtain secondary synthetic graphite from graphite electrode waste has kept synthetic graphite prices low in the PRC.[89] Growing demand for graphite electrodes, particularly as the PRC shifted steel production to EAF production, and later expected demand for synthetic graphite as an anode material, have encouraged growth in synthetic graphite production. PRC production of synthetic graphite grew at an annual average rate of 3.7 percent between 2006 and 2015.[90]

Following challenges by the EU and United States in the World Trade Organization, the PRC reportedly cancelled the 20 percent export duty on graphite as well as several other products.[91]

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83 Kalyoncu, Rustu S., "Graphite", Minerals Yearbook (Volume I. -- Metals and Minerals), (U.S. Geological Survey: National Minerals Information Center, 1999), https://d9-wret.s3.us-west-2.amazonaws.com/assets/palladium/production/mineral-pubs/graphite/310499.pdf.

84 Id.

85 Industrial minerals 2006. (2007). Mining Engineering, 59(6), 19-64, https://www.proquest.com/trade-journals/industrial-minerals-2006/docview/232293230/se-2.

86 Taylor, H. A., J. (2008). GRAPHITE. Mining Engineering, 60(6), 33-34, https://www.proquest.com/trade-journals/graphite/docview/232275059/se-2.

87 Tse, Pui-Kwan, "China", Minerals Yearbook, volume III, Area Reports—International—Asia and the Pacific, (U.S. Geological Survey: National Minerals Information Center, 2011), The Mineral Industry of China in 2011.

88 Roskill: Batteries spark dynamic change in graphite markets. PR Newswire. (July 10, 2017), https://www.proquest.com/wire-feeds/roskill-batteries-spark-dynamic-change-graphite/docview/1917271637/se-2.

89 Id.

90 Olson, Donald W., "Graphite", Minerals Yearbook (Volume I. -- Metals and Minerals), (U.S. Geological Survey: National Minerals Information Center, 2015), https://d9-wret.s3.us-west-2.amazonaws.com/assets/palladium/production/mineral-pubs/graphite/myb1-2015-graph.pdf.

91 Li, A., & Wong, Y. (2017). China revises minerals export tariffs in 2017. Industrial Minerals, https://www.proquest.com/trade-journals/china-revises-minerals-export-tariffs-2017/docview/1896882747/se-2 and Mauldin, W. (2016, Jul 14). U.S. brings WTO challenge against china over copper, graphite, other minerals; complaint says china failed to eliminate export duties as agreed. Wall Street Journal

That same year, it also provided funding for exploration, including around $30 million for graphite and production of graphite increased by 19 percent for crystalline flake while overall graphite production grew by 11 percent (flake and amorphous graphite).[92] This demonstrates the shift towards higher-value products, particularly battery-grade graphite. The PRC increased funding for graphite exploration in 2020 by 24 percent to $22.9 million.[93] In addition to continuing growth in both natural and synthetic graphite production, the PRC increased production of spherical purified graphite by 32 percent between 2020 and 2021, which is a processed form of natural graphite used to make anode material used in EV batteries.[94] The PRC accounts for nearly all of the production of uncoated spherical purified graphite and also dominates anode production, accounting for 94 percent of anode production in 2023.[95]

This overrepresentation of the PRC in the graphite battery supply chain is not attributed solely to its large natural graphite reserves but came out of its coordinated policies for the EV, battery, and graphite industries.

In the 10th Five Year Plan (covering 2001-2005), the PRC set out objectives concerning clean energy R&D, including batteries,[96] and accordingly the PRC provided funding worth two billion yuan (around $265 million) over ten years for R&D in energy vehicles.[97] While continuing to support R&D, the PRC used several different types of NMPPs to develop markets for EVs including government procurement prior to the wide commercial uptake,[98] consumer subsidies (for example, between 2009-2023, the PRC spent $183.4 billion on rebates and sales tax emptions),[99] and charging infrastructure (by 2023, The PRC had installed public 2.7 million charging stations, up from 30,000 in 2014).[100] This sustained support over decades has created

(Online), https://www.proquest.com/newspapers/u-s-brings-wto-challenge-against-china-over/docview/1803656729/se-2; WTO, "China - Export Duties on Certain Raw Materials: Request for the Establishment of a Panel by the United States," WT/DS508/6, Oct. 14, 2016, https://docs.wto.org/dol2fe/Pages/SS/directdoc.aspx?filename=q:/WT/DS/509-6.pdf&Open=True; and WTO, "China - Duties and Other Measures Concerning the Exportation of Certain Raw Materials: Request for the Establishment of a Panel by the European Union" WT/DS509/6, Oct. 27, 2016, https://docs.wto.org/dol2fe/Pages/SS/directdoc.aspx?filename=q:/WT/DS/509-6.pdf&Open=True.

92 Xun, Sean, The Mineral Industry of China, Minerals Yearbook, volume III, Area Reports—International—Asia and the Pacific, (U.S. Geological Survey: National Minerals Information Center, 2015), https://d9-wret.s3.us-west-2.amazonaws.com/assets/palladium/production/atoms/files/myb3-2017-18-ch.pdf.

93 Moon, Ji Won, The Mineral Industry of China, Minerals Yearbook, volume III, Area Reports—International—Asia and the Pacific, (U.S. Geological Survey: National Minerals Information Center, 2015), https://pubs.usgs.gov/myb/vol3/2020-21/myb3-2020-21-china.pdf.

94 Olson, Donald W., "Graphite", Minerals Yearbook (Volume I. -- Metals and Minerals), (U.S. Geological Survey: National Minerals Information Center, 2021), https://pubs.usgs.gov/periodicals/mcs2021/mcs2021-graphite.pdf.

95 See Benchmark Minerals Intelligence's Anode Active Material Production in its Anode Forecast Q1 2024 (https://www.benchmarkminerals.com/).

96 Liu, Yingqi and Ari Kokko, Who does what in China's new energy vehicle industry?, Energy Policy, Vol. 57 (June 2013), https://doi.org/10.1016/j.enpol.2012.05.046

97 Id.

98 Liu, Xiaoling, Xiaohua Sun, Hui Zheng, and Dongdong Huang, Do policy incentives drive electric vehicle adoption? Evidence from China, Transportation Research Part A: Policy and Practice, Volume 150 (August 2021), https://doi.org/10.1016/j.tra.2021.05.013; Liu, Yiran Xiaolei Zhao, Dan Lu, and Xiaomin Li, Impact of policy incentives on the adoption of electric vehicle in China, Transportation Research Part A: Policy and Practice, Volume 176, (October 2023), https://doi.org/10.1016/j.tra.2023.103801.

