Disruptions to Global Supply Chains Due to the War in Ukraine

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USITC Staff Research, April through June 2022

The war in Ukraine has disrupted the supply chains of materials and products that are integral to industries both in the United States and abroad. Since the Russian invasion of Ukraine in February 2022, USITC staff has published a series of short research papers on different commodities to highlight how supplies and trade have been affected by the ongoing war. The series begins by looking at two materials, neon gas and palladium, which although used in small quantities, are critical to global semiconductor manufacturing and heavily sourced from the conflict area. Similarly, production of helium and scandium are limited and a sizeable amount of each is sourced from the conflict region. Aluminum is a critical material for national security as well as several economically important industries in the United States, and Russia is a leading exporter. Rounding out this series of briefs is a look at how the war in Ukraine has impacted the supply of certain oilseeds and vegetable oils, influencing global food prices for staples (e.g., cooking oil).

The enclosed USITC staff research has been published as two-page research briefs termed Executive Briefings on Trade (EBOTs). In general, EBOTs provide a vehicle for staff to briefly document important developments in trade (e.g., supply issues, investments, shifts in production or trade). EBOTs help staff develop technical capacity and support USITC's mission to provide independent analysis and information on tariffs, trade, and competitiveness. This series can be found here on the USITC website.

Ukraine, Neon, and Semiconductors, explains neon capture, its chief downstream application (i.e., lasers), and Ukraine's importance in the neon supply chain. (Samantha DeCarlo and Samuel Goodman, April 2022)

Russia, Palladium, and Semiconductors, describes palladium and its uses, including semiconductor production; highlights Russia's role in the palladium supply chain; and discusses the effect Russian supply has on pricing. (Samantha DeCarlo and Samuel Goodman, May 2022)

The Impact of Conflict on the Global Helium Shortage, provides an update on the helium market, highlights progress on U.S. privatization of helium output and the effects of the war, and discusses past and present shortages. (Samantha DeCarlo and Samuel Goodman, May 2022)

Russia and Scandium's Scant Scale**,** provides information on scandium's uses, sources, market, and trade to offer context on the potential for the Russia-Ukraine war to disrupt supplies of this metal. (Samantha DeCarlo and Samuel Goodman, June 2022)

Russia and Aluminum Supply Chains, examines Russia's role in aluminum supply chains and how the war may affect prices and downstream consumers. (Kelsi Van Veen, June 2022)

A Tempest in the Oil Vat: Shocks to the Global Vegetable Oil Markets, reviews recent events that impacted exports of major vegetable oils in several key exporting countries (Canada, Argentina, Brazil, Russia, Ukraine, and Indonesia). These events have also contributed to increases in global prices of vegetable oils. (Marin Weaver, June 2022)

Ukraine, Neon, and Semiconductors

Samantha DeCarlo and Samuel Goodman, Office of Industries

Neon gas is a critical input for the semiconductor industry due to its use in lasers. One of the largest sources of neon is the steel industry, where it is a byproduct of liquid oxygen generation. As of 2022, Ukraine supplies an estimated 50 percent of neon worldwide, which is largely attributable to the legacy of the Soviet steel industry. The U.S. semiconductor industry is dependent on this portion of the global value chain, as Ukraine produces nearly all of the ultra-high-purity semiconductor-grade neon imported by the United States. This executive briefing explains neon capture, its chief downstream application (i.e., lasers), and Ukraine's importance in the neon supply chain.

Neon Capture: Neon is a rare gas, comprising 0.0018 percent of the atmosphere. Separating it from other atmospheric gasses, like oxygen and nitrogen, involves a process akin to a home dehumidifier—liquefaction. In liquefaction, air is progressively cooled and compressed until each component gas condenses at its boiling point. Only the largest air separation units (ASUs) include neon capture systems because neon's low concentration in air means that smaller ASUs will not produce commercial quantities.[1] Large ASUs have historically been co-located with steel manufacturing, as the basic oxygen steelmaking process requires a high volume of pure oxygen obtained through this type of gas separation.

Neon Market: While neon is universally associated with brightly colored signage, its largest downstream application is lasers.[2] The semiconductor industry accounts for up to 90 percent of neon gas laser demand. In manufacturing semiconductor chips, a mixture of gases (termed *excimer gas*) generates the single wavelength of light used for deep ultraviolet photolithography.[3] Within the gas mixture, neon is typically a buffer and carrier gas that helps minimize defects during the photolithography process, increasing the overall yield of usable chips. U.S. manufacturers that use excimer gas must verify it meets their requirements for purity and quality. Qualification of a gas source can take 3 to 18 months, and if a customer were to switch sources, the process would have to be redone.

Ukraine: Ukraine supplies approximately half of the world's neon and is a major source of the ultra-high-purity neon used in chip manufacturing. Over the past decade, it has been estimated that Ukraine has supplied up to 90 percent of U.S. imports of neon. Ukraine also exports substantial volumes to major chip producing nations in Asia (see figure 1). The current conflict in Ukraine raises concerns about the security of that supply.

The 2014 Russian occupation of Crimea helps inform what could happen to the neon market in the near future. Ukraine supplied about 70 percent of neon to chipmakers globally in 2014. The largest Ukrainian gas purifiers at that time, Cryoin and Iceblick, were located in the Black Sea port city of Odessa, west of the peninsula. After the occupation, neon prices reportedly spiked over 600 percent. Delayed shipments combined with border crossing issues (between the Russia-Ukraine border) further compounded tight supplies at that time. Prior to the present conflict between Ukraine and Russia, Cryoin (still operational) and a company called Ingas were major suppliers of neon to U.S. customers. As of March 11, 2022, Cryoin and Ingas, have been unable to continue production.[4] It is likely that the present conflict will have a substantial impact on the global neon market, which will affect the semiconductor value chain.

