ATTACHMENT 1

USGS
science for a changing world

USGS Mineral Resources Program

Copper—A Metal for the Ages

As part of a broad mission to conduct research and provide information on nonfuel mineral resources, the U.S. Geological Survey (USGS) supports science to understand

- *How and where copper resources form and concentrate in the Earth's crust*
- *How copper resources interact with the environment to affect human and ecosystem health*
- *How trends in supply of and demand for copper vary in the domestic and international markets*
- *Where future copper resources might be found*

Why is this important? Read on to learn about copper and the important role it plays in the national economy, national security, and the lives of Americans every day.

Copper was one of the first metals ever extracted and used by humans, and it has made vital contributions to sustaining and improving society since the dawn of civilization. Copper was first used in coins and ornaments starting about 8000 B.C., and at about 5500 B.C., copper tools helped civilization emerge from the Stone Age. The discovery that copper alloyed with tin produces bronze marked the beginning of the Bronze Age at about 3000 B.C.

Copper is easily stretched, molded, and shaped; is resistant to corrosion; and conducts heat and electricity efficiently. As a result, copper was important to early humans and continues to be a material of choice for a variety of domestic, industrial, and high-technology applications today.

How Do We Use Copper?

Presently, copper is used in building construction, power generation and transmission, electronic product manufacturing, and the production of industrial machinery and transportation vehicles. Copper wiring and plumbing are integral to the appliances, heating and cooling systems, and telecommunications links used every day in homes and businesses. Copper is an essential component in the motors, wiring, radiators, connectors, brakes, and bearings used in cars and trucks. The average car contains 1.5 kilometers (0.9 mile) of copper wire, and the total amount of copper ranges from 20 kilograms (44 pounds) in small cars to 45 kilograms (99 pounds) in luxury and hybrid vehicles.

As in ancient times, copper remains a component of coinage used in many countries, but many new uses have been identified. One of copper's more recent applications includes its use in frequently touched surfaces (such as brass doorknobs), where copper's antimicrobial properties reduce the transfer of germs and disease. Semiconductor manufacturers have also begun using copper for circuitry in silicon chips, which enables microprocessors to operate faster and use less energy. Copper rotors have also recently been found to increase the efficiency of electric motors, which are a major consumer of electric power.

The excellent alloying properties of copper have made it invaluable when combined with other metals, such as zinc (to form brass), tin (to form bronze), or nickel. These alloys have desirable characteristics and, depending on their composition, are developed for highly specialized applications. For example, copper-nickel alloy is applied to the hulls of ships because it does not corrode in seawater and reduces the adhesion of marine life, such as barnacles, thereby reducing drag and increasing fuel efficiency. Brass is more malleable and has better acoustic properties than pure copper or zinc; consequently, it is used in a variety of musical instruments, including trumpets, trombones, bells, and cymbals.

Where Does Copper Come From?

Copper occurs in many forms, but the circumstances that control how, when, and where it is deposited are highly variable. As a result, copper occurs in many different minerals. Chalcopyrite is the most abundant and economically significant of the copper minerals.

Research designed to better understand the geologic processes that produce mineral deposits, including copper deposits, is an important component of the USGS Mineral Resources Program. Copper deposits are broadly classified on the basis of how the deposits formed. Porphyry copper deposits, which are associated with igneous intrusions, yield about two-thirds of the world's copper and are therefore the world's most important type of copper deposit. Large copper deposits of this type are found in mountainous regions of western North and South America.

Another important type of copper deposit—the type contained in sedimentary rocks—accounts for approximately one-fourth of the world's identified copper resources. These deposits occur in such areas as the central African copper belt and the Zechstein basin of Eastern Europe.

Individual copper deposits may contain hundreds of millions of tons of copper-bearing rock and commonly are developed by using open-pit mining methods. Mining operations, which usually follow ore discovery by many years, often last for decades. Although many historic mining operations were not required to conduct their mining activities in ways that would reduce their impact on the environment, current Federal and State regulations do require that mining operations use environmentally sound practices to minimize the effects of mineral development on human and ecosystem health.

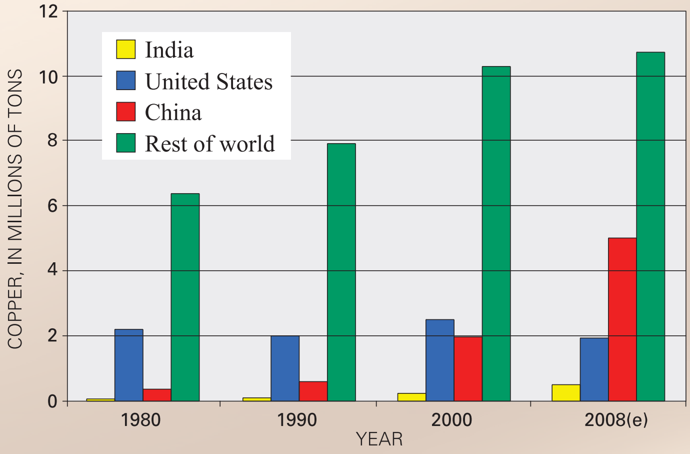
USGS mineral environmental research helps characterize the natural and human interactions between copper deposits and the surrounding aquatic and terrestrial ecosystems. Research helps define the natural baseline conditions before mining begins and after mine closure. USGS scientists are investigating climatic, geologic, and hydrologic variables to better understand the resource-environment interactions.

Visible from space, the Bingham Canyon copper mine in Utah has produced more than 12 million tons of porphyry copper. The mine is more than 4 kilometers (2.5 miles) across at the top and 800 meters (0.5 mile) deep and is one of the engineering wonders of the world. Photograph by C.G. Cunningham, USGS.