99 Kennedy, Scott, The Chinese EV Dilemma: Subsidized Yet Striking, (CSIS, June 20, 2024), https://www.csis.org/blogs/trustee-china-hand/chinese-ev-dilemma-subsidized-yet-striking.

100 IEA (2023), Global EV Outlook 2023, IEA, Paris https://www.iea.org/reports/global-ev-outlook-2023, Licence: CC BY 4.0 and IEA global EV Data Explorer, https://www.iea.org/data-and-statistics/data-tools/global-ev-data-explorer.

overcapacity that the PRC's domestic EV market has been unable to absorb, resulting in domestic manufacturers lowering prices to maintain or capture market share. In 2023, the PRC used less than 40 percent of its maximum cell capacity (excluding portable electronics like mobile phones) while its installed cathode and anode capacity was four and nine times greater than the global demand for EV battery cells.

Given its dominant position in the graphite supply chains, particularly for batteries, the PRC has an outsized influence on pricing in the global graphite market. Spherical graphite prices are tied to prices for natural graphite and are seen through exports to Japan and South Korea, the other significant producers of coated spherical graphite, i.e., anode material.[101] Reductions in demand in the steel and EV markets coupled with overcapacity across all nodes of the graphite supply chain in the PRC, combined with low prices for synthetic graphite, have contributed to prices for uncoated purified spherical graphite falling from around $4,550/t in 2015 to 2016 to around $2,800/t in 2023.[102] As a result, graphite prices are likely to remain low in the near term, particularly for natural graphite.

Despite the threat of export restrictions by the PRC, the low prices for graphite raw and anode materials have made it difficult to stand up production outside of the PRC. On December 12, 2024, Syrah Resources closed its Balama mine in Mozambique declaring a force majeure and defaulted on loans from U.S. government agencies worth more than $250 million.[103] While the recent closure was due to protests and civil unrest, the mine has struggled to remain open, significantly reducing output in 2023 due to low prices and overcapacity in the global market.[104] South Korea's POSCO Future M, the battery materials unit of POSCO Holdings has also struggled to compete with low-priced graphite from the PRC, reportedly dropping its capacity utilization from 60 percent in 2022 to just 15 percent in 2024.[105]

On December 18, 2024, the American Active Anode Material Producers Association filed antidumping duty (AD) and countervailing duty (CVD) petitions for relief from imports of unfairly priced and subsidized active anode material from the PRC. The petitions allege that the establishment of an industry in the U.S. to manufacture active anode material is being materially retarded by reason of the allegedly dumped and subsidized imports from PRC. Petitioners allege that, in the alternative, the allegedly dumped and/or subsidized imports from the PRC have materially injured, or threaten material injury to, the active anode material

101 Moores, S. (2012). Supply situation report: China widens its graphite sphere of influence. Industrial Minerals, https://www.proquest.com/trade-journals/supply-situation-report-china-widens-graphite/docview/1034368825/se-2.

102 See Benchmark Minerals Intelligence's Flake Graphite Price Forecast Q4 2023 for USPG 10 Micron (https://www.benchmarkminerals.com/).

103 Lasley, Shane, Syrah shutters Balama, defaults on US loans, Metal Tech News, December 12, 2024, https://www.metaltechnews.com/story/2024/12/18/tech-metals/syrah-shutters-balama-defaults-on-us-loans/2070.html.

104 Yelp, Eric and staff, Top global graphite miner Syrah to lower production from Balama mine on weak demand, (S&P Global, April 27, 2023) https://www.spglobal.com/commodity-insights/en/news-research/latest-news/energy-transition/042723-top-global-graphite-miner-syrah-to-lower-production-from-balama-mine-on-weak-demand.

105 Han, Jae-beom, Chu, Donghun and Yoon Yeon-hae, POSCO sees anode material plant operating rate fall to 15%, (Pulse by Maell Business News Korea, December 12, 2024), https://pulse.mk.co.kr/news/english/11189462.

industry in the United States. The petitions reference various alleged subsidy programs including grant programs, provision of goods for less than adequate remuneration, preferential tax programs, and below-market borrowings.

On January 8, 2025, the Department of Commerce announced its initiation of AD/CVD investigation on the petitions for active anode from the PRC. The active anode material covered by the scope of the investigations has an energy density of 330 milliamp hours per gram or greater. The scope of the petition includes:

> active anode material regardless of whether it is imported independently, as part of a compound, in a battery, as a component of an anode slurry or in a subassembly of a battery such as an electrode. In instances when the active anode material is imported as part of a compound, in a battery, as a component of an anode slurry or in a subassembly of a battery, only the anode grade graphite material is covered by the proposed scope.[106]

The preliminary CVD and AD determinations are currently scheduled to be announced on March 14, 2025, and May 28, 2025, respectively. The U.S. International Trade Commission (ITC), which is responsible for investigating and making a determination with respect to injury.

Cobalt

Cobalt has a broad range of applications including ceramics and pigments; hard metals for drilling equipment and cutting tools; lithium-ion batteries for electric vehicles, personal electronics, and stationary energy storage; petroleum refining catalysts; REE permanent magnets for direct drive motors in electric and hybrid vehicles and wind turbines; superalloys for gas turbines for power generation and jet engines.[107] Particularly because of its uses in military applications such as jet engines and propulsion systems for nuclear weapons, cobalt has long been considered a strategic and critical mineral. As such, cobalt has been a subject of international competition since the 1950s when the United States and the former Soviet Union competed for access to the rich copper-cobalt deposits in the southern region of the Democratic Republic of Congo (DRC).[108]

According to researchers, cobalt was first discovered in the DRC in 1914 as a constituent of large copper deposits located in the southern part of the country. Mining assets in the DRC were largely nationalized in 1967 by Joseph-D´esir´e Mobutu, the Army Chief of Staff, who came to power through a coup two years prior. Mobutu had been largely supported by the Western countries with the hope that he would maintain Western access and help stave off Soviet domination of the mining industry. In subsequent years, however, DRC cobalt supply was significantly disrupted by ongoing conflicts which damaged assets and main transportation

106 Active Anode Material from the People's Republic of China, Common Issues and Injury Petition, A-507-194, C-570-195, December 18, 2024, at 3-4.