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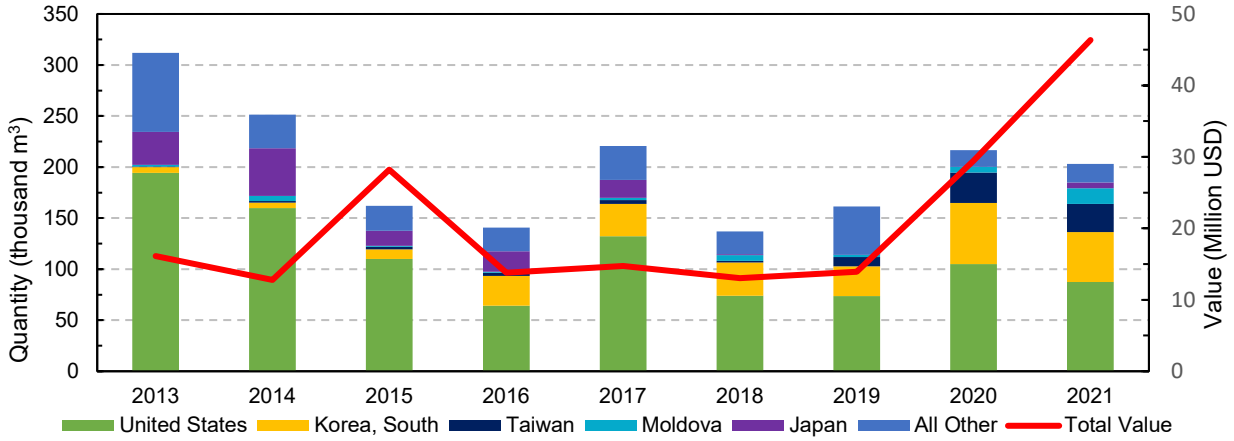
[1] Scarcity of neon in the atmosphere is due to its low density and inertness, which impede accumulation.

[2] Liquid neon can also be used as a cryogenic refrigerant.

[3] Photolithography is the process of using light to transfer patterns to silicon wafers via a photomask. Excimer gas mixtures for lithography are most commonly ArF (193 nm) or KrF (248 nm).

[4] It appears that Iceblick's neon operations are no longer occurring.

Figure 1: Ukrainian exports of rare gases quantity (cubic meters, m^3), value (dollars), and unit value



	2013	2014	2015	2016	2017	2018	2019	2020	2021
Unit Value ($/m³)	52	51	174	98	67	95	86	136	228

Source: Official exports statistics from Ukraine under HS heading 2804.29, as reported national statistical authorities in the Global Trade Atlas database, accessed March 4, 2021. Data may be overstated as HS heading 2804.29 contains trade other rare gases isolated via air separation (i.e., krypton and xenon).

Diversification of Supply: After 2014, some chip manufacturers diversified their neon sources, and Ukraine has since lost about 20 percent of global market share.[5] China has added significant capacity over the past decade, and at least one U.S. firm has expanded domestic production of neon.[6] Reportedly, the primary barrier for market entry is the scarcity of neon which limits the number of commercially viable neon purification sites. There is also an issue of scale: the U.S. excimer gas market only amounts to about $40 million, despite its overall criticality to laser gases.

The global capacity added since 2014 has not diminished U.S. reliance on Ukrainian semiconductor-grade neon. As of 2022, reports indicate that Ukraine was still the source for nearly all of semiconductor grade neon imported by the United States.[7] Additionally, six months ago, China shuttered steel mills to reduce pollution before the Winter Olympics and suppress demand for Australian iron ore, reportedly tripling neon prices into Q1 of 2022. The full extent of the neon gas bottleneck will depend on the overall course of the ongoing conflict, how rapidly Ukrainian production can restart, and when Ukrainian neon can re-enter the global market.

Sources: Fukuda, "Chipmakers Seek Solution," March 2016; Solid State Technology, "Neon Shortage Coming," February 2016; Diglogs, "Odessa, the Neon of War," March 8, 2022; Meaker, "Russia's War," March 4, 2022; FT reports, "Russia's Invasion," March 3, 2022; Yonhap, "Ukraine Tensions," February 24, 2022; Pimlott, "Linde Installs," July 19, 2016. Federal Trade Commission, "Analysis of Proposed Agreement," October 22, 2018; Moggridge, "Praxair Announces," August 20, 2020; Sterling, "ASML Seeking Alternative Sources," February 23, 2022; Alper and Freifeld, "Russia Could Hit," February 11, 2022; King, "Ukraine Invasion Rattles," March 2, 2022.

[5] Some firms have attempted to mitigate risk by stockpiling neon as well.

[6] Linde Gas AG installed neon production in Texas in 2016. Linde and Praxair announced in 2018 that they were merging, together representing about 70 percent of U.S. excimer gas production. The status of the previously announced investment is unclear.

[7] In comparison, Dutch firm ASML reportedly sources only 20 percent of its neon from the Russia-Ukraine region.

Russia, Palladium, and Semiconductors

Samantha DeCarlo and Samuel Goodman, Office of Industries

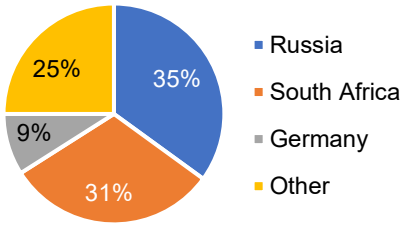
Palladium is critical to the U.S. economy and national security. Russia is the largest supplier of the metal to the United States. When the war in Ukraine began in February 2022 and sanctions against Russia were imposed, many reports highlighted how reliant the western world is on palladium from Russia. This executive briefing briefly describes palladium and its uses, including semiconductor production; expands on Russia's role in the palladium supply chain; and discusses the effect Russian supply has on pricing.

Palladium: Palladium is a member of the platinum group metals (PGM), a collection of rare precious metals.[1] Like other PGMs, palladium has a high melting point, is corrosion resistant, and is a key material in certain industrial processes.[2] The most common application is in automotive catalytic converters, where it helps to decrease pollution. Palladium is also a critical input for certain stages of semiconductor manufacturing. It is primarily used in the metal connections attaching chips to circuit boards and in the junctions between the chips and other metals.