107 Ampofo, Kwasi and Demidova, Marina (2024, Oct 08), Cobalt 2050: Unlocking potential for a net-zero future, Bloomberg NEF and Cobalt Institute, https://www.cobaltinstitute.org/resource/cobalt-2050-unlocking-potential-for-a-net-zero-future/.

108 Gulley, A. L. The development of China's monopoly over cobalt battery materials,. Miner. Econ. (2024), doi:10.1007/s13563-024-00447-w.

routes, particularly rail corridors. A persistent lack of re-investment subsequently led to a collapse in DRC mine production.[109]

Through about 1980, the DRC was also the world's leading producer of refined cobalt. DRC's share of refined production began to decline in the mid-1970s after a spike in prices brought on by communist-backed rebels' invasion of the Katanga region prompted increased refining capacity expansion in Japan, Finland, and the Soviet Union. The lack of sufficient and reliable power also contributed to the decline of the country's refining capacity.[110]

A series of events in the early 2000s contributed to fundamental restructuring of cobalt supply chains. Specifically, while Western investors still either owned or had long-term supply agreements with DRC mining operations, decades of political and economic instability had taken a toll on their confidence. The DRC Government's 2002 implementation of a new mining code and renegotiation of contracts with U.S. and Western firms subsequently triggered a wave of divestment.[111] These events coincided with the implementation of the PRC's "Going Out" strategy. PRC investments in cobalt were also increasing dramatically because of the government's long-term plans to build self-sufficient battery supply chains for personal electronics and electric vehicles. For example, refined cobalt production from PRC state-owned cobalt refiners increased production by 42 times from 1999 to 2005. Initially, PRC activities in the DRC were smaller-scale transactions, such as ore purchases by traders and processors from artisanal miners that were processed at small facilities in the DRC or exported to PRC. However, by 2005, larger PRC firms such as the China Railway Group, Wanbao Resources, Zejiang Huayou's Congo Dongfang Mining began making large investments in DRCs intermediate processing plants and mine development projects.[112]

Revitalization of DRC's transportation networks was also a significant feature of PRC investment. Reportedly in exchange for access to cobalt and copper development rights, the so-called 'minerals for infrastructure' agreement in 2008 between Kinshasa and Beijing facilitated favorable loans between PRC state-owned banks to the DRC Government for PRC state-owned construction firms to rebuild transportation networks such as rail systems.[113] In 2021, President Felix Tshisekedi announced a review of mining contracts struck under his predecessor, Joseph Kabila, with a focus on PRC companies, according to news reports. Government reports indicated that less than one-third of the $3 billion that had been committed under the agreement had been paid, and the deal was renegotiated and finalized in

109 Gulley, A. L. The development of China's monopoly over cobalt battery materials. Miner. Econ. (2024), doi:10.1007/s13563-024-00447-w.

110 Gulley, A. L. One hundred years of cobalt production in the Democratic Republic of the Congo. Resour. Policy 79, 103007 (2022)

111 Id.

112 Gulley, A. L. The development of China 's monopoly over cobalt battery materials. Miner. Econ. (2024) doi:10.1007/s13563-024-00447-w.

113 Gulley, A. L. The development of China 's monopoly over cobalt battery materials. Miner. Econ. (2024) doi:10.1007/s13563-024-00447-w and Ross, Aaron and Helen Reid, Congo's $6 bln China mining deal 'unconscionable', says draft report, Reuters, (October 8, 2021), https://www.reuters.com/business/congos-6-bln-china-mining-deal-unconscionable-says-draft-report-2021-10-08/ .

March 2024.[114] The new agreement provided an additional $7 billion for infrastructure, with an emphasis on road construction. According to news reports, the parties agreed that Sicomines (68 percent owned by Chinse SOEs Sinohydro Corp. and China Railway Group, and 32 percent owned by DRC's SOE Gecamines) profits would be used to reimburse PRC partners for loans with PRC banks, contingent on copper prices, likely because cobalt is a byproduct of copper production in the DRC. These reports show that $324 million would be invested annually from 2024 through 2040, provided copper prices remain above $8,000/t, with an additional 30 percent of profits committed should prices increase by at least 50 percent above the $8,000/t mark. If the copper price falls below $5,200, Sicomines would cease to finance infrastructure payments. Sicomines would also be exempt from paying taxes until 2040,[115] as the deal designated Sicomines as an infrastructure provider, making it exempt from normal mining taxes.

Since the PRC's entrance into the DRC cobalt industry, increases in the PRC's refined cobalt production far outpaced increases in global demand for refined cobalt. Between 2000 to 2020, global refined cobalt demand has expanded by a factor of 5.4, whereas the PRC's refined cobalt production increased by a factor of 78, accounting for 97 percent of the growth. Since 2020, PRC cobalt investments have been focused in Indonesia, which has resulted in a rapid production increase in cobalt in the form of nickel and cobalt intermediate products which are primarily exported to the PRC for further refining. These investments have largely been leveraged through collaboration between leading PRC companies including battery companies (such as GEM Group and Brunp), cobalt refiners (such as China Molybdenum Corp. and Zheijiang Huayou Cobalt), and stainless-steel companies (such as Lygend Resources & Technology and Tsingshan Holding Group), which will be discussed in the nickel section.[116]

Driven primarily by capacity expansions in the DRC and new cobalt production from nickel projects in Indonesia (which are discussed in the nickel section), cobalt production has surged in 2023, overtaking increases in demand and driving down prices. CMOC, for example, increased production at its two mines in the DRC by 172 percent in 2023, and an additional 78 percent in the first three quarters of 2024, which far exceeded the company's production guidance for the year. Meanwhile, CMOC's top competitor, Glencore, had to take a $1 billion impairment on its Mutanda Mine in DRC and decrease its 2024 production guidance, effectively increasing PRC companies already sizeable cobalt market share.[117] In January 2025, another cobalt producer,

114 Reuters, Chinese companies to invest up to $7 billion in Congo mining infrastructure, January 27, 2024, https://www.reuters.com/markets/commodities/chinese-invest-up-7-bln-congo-mining-infrastructure-statement-2024-01-27/.

115 Reuters, Congo's $7 billion infrastructure deal with China will depend on copper prices, May 3, 2024, https://www.mining.com/web/congos-7-billion-infrastructure-deal-with-china-will-depend-on-copper-prices/

116 Gulley, A. L. The development of China's monopoly over cobalt battery materials. Miner. Econ. (2024) doi:10.1007/s13563-024-00447-w, including supplemental materials.