Palladium is typically sourced as a byproduct or from recycling operations due to its low concentration in commercially significant ores. All primary commercial sources are tied to other mining operations, typically nickel and copper mining. Palladium is initially extracted as an impure concentrate, which is subsequently refined to higher purities at other facilities. In the United States, one company (Sibanye-Stillwater in Montana) produces palladium concentrates and an initial refined product, but that material is exported to the United Kingdom for further refining into commercial grades. Total U.S. output averages 14,000 kilograms per year, which represents only about 16 percent of total U.S. palladium consumption in 2021.[3]

Palladium, Russia, and Prices: Most of the PGMs produced today are sourced from mineral deposits in the Noril'sk-Talnakh area of Russia and from South Africa.[4] The composition of ore deposits vary widely from country-to-country: Russia produces about three times as much palladium as platinum, while South Africa produces twice as much platinum as palladium. Over several decades, Russia built a palladium stockpile, although the true amount in the stockpile has never been known. Approximately two-fifths of the global palladium supply, and over one-third of 2021 U.S. imports, is sourced from Russia (figure 1). As of 2022, one Russian mining company (MMC Norilsk Nickel PJSC, the world's largest nickel producer) produces about 40 percent of Russian palladium.

Figure 1: Country Sources of 2021 U.S. Palladium Imports



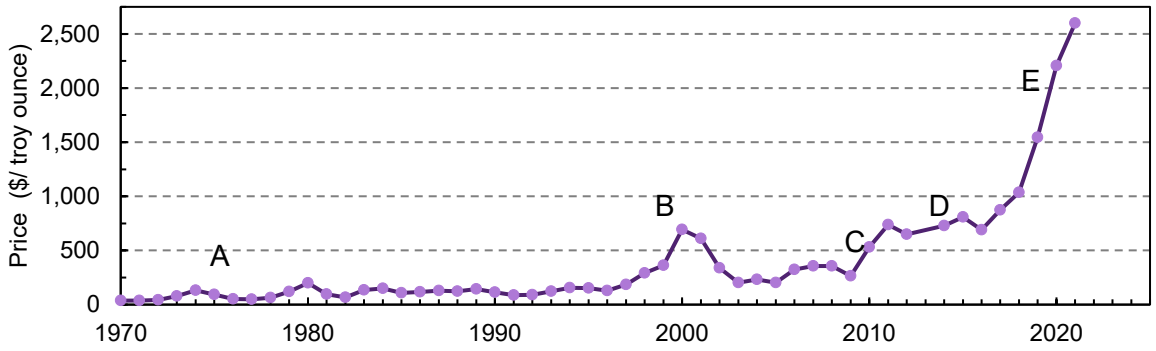
Source: USGS "Platinum-Group Metals," January 2022.

Palladium prices were relatively stable in the decades prior to the 2000s but have since undergone several spikes (figure 2). The first noticeable price increase, in the latter half of the 1990s, while due in part to the tech boom, was primarily attributable to Russian implications that it was not going to sell any of its

[1] Precious metals have a perceived scarcity and high economic value. Platinum, iridium, osmium, rhodium, and ruthenium are other PGMs.
[2] PGMs, including palladium, do not have adequate substitutes for their various applications.
[3] As a precious metal, palladium is often traded in Troy ounces, where 1 kilogram equals 31.1507 troy ounces.
[4] Significant development did not begin until the 1960s when industrial demands for PGMs increased.

palladium reserves.[5] Russia eventually did sell from its reserves, causing prices to fall. In 2011, speculation over reports that Russian reserves would be depleted over the succeeding three years drove palladium prices back up to similar highs, which were maintained for several years. Further speculation in 2019 that the Russian palladium stockpile was again facing imminent depletion contributed to the subsequent rapidly rising prices. These events detail how integral Russia is to the global palladium market and how even its rumored developments affect the global price. Despite reports of Russian palladium depletion, Russia has consistently exported over 80 million kilograms annually since 2016 (figure 3).

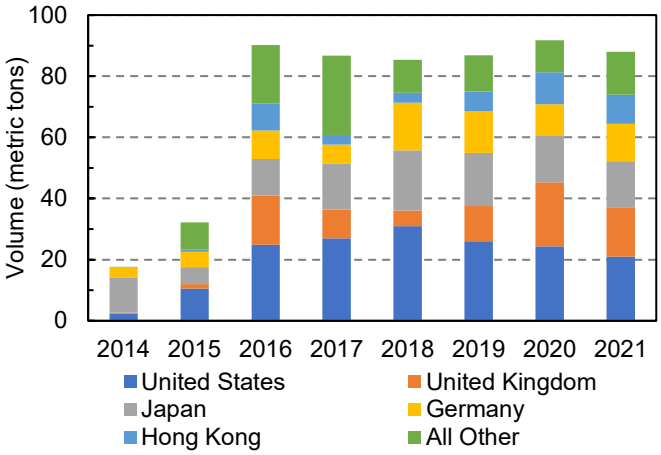
Figure 2: Price of Palladium in dollars per troy ounce, 1970–2021



Source: Compiled based on USGS, "Metal Prices in the United States Through 2010," March 5, 2013; USGS, "Platinum-Group Metals," January 2016; USGS "Platinum-Group Metals," January 2022.
Notes: (A) widespread introduction of catalytic converters U.S. automobile market; (B) shortfall of palladium supplies from Russia; (C) speculation over Russian palladium reserves; (D) occupation of Crimea; (E) COVID-19 pandemic.

Outlook: Palladium prices have continued to climb throughout the Russian war with Ukraine. As of March 2022, no sanctions have been announced on palladium. However, in February 2022 the White House did issue a warning to certain industries, including semiconductor manufacturers, to diversify their supply chains for certain key materials, such as palladium. Even without sanctions, securing supplies from Russia will likely be difficult as palladium is primarily shipped via airfreight and several countries have closed airspace to Russian planes. Reportedly, many western companies are attempting to diversify their supply away from Norilsk Nickel. The full extent of the palladium supply disruption will depend on the overall course of the ongoing conflict.

Figure 3: Russian exports of palladium, 2014–2021



Source: Official exports statistics from Russia under HS heading 7110.21 and 7110.29, as reported by national statistical authorities in the Global Trade Atlas database, accessed March 24, 2022.

Sources: USGS, "Platinum-Group Elements," 2017; USGS, "Fact Sheet 2014–3064," July 25, 2014; USGS, "U.S. Geological Survey Releases 2022," February 22, 2022; Loferski, "Platinum-Group Metals," 2012; Quinio, "Oil Ban Talk," March 7, 2022; MacDonald, "This Russian Metals Giant," March 7, 2022; Touryalai, "A Russian State Secret," October 21, 2010; White, "A Mismanaged Palladium Stockpile," February 6, 2022; Rapoza, "What Russia Means to Palladium Prices," February 3, 2012; Reuters, "Russia Could Hit U.S. chip industry," February 11, 2002; Warwick, "Palladium Spot Price," March 3, 2022.