117 Home, Andy (2024, August 21), Cobalt supply tsunami hits the market of last resort, Reuters, https://www.reuters.com/markets/commodities/cobalt-supply-tsunami-hits-market-last-resort-2024-08-21/; Dempsey, Harry (2024, March 1), "Cobalt market stung by record oversupply", Financial Times, Cobalt market stung by record oversupply; and Cook, Alexander (October 29, 2024), "Top cobalt producer, CMOC, smashes through 2024 guidance with three months to go", Fastmarkets, Top cobalt producer, CMOC, smashes through 2024 guidance with three months to go - Fastmarkets.

Jervois Global Limited, owing to 'all-time low' cobalt prices, announced that it would file for bankruptcy and delist from the Australian Securities Exchange.[118] The company owns several cobalt assets including a mining project in Idaho, which was idled in 2023 only weeks before it was set to open; a cobalt and nickel mining project in Australia; an active cobalt refinery in Finland; and an idled nickel and cobalt refinery in Brazil that the company was working to modernize and restart.[119] The company had received funding awards from both the U.S. Department of Defense and the Finnish Government.[120]

A study released in 2024 concluded that in 2022, when factoring in domestic PRC production, production from PRC-owned assets in third party countries, and known long-term supply agreements, PRC controlled cobalt materials at all nodes in the battery supply chain including 62 percent of cobalt mine production used for chemical refining, 95 percent of refined commercial-grade cobalt chemicals, 92 percent of battery-grade tricobalt tetraoxide, 85 percent of battery-grade sulfate, and 91 percent of nickel-cobalt-manganese precursor materials.[121] The scope of PRC's control over the cobalt supply chain provides multiple levers for it to use to significantly and unilaterally influence cobalt prices. Furthermore, there have been cases where PRC-owned companies have allegedly reneged on supply agreements with Western companies. For example, Freeport McMorran formerly owned both the Tenke Fungurume Mine in DRC and Kokkola Refinery in Finland. The two subsidiaries had executed a cobalt supply agreement in 2013, whereby the DRC mine would supply all of the intermediate cobalt feedstock to the Finnish refinery (with a 15,000 t/yr capacity) for the life of the mine and guaranteed until at least 2026. China Molybdenum acquired Tenke Fugurume in 2016, after which feedstock sent to Kokkola reportedly declined. In 2020, Kokkola, which had been acquired by Umicore, received only half the amount of feedstock that it received in 2019. In 2022, it was reported that most of the mine's feedstock was exported to PRC, and Umicore subsequently signed a new supply agreement with Glencore.[122]

Nickel

Nickel has a wide variety of uses including in the manufacture of gas turbines for aircraft and electrical power generation, medical devices, oil and gas extraction, shipbuilding, and batteries (such as lithium-ion, nickel-cadmium, nickel metal hydride, and nickel-zinc). Nickel is produced in multiple forms such as ferronickel, which is predominantly used in stainless steel, and high-

118 Jervois. Jervois Global signs recapitalization agreement, January 2, 2025, https://wcsecure.weblink.com.au/pdf/JRV/02899949.pdf and 118 Scheyder, Ernest and Eric Onstad, Cobalt miner Jervois in rescue deal to better compete with China, Reuters, January 2, 2025, https://www.reuters.com/markets/commodities/cobalt-miner-jervois-rescue-deal-after-struggle-compete-with-china-2025-01-02/.

119 See assets listed on Jervois' website, https://jervoisglobal.com/.

120 U.S. Department of Defense, DOD Enters Agreement to Expand Domestic Manufacturing and Strengthen U.S. Cobalt Supply Chains, (June 15, 2023), https://www.defense.gov/News/Releases/Release/Article/3429442/dod-enters-agreement-to-expand-domestic-manufacturing-and-strengthen-us-cobalt/

and Crocker, Bryce, Jervois Global Awarded 12 Million Euro Grant for Finland Cobalt Refinery Expansion, Junior Mining Network, (June 23, 2023), https://www.juniorminingnetwork.com/junior-miner-news/press-releases/2313-tsx-venture/jrv/143765-jervois-awarded-12-million-euro-grant-for-finland-cobalt-refinery-expansion.html.

121 Gulley, A. L. The development of China's monopoly over cobalt battery materials. Miner. Econ. (2024) doi:10.1007/s13563-024-00447-w.

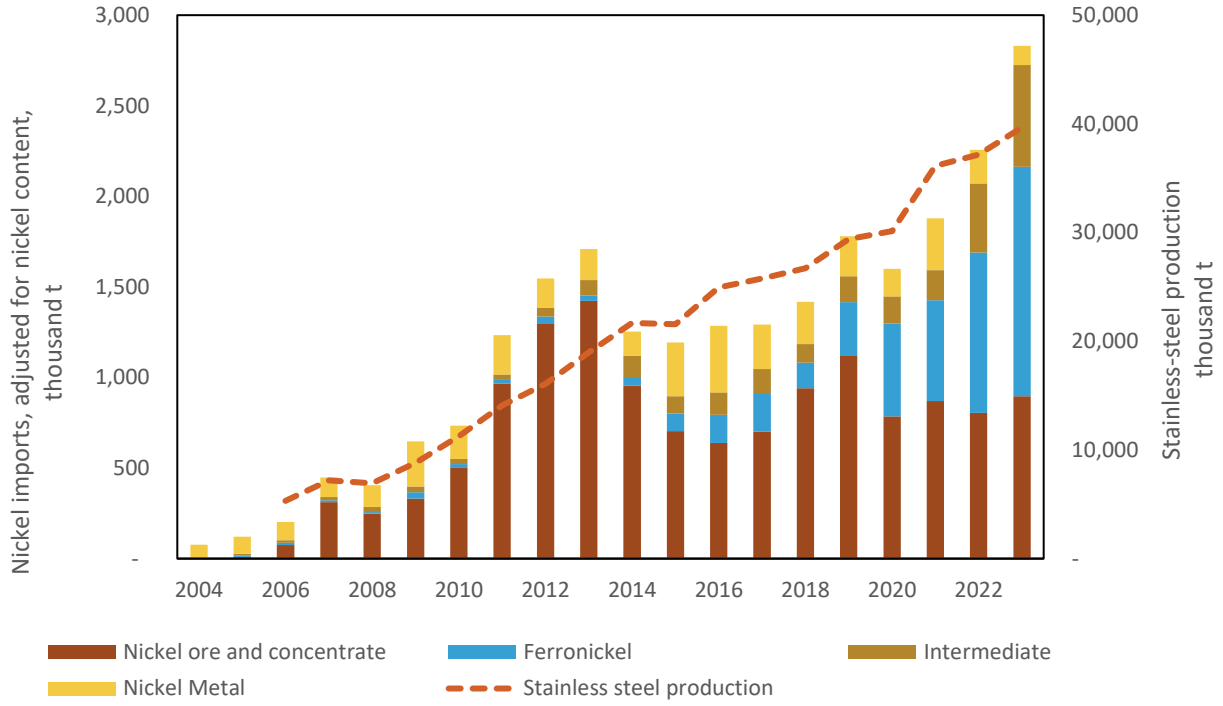
122 Gulley, A. L. "One hundred years of cobalt production in the Democratic Republic of the Congo". Resour. Policy 79, 103007 (2022).

purity nickel metal or chemical form, which are used in other applications such as high-nickel alloys and lithium-ion batteries.