[5] Some firms secured supplies when prices were high and some, like Ford, incurred billion dollar-level losses.

The Impact of Conflict on the Global Helium Shortage

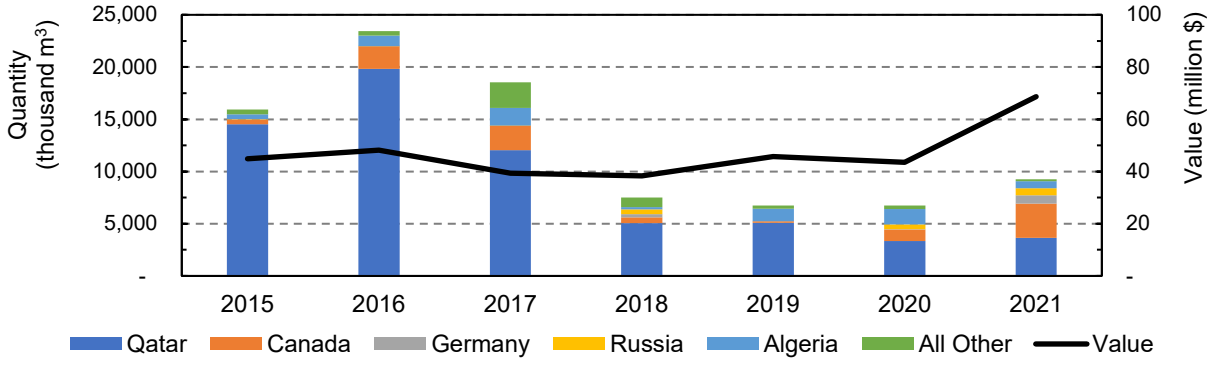
Samantha DeCarlo and Samuel Goodman, Office of Industries

The end of the Federal Helium Program and exit of the United States Government as the major producer of helium has been anticipated for over two decades. The transition to full privatization of the sector has led to changes in production and sourcing both domestically and abroad. Since the 2017 *executive briefing on helium, several events have sent shocks through the global helium market—which is key to the fields of medicine, science, and defense. The most recent event, the 2022 shortage, is a combination of pre-existing market conditions and stress from the Russia-Ukraine War. This executive briefing on trade will provide an update on the helium market, highlight progress on U.S. privatization of helium and the effects of the war as well as a discuss of shortages (past and present).*

Domestic Helium Industry: Since 2017, the U.S. helium industry has continued to evolve. The Bureau of Land Management (BLM) announced on April 16, 2020, that effective September 30, 2021, in accordance with the Helium Stewardship Act of 2013 (HSA), it would no longer manage the Federal Helium System and Federal Helium Reserve (FHR). The General Services Administration took possession of the assets on that date to begin statutory disposal processes. Federal "in-kind" users will have access to helium until September 30, 2022, after which they must seek new sources on the open market.[1]

The U.S. industry continues to be the world's largest producer of helium throughout the privatization process. As of 2022, it maintains reserves of nearly 8.5 billion cubic meters (m^3).[2] In 2021, fifteen U.S. plants extracted helium from natural gas (producing < 50 percent purity crude and 50–99 percent purity helium), two plants produced Grade-A helium (99.997 percent or greater purity), and four plants purified crude helium sourced from private industry or BLM to Grade-A helium. The United States continues to supplement its own production with imports, and the largest source continues to be Qatar, the second-largest producer of helium globally (figure 1).

Figure 1: U.S. imports, quantity, total value, and calculated unit value (2015–21)



Unit Value ($/m³)	2015	2016	2017	2018	2019	2020	2021
	3.08	2.43	3.27	7.56	8.97	13.09	18.85

Source: USITC/Census DataWeb, HTS-10 statistical reporting number 2804.29.0010, accessed March 29, 2021.

[1] "In-kind" rules require federal agencies to buy helium sourced from BLM through private firms. These firms must buy equivalent amounts of crude helium from BLM; the in-kind helium is offered at a reduced rate to the agencies.

[2] Helium is typically sourced from natural gas fields, production is considered profitable when helium concentration levels are greater than or equal to 0.3 percent, but few natural gas fields in the world meet this requirement. Shale sources of natural gas are relatively porous and retain insignificant amounts of helium. Helium is light enough to escape Earth's atmosphere, meaning any gas capable of reaching the surface is irreplaceably lost to space.

Helium Shortages: There have been four notable global helium shortages in the past twenty years, including two since publication of the original briefing (figure 2). The June 2017 blockade of Qatar by Saudi Arabia cut off 30 percent of the global supply, priming the market for the third shortage (i.e., Shortage III), which resulted in a 10–15 percent market deficit. The situation was exacerbated in summer 2019, when a maintenance shutdown of ExxonMobil's helium plant in Wyoming and a maintenance outage at a plant in Algeria temporarily increased the deficit to about 40 percent. During Shortage III, refiners sourcing from BLM were on quota or allocation, and some customers reported receiving less than ordered and longer lead times.[3] Shortage III was ultimately abated by the economy-wide effects of the COVID-19 pandemic in 2020, which led to a dip in demand, bringing relief to the market. That drop also coincided with new helium sources coming online, resulting in a more resilient supply of helium.[4]

Figure 2: Notable Helium Shortages of the 21st century

Source: Compiled by USITC Staff.

Following Shortage III, industry believed it would be the last such event in the near future; however, events in 2021 ultimately led to the start of Shortage IV. The first was a set of unexpected shutdowns at BLM's Crude Helium Enrichment plant in summer 2021 and January 2022. These shutdowns were compounded by fires at Russian natural gas process plants in October 2021 and January 2022, halting helium production at the recently completed Anwar 1 facility. Output is not expected to resume from that source until at least Q3 2022. Unexpected problems for U.S. and Russian production also coincided with scheduled maintenance and downtime in Qatar between February and March 2022. Collectively, helium suppliers resorted to allocating supply to their customers by February 2022 in response to these events.