As with cobalt, the PRC's influence in the nickel market began to expand in the early 2000s, but development was linked to its growing stainless-steel industry rather than batteries (see Figure 6). To increase its global market share in the stainless-steel supply chain, the PRC employed NMPPs as described in the Overseas Market Access and Firm-Level Cooperation Strategies section above to secure access to raw materials. As a less mature economy, the PRC lacked sufficient quantities of stainless-steel scrap, which in developed countries such as the United States and Europe account for a large percentage of starting raw materials. The PRC turned to importing large quantities of nickel because of a lack of sufficient domestic nickel resources. Initially, the PRC had to rely primarily on imports of high-purity metal, which is much more expensive than ferronickel. Around 2006, however, the PRC developed a lower-grade form of ferronickel called nickel pig iron (NPI), which was produced from the smelting of imported nickel laterite ores to supply lower cost nickel units. (Nickel laterite ores form in hot, humid tropical climates such as the Brazil, Colombia, Cuba, Dominican Republic, Indonesia, the Philippines, New Caledonia, and others). The PRC's imports of nickel ore and concentrate subsequently surpassed that of nickel metal. The PRC's share of Indonesia's nickel ore exports on the basis of value increased from 0.2 percent in 2005 to 96 percent 2014. For the entire period, the PRC accounted for 71 percent of Indonesia's total exports. However, in 2014 the Government of Indonesia began to enforce the Mining Law (Law No. 4) on Mineral and Coal Mining that was passed in 2009, which prescribed national policies for the management and control of mineral and coal mining. The law requires domestic processing and refining of ores before export.[123]

123 Lederer, Graham W. (2016), Resource Nationalism in Indonesia—Effects of the 2014 Mineral Export Ban, U.S. Geological Survey Fact Sheet, http://dx.doi.org/10.3133/fs20163072 and https://www.loc.gov/item/global-legal-monitor/2014-01-23/indonesia-export-ban-on-unprocessed-minerals-comes-into-effect/.

Figure 6. The PRC's Stainless-Steel Production and Imports of Nickel Raw Materials



Source: Argus Media, SMR Group, S&P Global, Worldstainless

Following implementation of the export ban, PRC investment in Indonesia soared.[124] According to a report, many of the PRC's stainless-steel firms have large ownerships shares in industrial parks dedicated to nickel, which are often vertically integrated with stainless-steel production. For example, Indonesia's Harita Group and the PRC's Lygend Resources jointly own the Obi Island Industrial Estate, China's Jiangsu Delong Nickel Co., Ltd. owns Kawasan Industri VDNI (also known as the Delong Industrial Park).[125]

One of the most active investors is the PRC's Tsingshan Holding Group. Tsingshan, through its subsidiaries Shanghai Decent Investment Group Ltd. and Perlus Technologies, is the majority shareholder in the Indonesia Morowali Industrial Park ("IMIP") and the Weda Bay Industrial Park ("IWIP"), respectively. Tsingshan also heavily invested in the development of the Indonesia Konawe Industrial Park and the Kalimantan Industrial Park Indonesia. [126]

IMIP is a massive industrial complex, with more than 70,000 workers, four hectares of land plus extraction rights to 47,040 hectares of mineral concessions, and infrastructure including an airport and seaport, captive coal plants, a dedicated telecommunications network with

124 Tritto, Angela, 2023, How Indonesia used Chinese Industrial Investments to Turn Nickel into the New Gold, Carnegie Endowment for International Peace, https://carnegie-production-assets.s3.amazonaws.com/static/files/files__Tritto_Indonesia_Nickel.pdf.

125 M. Schreier, J. Lou, A. Dahiwadkar, A. Rader, C. Squire, F. Tumiwa, May 2024, Challenges and Opportunities for Sustainable Industrial Development, Center for Global Sustainability, University of Maryland, https://cgs.umd.edu/sites/default/files/2024-06/file_Indonesia%20industrial%20parks%20policy%20brief_6.4.pdf.

126 Tritto, Angela, 2023, How Indonesia used Chinese Industrial Investments to Turn Nickel into the New Gold, Carnegie Endowment for International Peace, https://carnegie-production-assets.s3.amazonaws.com/static/files/files__Tritto_Indonesia_Nickel.pdf.

underwater cables that link to PRC-owned satellites, factories for supporting raw material development, and residential areas. IMIP received funding from PRC's Belt and Road Initiative, first through the China-ASEAN Investment Cooperation Fund, and later through a $1.22 billion loan from the China Development Bank. The signing of the memorandum of understanding to develop IMIP was witnessed by both PRC's President Xi Jinping and Indonesia's former President Susilo Bambang Yudhoyono. Financing for construction of the complex's coal-fired power plants were provided by several of PRC's leading state-owned banks including the Bank of China, the China Development Bank, the Export-Import Bank of China, and the Industrial and Commercial Bank of China.[127]

Early investments in Indonesia's nickel processing and stainless-steel operations were coming to fruition just as the demand for nickel in EV batteries began to emerge. According to Department of Commerce's industry experts, these prior investments served as a catalyst for the development of battery-grade nickel projects through production of nickel intermediates for use in the manufacture of nickel sulfate for battery cathodes. By 2022, Indonesian nickel production was surging, which pushed the market for ferronickel and NPI (low-purity forms of nickel) into surplus, although this surplus did not impact the global market for higher-purity forms of nickel until the latter part of 2023. This is because nickel contract pricing outside of the PRC is typically referenced to the London Metals Exchange ("LME"), which only accepts high-purity forms of metal. Therefore, most of the forms of nickel produced in Indonesia are not eligible for trading on the LME. Concerns about the availability of Russian metal following the onset of conflict with Ukraine also helped insulate high-purity nickel prices. Demand for high-purity nickel, especially nickel sulfate for batteries continued to increase. However, it was outpaced by increases in Indonesian production, so that by early 2023, the nickel sulfate market also tipped into surplus. In response, companies in the PRC announced plans to build new nickel refineries to convert excess nickel sulfate to high-purity metal, effectively creating a 'bridge' between the low-purity and high-purity markets.[128] The LME monthly average price subsequently fell by more than 40 percent in 2023, ending the year at $16,400.