Outlook: The Russian war in Ukraine has further stressed the helium market. Beyond Russia's position as a global supplier of helium, restrictions on Russian natural gas imports by the EU has altered trade flows and operations in third-party countries. Algeria, for instance, normally compresses and liquifies its natural gas prior to shipping, allowing for helium to be collected at certain sites. However, due to the pressure on the European natural gas market, Algeria has been sending its natural gas straight to the pipeline without intervening liquefaction, preventing the extraction of helium. As the future of international relations remains uncertain, current geopolitical affairs will likely stress the global helium market beyond all that has occurred to date. Scientific researchers, who depend on helium for operating complex instruments, have reportedly already faced difficulty sourcing supplies.[5] Ultimately, a prolonged shortage could have wide-ranging effects across multiple sectors.

Sources: Bettenhausen, "How Helium Shortages Have Changed Science," October 21, 2020; Bettenhausen and Jansen, "The Helium Shortage that Wasn't," March 24, 2022; Reisch, "Help for Helium Users," November 24, 2019; BLM, "BLM Announces Disposal Process," April 16, 2020; Kramer, "Helium Shortage has Ended," June 5, 2020; USGS, "Helium," January 2022; Kornbluth, "Helium Markets Now Experiencing 'Helium Shortage 4.0'," February 8, 2022.

[3] Reportedly, lead times jumped by 30 percent or more. The 2021 estimated price for private industry's Grade-A helium was about $7.57/m^3, with some producers posting surcharges to this price.

[4] Three projects often cited are: Gazprom—Amur 1, 2, 3 (Russia); Irkustsk Oil—Yaraktinsky field (Russia); and RasGas—Helium 3 (Qatar). Amur has been cited as Russia's grab to increase its global share of the market.

[5] Notably, the medical community also uses helium for diagnostic imaging (e.g., by MRI machines).

Russia and Scandium's Scant Scale

Samantha DeCarlo and Samuel Goodman, Office of Industries

Scandium, a rare earth element, is primarily used in aluminum alloying and other specialty applications. This metal is one of the elements listed on the USGS 2022 List of Critical Minerals. The Russia-Ukraine war has the potential to disrupt supplies of this metal. Beyond Russia and Ukraine, only a few other nations are producers of scandium such as China and Kazakhstan. This executive briefing provides information on scandium's uses, sources, market, and trade data to help put this situation into context.

Scandium: Scandium is an input for a variety of niche applications. It is a key alloying material in certain high-performance aluminum alloys. Incorporation of scandium in aluminum alloys improves the mechanical properties of the metal, offering increased corrosion resistance, tensile strength, and the ability to make weldable components. Scandium-aluminum alloys were key materials in the production of advanced aerospace materials in the former USSR, and these alloys are still used in Russian MiG aircrafts today.[1] Outside of specialty markets, scandium-alloyed aluminum is used in the manufacture of certain sporting goods, such as lacrosse sticks.[2]

Extraction and refinement of scandium occurs only as a byproduct of other beneficiation processes and only on a small scale. While classified as a rare earth, scandium is modestly abundant in the Earth's crust (concentration is approximately 22 parts per million [ppm]), and it is the fifth most abundant rare earth element. Substantial reserves of scandium exist across Asia, Africa, Europe, Australia, and the United States, but only a handful of countries have active sourcing operations. Although scandium's concentration is similar to that of copper (~30 ppm), which is extracted globally on a substantial scale, it is not economically viable to solely mine scandium, as it does not generally exist in concentrated ores. Scandium is sourced from a variety of sources, including cobalt, nickel, titanium, uranium, zirconium, and other rare earth production operations. Reportedly, Russia is one of the three largest producers of scandium. As of 2019, the latest year for which foreign mining data is available, Kazakhstan, Russia, and Ukraine were producing scandium (largely as byproduct of uranium operations), and China had at least two firms producing scandium (downstream of iron, rare earth, titanium, and zirconium production).[3] While the United States has mined and refined scandium in the past, and there are reportedly plans to do so again in multiple states, there is presently no capacity in operation.[4]

Market, Russia, and Trade: Global supply and consumption of scandium only amounts to 15–25 metric tons per year, and as the market is niche, it is difficult to gather scandium-specific data. It is not included in any large metal exchange, and the non-public contracts between purchasers and producers make it difficult to estimate current and historic prices.[5] Over the past five years, price estimates for scandium oxide range from $3,000–$5,000 per kilogram, and in 2010, costs reached as high as $7,000 per kilogram. Other scandium compounds (e.g., scandium oxide or scandia) fetch several hundred dollars per gram.

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[1] MiG is an abbreviation for the Russian Aircraft Corporation based on its Soviet predecessor, the Mikoyan and Gurevich Design Bureau. MiG aircraft have been contracted and delivered to countries outside Russia.
[2] Other applications include certain solid oxide fuel cells, light sources, ceramics, and electronic components.
[3] Russia also reportedly maintains a Cold War-era scandium stockpile. Some additional capacity is either operational or in the testing phase in the Philippines (from nickel mining), Greece, Finland, Canada, and Australia.
[4] Scandium has been listed in the USGS 2022 final List of Critical Minerals (87 FR 10381, February 24, 2022).
[5] Since 1999, USGS supplied pricing data for scandium metal and scandium compounds has been based on prices from Alfa-Aesar, a chemical supply company.

Scandium is typically traded as either a pure metal or as a higher purity (greater than 99.9 percent) chemical compound.[6] U.S. imports of scandium metals and alloys enter under 10-digit HTS statistical reporting number 2805.30.4090, and certain scandium containing compounds enter under numbers 2846.90.2015, 2846.90.2082, and 2846.90.8075, but none exclusively cover scandium.[7] A handful of economies have export classification numbers specific to scandium metal and its compounds, including Russia, China, the European Union, Kazakhstan, and Ukraine.[8] Of those, only Russia reported trade for scandium metal from 2017–21, and no national statistical authorities reported trade specific to alloys of scandium in these years. Based on the available data, the United States is the primary (if not the only) market for scandium metal exports from Russia (table 1).