Owing predominately to the PRC's massive investments in Indonesia's nickel and stainless-steel sector, Indonesia is now the second-leading stainless-steel producer in the world, and the leading producer of both mined and primary nickel. However, PRC's investments in Indonesia's nickel sector are currently underpinning significant global overcapacity in the global market. First, some analysts estimate that more than half of the world's nickel is uneconomic at 2024 prices, with margins thin for even Indonesian producers.[129] According to news reports, in October 2024, the Government of Indonesia therefore announced that it would begin to

127 Id.

128 U.S. Geological Survey: National Minerals Information Center, Mineral commodity summaries 2024, (2024), pubs.usgs.gov/periodicals/mcs2024/mcs2024.pdf.

129 Dempsey, Harry, Lakshimi, A. Anantha, and Ruehl, Mercedes, 2024, January 29, Indonesia's Flood of Nickel Sparks 'Darwinian' battle for survival among miners, Financial Times, https://www.ft.com/content/dd9434b4-04e5-474d-85ff-7149f89efd19.

regulate nickel ore supply and demand in order to help support price.[130] Second, owing to the rapid depletion of the highest-grade nickel resources, the Indonesian Government is reportedly also imposing a moratorium on the development of new ferronickel and NPI smelters.[131] Third, mining companies may not be paid for the cobalt content of their ore, even though cobalt is a constituent of intermediate feedstocks used to produce high-purity forms of nickel.[132] In addition, with the export of ore no longer an option, Indonesian mining companies' only option is to sell domestically. This gives the predominately-PRC owned processing industry a great deal of leverage over ore prices, and mining companies have been pressured to sell ore at below market prices.[133] Finally, owing to continually increasing smelter demand and delays in the Government of Indonesia's issuance of mining quotas, Indonesian processing plants have been importing increasing quantities of nickel ore from the Philippines in 2023 and 2024.[134]

Globally, while nickel mine and primary (smelted or refined) production has historically been well-diversified, it is increasingly becoming more concentrated. According to statistics from the International Nickel Study Group, since 2022, 28 countries produced nickel ore or concentrate (mine production), and 27 countries produced primary products. In 2023, Indonesia's mine production grew by nearly 30 percent, accounting for more than 50 percent of global production. Indonesia's primary production increased by 17 percent in 2023 and accounted for more than 40 percent of global primary production and is expected to grow by an additional 10 percent in 2024. PRC companies exert control over the vast majority of Indonesian intermediate and primary nickel production, either through ownership or because of processing facilities' location in PRC-owned industrial parks. Growth in the PRC's primary nickel production has also been robust, with an estimated 14 percent growth in 2023, with an additional six percent increase expected in 2024. If considered together, the PRC and Indonesian primary nickel production accounted for approximately 70 percent of global production in 2023. Most nickel market analysts expect production surpluses to persist for several more years. At the same time, production in most other countries has declined, sometimes dramatically. Mine production has decreased in 17 countries, and producers in five countries including Australia, the Dominican Republic, Greece, Kosovo, New Caledonia have been idled or closed. Primary production declines are similar, with production decreases in 17 countries, and smelting and/or refining operations idled in eight countries. In Australia, typically the sixth-ranked producer of primary nickel, idling of facilities is expected to decrease primary production by more than 15 percent in 2024 and nearly 50 percent in 2025.

130 Reuters, 2024, October 18, Indonesia Aims to Manage Nickel Ore Supply to Support Prices, Reuters, https://www.reuters.com/markets/commodities/indonesia-aims-manage-nickel-ore-supply-support-prices-2024-10-18/.

131 Indonesian govt agrees to moratorium on new RKEF nickel smelters, Mysteel, (August 12, 2024), https://www.mysteel.net/news/5059998-indonesian-govt-agrees-to-moratorium-on-new-rkef-nickel-smelters.

132 Indonesian Nickel Miners Association, 2024, September 23, Presentation at the Fall Meeting of the International Nickel Study Group, Lisbon, Portugal.

133 Tritto, Angela, 2023, How Indonesia used Chinese Industrial Investments to Turn Nickel into the New Gold, Carnegie Endowment for International Peace, https://carnegie-production-assets.s3.amazonaws.com/static/files/files__Tritto_Indonesia_Nickel.pdf.

134 Reuters, 2024, May 29, Indonesia Buying Record Amounts of Philippine Nickel Ore Due to Quota Delays, Mining.com, https://www.mining.com/web/indonesia-buying-record-amounts-of-philippine-nickel-ore-due-to-quota-delays-sources-say/.

Magnesium

Magnesium is an indispensable element for aluminum alloys and desulphurization of steel, affecting the automotive, aerospace, and construction industries. In addition, it is crucial in manufacturing electronic devices such as laptops and mobile phones. As the lightest of all commonly used structural material as well as being fully recyclable, magnesium is highly valued in the aerospace, automotive, and electronics industries, for its combination of lightness and strength.

The impact of the PRC on the European magnesium industry has been profound, leading to significant changes and challenges for European producers. Norsk Hydro was the world's largest primary magnesium producer, with production in Norway and Canada amounting to nearly 25 percent of the global magnesium output. A significant portion of Hydro's magnesium production and research took place at its plant in Porsgrunn, Norway, which reached a maximum production capacity of 50,000 t of magnesium per year. Hydro also operated a remelting plant in Germany and a primary magnesium plant in Canada. However, due to low magnesium prices caused by increased PRC production and exports to Europe in the 1990s, Hydro struggled to make a profit from magnesium, despite growing demand from the automotive industry.