Table 1: Russian exports of scandium and certain scandium containing compounds to the United States, by quantity (kilograms) and value (dollars), 2017–2021

	Scandium Metal (Quantity)	Scandium Metal (Value)	Scandium Metal Exports to U.S., share of total (percent)	Scandium Compounds (Quantity)	Scandium Compounds (Value)
2017	14	199,820	100	5	14,420
2018	54	757,800	100	3	17,131
2019	60	819,000	97	5	32,725
2020	130	1,746,780	100	2	52,840
2021	420	5,557,980	95	7	179,870

Source: Official export statistics from Russia under Russian export classification numbers 2805.30.4000 and 2846.90.3000, as reported by national statistical authorities in the Global Trade Atlas database, accessed April 22, 2022.

Notes: Compounds represents trade of scandium containing salts (e.g., scandium oxide). There was no recorded trade during this period under the scandium-specific export classification numbers for China, Kazakhstan, or Ukraine.

Conflict and Outlook: Based on what can be gleaned from the available trade data, it's possible that the present conflict between Russia and Ukraine will affect scandium metal supplies in the United States.[9] As with other commodities sourced from Russia, the potential for a substantial shortfall for downstream U.S. manufacturers and end-users of scandium becomes more likely as the war continues.[10] Moreover, the war is likely disrupting operations and production in Ukraine, intensifying global supply shortages. However, in the long-term, the potential development of scandium sources in other nations, including proposed U.S. projects, may help offset future supply shocks.

Sources: Benton, "Australian Mines," May 17, 2020; Duyvesteyn and Putnam, "Scandium," May 2014; Emsley, "Unsporting Scandium," November 2014; Kay, "The Scandium Price," June 11, 2018; Lasley, "Scandium," September 2021; Strategic Metal Investments, "Scandium Price," accessed April 14, 2022; USGS, "Scandium," January 2022; Williams-Jones and Vasyukova, "The Economic Geology of Scandium," June 2018; Johnston, "Supply of Critical Minerals," April 19, 2022.

[6] Purity needs wholly depends on the application. For aluminum end-users, a master alloy of two percent scandium in aluminum is produced as an intermediate.

[7] These reporting numbers are unlikely to capture all scandium compounds imports into the U.S.

[8] Exported under 2805.30.4000 (Russia, Turkey), 2805.30.1800 (China), and 2846.90.3000 (all listed).

[9] Unit value calculations based on Russian national export statistics do not match reported information about scandium prices. This situation highlights the ambiguity of the global scandium market, and it is unclear what fraction of global production is represented by Russian exports to the United States

[10] U.S. legislation revoking Russia's most favored nation status may also nominally increase prices, as the U.S. duty rate for scandium metal under HTS 6-digit subheading 2805.30 and scandium compounds under 2846.90 would increase from 5 to 31.3 percent and free to 25 percent ad valorem, respectively.

Russia and Aluminum Supply Chains

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Aluminum is considered a critical material for several U.S. industries and national security. Although Russia is not a major source of U.S. imports of aluminum, the ongoing conflict between Russia and Ukraine appears to be impacting global prices, which does have an impact on U.S. downstream industries. This executive briefing on trade examines Russia's role in aluminum supply chains and how the war may affect prices and downstream consumers.

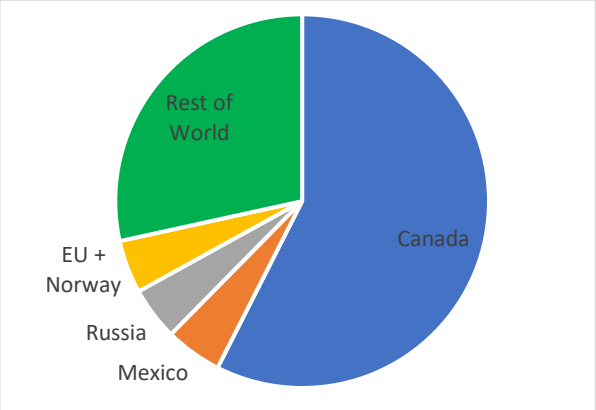
Background: On April 8, 2022, President Biden signed a bill suspending normal trade relations with Russia, in response to the war in Ukraine. Duties on imports of unwrought aluminum from Russia, which were between 0 and 2.6 percent, have increased to between 10.5 and 25.0 percent.[1] In addition, the major Russian aluminum producer Rusal's alleged ties to the Kremlin have created concerns that additional import restrictions may also be imposed on the company's product. The United States is the world's largest aluminum importer. The major U.S. consumers of aluminum are the transportation, packaging, and building sectors that accounted for 35, 23, and 16 percent of consumption, respectively in 2021. Aluminum is also an important input for electrical applications, consumer durables, and machinery, among other uses.

Russia and global aluminum supply chains: According to USGS, Russia was the world's third-largest unwrought aluminum producer in 2021. Russia produced 3.7 million metric tons of unwrought aluminum, accounting for approximately 5.4 percent of global production, as well as several mill products. The European Union is the largest export destination for unwrought aluminum and mill products from Russia, while the United States is the fifth-largest export destination. Rusal is also a major producer of bauxite, which is refined by the company into alumina, the principal raw material for aluminum.

U.S. import sources: While the United States sources the majority of its unwrought aluminum and mill products from Canada and Mexico, Russia is the third-largest supplier. Russia's principal contribution to the U.S. market is primary unwrought aluminum. In 2021, Russia accounted for 5 percent of U.S. imports of unwrought aluminum and mill products by volume (figure 1). Looking at certain mill products separately, Russia accounted for 10 percent of U.S. imports of aluminum wire, and smaller shares of aluminum bars, rods, and profiles, plates, sheet and strip, foil, and pipes and tubes.

European countries are another large source of U.S. imports. The majority of European imports are mill products, some of which have been produced from unwrought aluminum originating in Russia.

Figure 1: U.S. imports of unwrought aluminum and mill products, by source, for 2021, in metric tons.



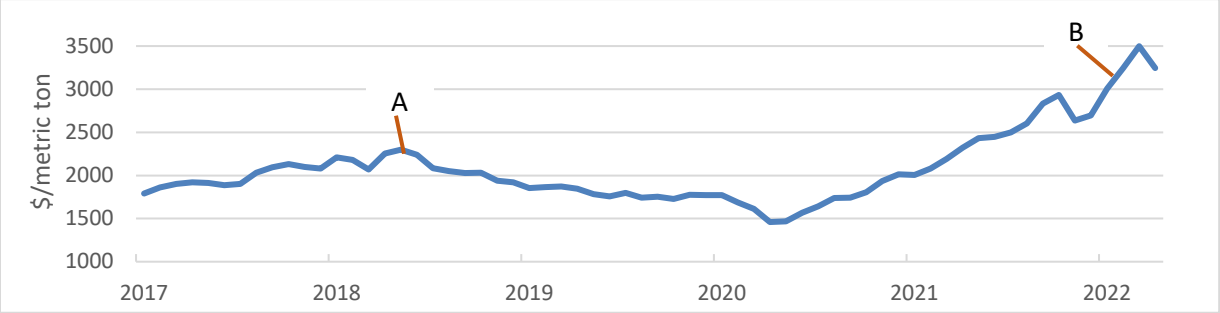
Source: USITC DataWeb/Census, HTS 4-digit subheadings 7601-7609, accessed April 28, 2022.

Impacts on prices: Although the United States does not source a large share of its aluminum imports from Russia, the conflict has contributed to already surging global prices and supply constraints. In the past, similar supply chain disruptions in Russia have impacted U.S. downstream consuming industries. In 2018

[1] Note that unwrought aluminum from Russia and other countries are subject to additional 10% Section 232 tariffs on top of the duty rates described above.

(figure 2, point A), global aluminum prices spiked to a seven-year high, which was partially attributed to U.S. sanctions on Rusal. According to several news sources, those higher prices led to a rise in production costs for downstream consumers. In October 2021, other supply disruptions pushed aluminum prices to their highest levels since 2008 (a record high due to the 2000's commodity boom, not shown in the graph).[2] Then, between January and March of this year, aluminum prices rose by 16 percent from $3,006 to $3,498 per metric ton, which is likely, at least in part, due to the ongoing conflict (point B).

Figure 2: Global aluminum prices, January 2017 – April 2022.



Source: The World Bank Group, Commodity Pricing Data ("The Pink Sheet"), accessed May 13, 2022.
Note: (A) June 2018, one month after the U.S. announced sanctions on Rusal, global aluminum prices rose to a 7-year high. Note that additional section 232 tariffs on U.S. imports of aluminum were imposed three months prior and may also have had an effect on prices. (B) February 2022, Russia's invasion of Ukraine.

Other supply concerns: In addition to rising prices, Russia's aluminum production may also be impacted by supply disruptions, as Rusal has now been cut off from 68 percent of its imported supplies of alumina. Ukraine was the largest source of these imports, accounting for 36 percent in 2021. However, the major Ukrainian alumina refinery has been shut down due to the conflict. Australia was the second largest source of Russian imports of alumina, accounting for 32 percent in 2021. In March, Australia announced it would be banning the export of alumina and bauxite in response to the conflict in Ukraine. Meanwhile, tight supplies and growing demand in other countries, such as China, may make it more difficult for Russia to replace these imports.

Another concern to the aluminum industry and downstream consumers is the European aluminum industry's dependence on natural gas, where already high prices have been exacerbated by Russian threats to cut off supplies. In particular, Germany and Italy are highly dependent on natural gas from Russia. Although they supplied less than 2 percent of U.S. aluminum imports in 2021, these two countries are among the world's top exporters. Thus, energy cost driven production cuts in these countries could further tighten global supplies and drive prices even higher.

Sources: IHS Markit, Global Trade Atlas, HS subheading 2818.20, accessed April 28, 2022; USGS, "Mineral Commodity Summaries 2022: Aluminum," January 2022; Rusal, "Alumina and Bauxites," accessed April 27, 2022; The World Bank, "Commodity Markets Outlook: The Impact of the War in Ukraine," April 2022; Detrixhe, "China's Environmental Goals are Driving Aluminum Prices," August 30, 2021; S&P Global, "Russia's Invasion of Ukraine to Impact Global Aluminum Supply," February 24, 2022; Blanc, "The United States Makes One Smart Move on Russia Sanctions," October 4, 2018; Bavier et. Al., "Russia's Rusal Diverts Ore to Ireland After Ukraine Plant Shuttered," March 15, 2022; Hernandez, "Australia Bans the Export of Aluminum Ores to Russia," March 20, 2022; Soreng and Menon, "China Faces Challenges Supplying Russia with Alumina," March 24, 2022; Grossman, "Russian Supply Concerns Drive Natural-Gas Prices Higher," April 27, 2022; Horton et. Al, "How Reliant is the World on Russia for Oil and Gas?" April 28, 2022.

[2] High energy costs, and production curtailments in China last year and Europe this year, among other disruptions, have decreased the global supply of aluminum at a time when demand has been very high following the initial COVID-19 pandemic recovery.

A Tempest in the Oil Vat: Shocks to the Global Vegetable Oil Markets

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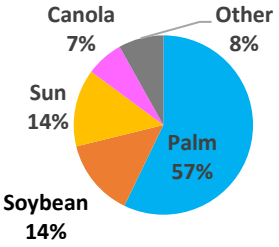
A series of events have impacted the global supply of vegetable oils during 2021 and 2022, which have resulted in historically high prices for these oils. According to the Food and Agricultural Organization (FAO), this has been a major contributor to rising global food prices. Exports of major vegetable oils in several key exporting countries have been impacted by events (including drought in Canada, Argentina, Brazil, Russia's war on Ukraine, and Indonesian and Russian government policies that may restrict exports) that contributed to the increase in prices. It appears that, near term, vegetable oil markets will continue to be impacted by these events.

Vegetable oils

Vegetable oils, which are primarily used as cooking oils or ingredients in both food and non-food applications (e.g., cosmetics), can be derived from a range of plants. Among the most consumed of these are those extracted from oilseeds, such as soybeans, rapeseed, and sunflower, as well as oil palm and olive trees. Most oils go through an initial processing stage (for oilseeds this is commonly referred to as crushing) to extract the crude oil from the seed or fruit. Further processing produces refined oils and their fractions, which are sold for consumption. Oils have different characteristics (e.g., flavors and smoke points) that can impact their uses. However, the major vegetable oils (those with the highest production and trade) —palm oil, soybean oil, sunflower seed oil (sun oil) and rapeseed oil (i.e., canola oil) —are broadly substitutable in many applications (figure 1).