In the 1990s, the PRC rapidly increased its magnesium production, becoming a dominant global player. PRC magnesium producers benefited from low production costs due to allegedly less stringent social and environmental standards. In 1997, the Euro Alliages association filed a complaint about PRC dumping. The EU imposed an antidumping duty of 31.7 percent in 1998, which was later increased to 63.4 percent. However, these measures were insufficient to protect European producers. Hydro decided to cease operations in Porsgrunn in 2001, at a time when the plant was still producing 42,000 t annually. Due to increasingly tough competition from PRC producers, Hydro announced its worldwide withdrawal from magnesium production in 2006. The same year as Hydro closed its plant in Porsgrunn, the French producer Pechiney Electro-Métallurgie (Pechiney) announced that it would close its magnesium plant in Marignac. This effectively marked the end of primary magnesium production in Europe.

The production of low-emission magnesium in Norway and France was dependent on a highly energy-intensive electrolysis process and was therefore sensitive to energy prices. The PRC established the simpler thermal reduction process (Pidgeon) route that uses ferrosilicon and coal for the reduction of dolomite oxide. Thermal energy was mainly coal-based, resulting in significantly higher carbon intensity. The closures of Hydro's and Pechiney's magnesium smelters led to significant carbon leakage and to increased global emissions as production shifted to PRC.

PRC companies now control large parts of the global magnesium value chain. As of 2022, 88 percent of the world's production of primary magnesium stems from the PRC, primarily centralized in Yulin city in the Shaanxi province, which alone accounts for 63.5 percent of the

global magnesium production, approximately 0.61 Mt. Industrial overcapacity and economic imbalance in certain sectors have been significant challenges with the PRC's industrial policy. These problems appear to be either intended or tolerated effects in the process of building globally leading industries.

Europe has a high dependence on magnesium imports from the PRC. This dependency left European industries particularly vulnerable when in early autumn 2021, PRC production of magnesium saw a sharp decline leading to spiked magnesium prices. European industrial users of magnesium not only had to bear the cost but also faced a threat of shortages. While the supply disruptions eased over the first half of 2022, the crisis demonstrated that this high dependency is a concern to European supply chains. Magnesium has been on the EU's list of critical raw materials since it was established in 2014.

Aluminum, silicon, manganese alloys, and other ferroalloys have much in common with magnesium: all are energy-intensive and face PRC overcapacity while competing globally.

B. Impacts on Market-Oriented Mineral Producers and Supply Chains: Summary of Questionnaire Responses

As reviewed above, PRC NMPPs have had significant impacts on mineral markets and have negatively impacted market-oriented producers. The Ministry of Trade, Industry and Fisheries of Norway conducted a voluntary comprehensive questionnaire aimed at understanding the impact of NMPPs on the critical raw materials sector in Norway, specifically focusing on mining and processing activities. These survey responses illustrate the impact on market-oriented producers more broadly. The questionnaire was circulated to the Norwegian business community involved in this sector, and it received a response rate of 50 percent. The questions covered a range of topics to gather detailed insights from the respondents. These included the general impact of NMPPs on business operations, investment decisions, export and trade dynamics, global prices, supply chain operations, risk management strategies, regulatory impacts, and market dynamics.

The responses indicate that NMPPs from other countries, particularly the PRC, have significantly affected business operations in the critical raw materials sector. Respondents highlighted that state-controlled entities in some countries benefit from immediate access to government funding and control over market prices, leading to artificially low prices. This has made global competition difficult, resulting in halted expansions and unprofitable new projects outside these regions. The lack of transparency in market indexes and the ability of certain players, due to their control of entire value-chains, to offer higher prices to suppliers outside their country further exacerbate these challenges. Some respondents noted increased costs for certain raw materials as a consequence of NMPPs such as export restrictions.

The dominant position of certain countries, particularly the PRC, in the market for critical raw materials has furthermore created challenges for establishing a value chain outside of these regions. The introduction of export restrictions and nationalization of resources by some

countries has complicated the situation. Respondents emphasized the need for risk mitigation and strategic positioning to secure raw materials and reduce dependency on these regions. The geopolitical importance of critical raw materials and the need for sustainable and competitive production practices were highlighted. Some respondents provided detailed insights into their specific challenges and strategies, underscoring the importance of developing domestic capacities and securing long-term supply agreements to ensure resilience and competitiveness in the critical raw materials sector.

Investment Decisions

When asked about how NMPPs impact their investment decisions, respondents indicated that NMPPs have influenced their investment decisions in several ways. The uncertainty and lack of profitability due to monopolistic pricing and subsidized value chains make large investments risky and often difficult to justify based on market conditions alone. Some respondents have shifted their investment priorities from Europe to North America due to favorable policies like the U.S. IRA and highlighted that the IRA has created a protected market for EV batteries in the U.S. with significantly stronger pricing conditions than the global market.

Respondents also highlighted that complex public decision-making processes and strong local opposition to mining projects in some regions delay investments. Some companies are aiming for increased self-sufficiency in raw materials to mitigate risks associated with NMPPs and reduce dependence on external suppliers. For instance, a few respondents have a strategy to become fully self-sufficient in certain raw materials to manage future supply and demand challenges.

While respondents did not criticize the high environmental, climate, and labor standards in Europe and Norway, several respondents pointed out that these standards create an uneven playing field when compared to regions with lower standards. The higher operational costs associated with stringent environmental and social regulations in Europe and Norway make it challenging to compete with producers in regions where such standards are more lenient. This disparity in regulatory environments can deter investments in regions with higher standards, as companies face increased costs and competitive disadvantages.

Export Restrictions and Trade

Respondents are indicating that NMPPs of other countries have impacted exports by creating significant price gaps between government-controlled market prices and global market-based prices. Some respondents noted that dominance in exports by certain countries, particularly the PRC, has made it difficult to compete in markets without protective measures like anti-dumping duties. The imposition of trade remedies such as anti-dumping duties against imports from The PRC and other countries in regions like the EU and the U.S. has had a positive effect on Norwegian companies establishing long-term agreements with local partners. However, overall, the ability to compete internationally has been hampered by subsidies and other NMPPs provided to foreign competitors. Increased use of export restrictions for raw materials

as well as for certain processing technologies imposed by some countries have further complicated the competitive landscape, making it challenging for companies to maintain their market positions. Some respondents highlighted the challenges posed by these policies, including the need for increased R&D to develop competitive processing technologies.

Global Prices

A significant majority of respondents reported that NMPPs have contributed to a decrease in global prices for critical raw materials. They indicate that this trend is largely driven by subsidies and overcapacity in specific regions, particularly the PRC. Downward price pressure has reduced profitability for producers outside these regions. The regionalization of supplies due to price differences has also been noted, with higher prices in some areas due to protective measures against imports supported by NMPPs. Volatility in prices has affected profitability, with some materials experiencing significant price drops. Respondents emphasized the influence of market practices in certain regions on global prices, with the ability to manipulate prices to maintain market dominance and drive out competition. Some respondents mentioned specific examples of how changes in global prices have affected their profitability and pricing strategies.

Supply Chains

NMPPs have disrupted supply chain operations by creating dependencies on low-cost products from certain regions. The ability to maintain stable supply chains has been challenged by the dominance of production in these regions and the imposition of export restrictions by other countries. Respondents have had to find alternative suppliers and adjust their supply chain strategies to mitigate these risks. The reliance on raw materials from specific regions has increased, making it difficult to re-establish production outside these areas. The challenges in sourcing raw materials globally have highlighted the need for diversified supply chains and strategic partnerships to ensure resilience and security of supply. Some respondents mentioned specific measures they have implemented to address these challenges, such as enhancing their supplier screening processes and ensuring strict adherence to international standards.

Risk Management

To mitigate risks associated with NMPPs, respondents have implemented measures such as diversifying their value chains, increasing inventory levels, and working with policymakers in partner countries to protect domestic industries in the same sector through trade defense instruments. Strategic decisions have been influenced by the need to secure raw materials and reduce dependency on regions with NMPPs. Several respondents emphasized the importance of developing alternative sources and ensuring compliance with high international environmental, social, and governance standards. They screen suppliers to meet the principles of the UN Global Compact, prioritize sustainable production processes and strict ESG regulations, and maintain high standards for worker safety and environmental protection.

These efforts not only ensure their own compliance but also promote the adoption of high standards globally to level the playing field and ensure fair competition. Respondents have also engaged in dialogue with relevant authorities and stakeholders to address the challenges posed by NMPPs and to advocate for supportive policies and measures. Several respondents emphasized the importance of regularly assessing the risks associated with critical raw materials and supply chain vulnerabilities. This includes evaluating the security of supply, potential disruptions, and the impact of NMPPs on their operations.

Regulatory Impact

Respondents highlighted that varying environmental, climate, and labor standards across countries have significantly impacted operational costs. Stricter regulations in some regions have led to higher costs compared to countries with more lenient standards. This disparity has created unfair competition, as companies in regions with higher standards face greater environmental and social costs while competing with imports produced under less stringent regulations.

Mechanisms like the Carbon Border Adjustment Mechanism ("CBAM") have been introduced in EU to level the playing field, but some respondents question their effectiveness. Respondents emphasized that higher operational costs in regions with stricter regulations have put producers at a competitive disadvantage, necessitating measures to protect domestic industries and ensure fair competition.

For example, some respondents noted that the European industry faces increased environmental costs through the EU Emissions Trading System ("ETS"), while competitors in countries like the PRC benefit from lower operational costs due to less stringent regulations. This has led to a situation where European producers struggle to compete with lower-priced imports.

Additionally, respondents provided specific examples of how these varying standards have affected their operational costs and competitive positions. They mentioned the need for long-term contracts and risk-sharing agreements to secure prices above cost levels, and the challenges of competing with subsidized products from countries with lower environmental and social standards.

Market Dynamics

Several respondents highlighted that state-owned enterprises in certain countries have shaped the competitive landscape by receiving subsidies and support from their governments. This support has led to overcapacities and distorted market dynamics, making it difficult for companies in other regions to compete on a level playing field.

To mitigate the adverse effects of NMPPs, respondents have highlighted the importance of implementing several measures. These include stricter environmental requirements for raw material procurement, the use of trade defense instruments such as anti-dumping duties, and

the establishment of trade agreements that include provisions for fair competition and environmental standards. Ensuring a level playing field and protecting domestic industries from unfair competition are seen as crucial steps for maintaining competitiveness.

Respondents noted that the role of state-owned enterprises in driving market dynamics and influencing global competition has been significant, with their ability to operate under different economic and regulatory conditions.

VI. Conclusion and Looking Ahead

The analysis in this report shows that the PRC's approach to minerals generally targets sectors or technologies in a coordinated manner, financing both upstream and downstream segments of a particular mineral supply chain. These investments were initially focused on base metals (such as steel or aluminum) for general industrial development, and then on strategic sectors such as electric vehicles. In general, where the PRC has sufficient geological resources to grow these sectors, it directs its NMPPs inwards to capture market share. Where it lacks sufficient geological resources, it directs NMPPs for processing internally (for example, cobalt and nickel to grow the steel and electric vehicle sectors) and externally to resource-rich countries (such as the DRC or Indonesia) to secure raw materials and to increase its market share throughout the value chain through ownership of facilities in these countries.

This approach has enabled the PRC government to gain a strategic advantage in mineral supply chains both in and outside the PRC, including via state-owned or state-influenced firms that have benefitted from growing market share in the process. PRC NMPPs have had sustained impact on the minerals market and allowed SOEs and other agents of government direction to act without regard to changing market conditions. The non-transparent timing, breadth, and depth of such NMPPs has had a profound effect on the ability of firms along global supply chains to viably respond to market changes, ultimately weakening their resilience to changing market dynamics and competitive pressures.

This has been demonstrated in the markets for minerals and metals needed for the energy transition. According to the International Energy Agency's ("IEA") 2024 Critical Minerals Outlook (which focuses on cobalt, graphite, nickel, rare earth elements, copper, and lithium), while the magnitude of demand introduced by the energy transition presents significant opportunities for new market entrants and further diversification of supply, supply has actually expanded at a faster rate than demand, resulting in reduced prices across a range of commodities. Because most of the anticipated supply growth comes from countries with existing production, supply has become more geographically concentrated rather than less, especially metals refining for nickel and cobalt. The IEA largely attributes this to the PRC's

increased market share in all mid- and downstream manufacturing nodes across the EV supply chain.[135]

Absent action by market-oriented countries, supply is likely to remain concentrated or become further concentrated. Moving forward, given the PRC overcapacity, the PRC will likely seek to export its excess output, which would further impact market-oriented producers. In this environment, market-oriented countries would need to consider factors that could differentiate markets, such as quality, transparency, environmental, social, and governance standards. Consistent with the goals of the U.S.-Norway MOC, this would advance the long-term commercial viability of sustainable, high-standard, market-oriented critical minerals mining and processing activities in the United States, Norway, and globally.

135 IEA (2024), Global Critical Minerals Outlook 2024, IEA, Paris https://www.iea.org/reports/global-critical-minerals-outlook-2024, Licence: CC BY 4.0.