Figure 1: Global Vegetable Oil Exports, by type



Source: USDA, PSD Online: Oils (all) MY 2018/19-2020/21, accessed April 25, 2022

Major Global Suppliers

While all countries consume vegetable oils, exports–of both oils and the upstream oil stock– of the most consumed oils are heavily concentrated in a few countries. (In nearly all cases, exporters are also the largest producers of the oil.[1]) The two largest exporters by oil type are, as follows: Indonesia and Malaysia account for 55% and 34% of global palm oil exports, respectively; Argentina and Brazil, 46% and 10% of soy oil; Ukraine and Russia, 50% and 27% of sun oil; and Canada and Russia, 57% and 11% of canola oil.[2]

Prices Soar in Response to Supply Shocks

Global vegetable oil prices have skyrocketed during 2021 and into 2022 (table 1). In March 2022, the FAO vegetable oil price index reached an all-time high. Mintec (a market research firm) estimated prices to be up 72% for canola oil, 61% for palm oil, 44% for sun oil, and 41% for soybean oil year-on-year (as of March 30). Prices have risen because of a number of events impacting tradable supply (some occurring after March), that have taken place in some of the largest exporting countries as laid out below:

Table 1: FAO Annual Vegetable Oil Price Index, 2014-16=100

Year	Oils Price Index
2020	99.4
2021	164.9
2022	212.1

Source: FAO, Price Indices for Oilseeds, accessed May 26, 2022

[1] China is the world's largest soybean oil producer (28%), but its exports are small (about 1%). China's soybean oil production is dependent on imports of soybeans, especially from Brazil and the United States.

[2] Unless otherwise noted data are based on an average of 2018/19–2020/22 from PSD Online. These data are not comprehensive, but include all major edible oils plus palm kernel, olive, cottonseed, peanut, and coconut oils.

Canola and Soybean Oils: Both soybeans and rapeseed have been impacted by drought during 2021–22. A 2021 drought in western Canada reduced the country's canola harvest from the previous year by almost 36% (soybean were also down about 1%). In November 2021, a severe drought began damaging crops in Argentina and southern Brazil, reducing the estimated soybean harvest in those locations.[3] Argentina expects to see one of its smallest harvests in a decade, although the impact on Brazil is expected to be relatively minor as the drought was concentrated in the southern states. These actual and anticipated production shortfalls have contributed to increased oil (and oilseed) prices. While drought conditions appear to have eased somewhat by April 2022, conditions are still drier than average. Of note, climate change is increasing weather events such as droughts. While some in industry are taking steps to adjust production practices in response to changing conditions, these events could impact future production.

Sun Oil: On February 25, 2022, Russia attacked Ukraine and as of May its war was ongoing. As a result, sun oil exports have been greatly disrupted. Ukraine has suspended crushing operations as well as operations at ports. USDA estimates that Ukraine's exports of sun oil will be 18% lower in 2021/22 compared to average exports of the previous three years. It estimates Russia's exports would only decline about 1%. There is a great deal of uncertainty surrounding the supply of sun oil in the near term. On May 4th, Russia announced it was increasing its sun oil export duty to 41% as of June 1st to try to control domestic prices. This is likely to tighten global vegetable oils supplies. Also, the FAO estimates in 2022 that area planted in Ukraine with sunflower seeds will be 35% lower than in 2021. The inability of Ukrainian farmers to plant may have an impact on world vegetable oil trade and prices in 2022 and into 2023.

Palm Oil: Since the start of 2022, Indonesia has started enacting policies that reduce its exportable supply of palm oil, the world's most consumed edible oil. In January 2022, the government began requiring palm oil exporters to obtain export approval and it established the Domestic Market Obligation (DMO). The DMO initially required exporters to sell 20% of their exportable supply domestically, but this was raised to 30% in March. On April 28th Indonesia enacted a ban on palm oil exports that lasted until May 23rd. This ban, which did not include crude palm oil, was aimed at reducing domestic palm oil prices. It was lifted as domestic prices fell although exporters are still subject to the DMO. (Per GTA data, crude palm oil accounted for roughly one-third of palm oil exports during 2016–20, but only 11% during 2021.) The Indonesian government's policies seek to ensure a reasonably priced domestic supply of palm oil. However, palm oil trade is economically important in Indonesia. It is one of the country's top two exports, and according to the United Nations contributed to 4.5% of GDP in 2019. Overall, it is unclear how much palm oil Indonesia will export going forward. Press reports make it clear that such changes in government policies are expected to influence global oil markets because of Indonesia's importance as the largest producer and exporter of palm oil.

Conclusion

Vegetable oil prices seem likely to remain relatively high (near term), although markets have reportedly started to respond to the current conditions (e.g., producers increasing production of oilseed crops and drawing down oilseed stocks and importers diversifying types of oils and suppliers).

Sources: Penn State Extension, "Oils: What's Cooking," 11/4/19; USPTO, CPC Definition, 1/22; Wilson, "Oil Prices Surge," 2/17/22; Statistics Canada, "Production of Principal Field Crops" 12/3/21; Colussi et al. "Soybean Prices Rise," 2/25/22; Baranick, "South America Calling" 3/3/22; Gov. of Canada, Canadian Drought Monitor, accessed 4/26/22; Franz-Warkentin, "Drought Conditions Ease," 2/8/22; Agricensus, Indonesia to Ban Exports, April 22, 2022; Farm Policy News, Indonesia Bans Palm Oil Export, 4/23/22; Reuters, Indonesia's Palm Oil Export Ban, 4/25/22; Reuters, Crude Palm Oil Excluded, 4/25/22; UNDP, Indonesia, 5/8/19; S&P, GTA database, accessed 4/26/22; USDA: PSD Online: Oil (all), accessed 4/25/22; Oilseeds: World Markets, Mar.& Apr. 2022; Oilseeds Update (Argentina), 2/28/22; Oilseeds Annual (Indonesia), 3/23/22; USDA, FAS, Oilseeds Update (Indonesia), 1/31/22; Action Plan for Climate Adaption, 8/21; FAO: Price Indices for Oilseeds, accessed 4/26/22; Global Food Prices Rise, 3/2/22; Food Price Index, accessed 4/26/22; Ukraine, 3/25/22; AgriCensus, "Russian June Duty on Sunoil Jumps," 5/4/22; Christina and Nangoy, "Indonesia Policy Uncertainty," 5/23/22.