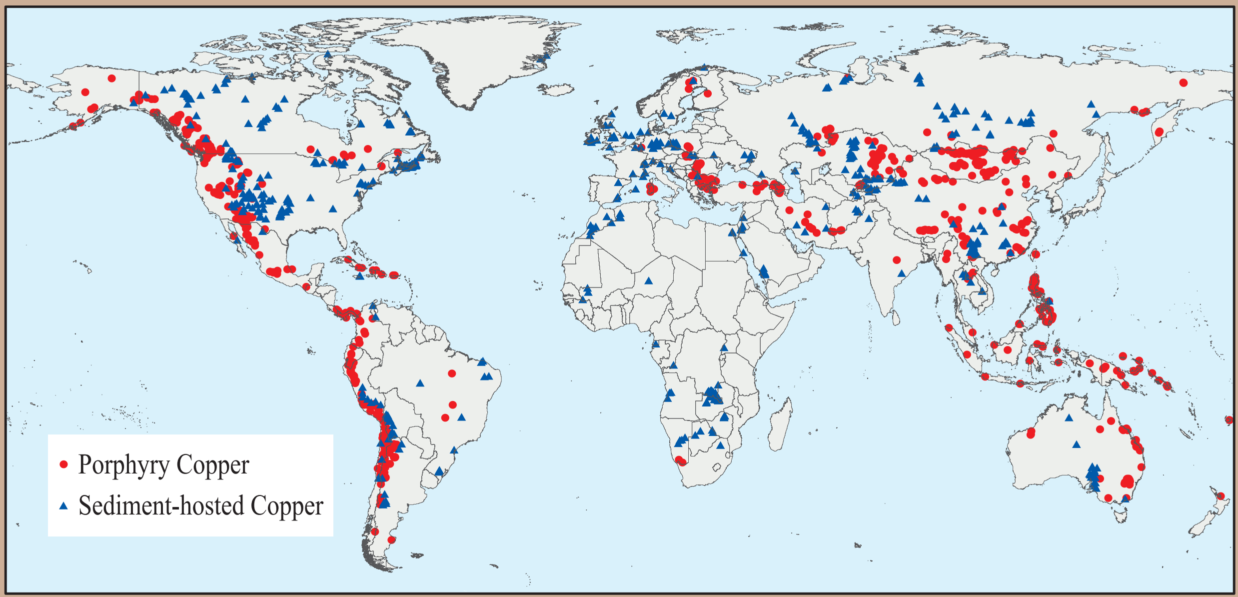
Did you know?... ***At least 160 copper-bearing minerals have been identified in nature; some of the more familiar minerals are chalcopyrite, malachite, azurite, and turquoise***

Copper consumption changes from 1980 through 2008 for India, the United States, China, and the rest of the world

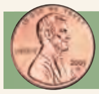
The qualities of copper that have made it the material of choice for a variety of domestic, industrial, and high-technology applications have resulted in a steady rise in global copper consumption. USGS studies of copper consumption show some interesting trends for the 1980 to 2008 time period. Copper consumption in emerging economies, such as China and India, rose considerably, whereas the consumption rate in industrialized economies, such as the United States, fell slightly. Until 2002, the United States was the leading copper consumer and annually used about 16 percent of total world refined copper (about 2.4 million tons). In 2002, the United States was overtaken by China as the world's leading user of refined copper. The booming economy in China contributed to a tripling of its annual refined copper consumption during the 8 years from 1999 to 2007. Data for 2008 are estimates (e) based on data for three-quarters of the year.



Did you know?... ***The United States was the world's largest copper producer until 2000; beginning in 2000, Chile became the world's leading copper producer***



Distribution of known copper deposits in 2008. Red indicates copper associated with igneous intrusions (porphyry copper deposits) and blue indicates copper contained in sedimentary rocks (sediment-hosted copper deposits).

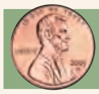

Did you know?... Before 1982, the U.S. penny was made entirely of copper; since 1982, the U.S. penny has been only coated with copper

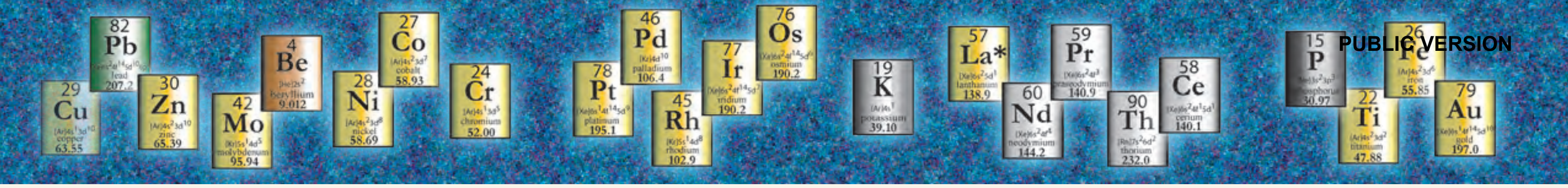
Worldwide Supply of and Demand for Copper

The world's production (supply) and consumption (demand) of copper have increased dramatically in the past 25 years. As large developing countries have entered the global market, demand for mineral commodities, including copper, has increased. In the past 20 years, the Andean region of South America has emerged as the world's most productive copper region. In 2007, about 45 percent of the world's copper was produced from the Andes Mountains; the United States produced 8 percent. Virtually all copper produced in the United States comes from, in decreasing order of production, Arizona, Utah, New Mexico, Nevada, or Montana.

The risk of disruption to the global copper supply is considered to be low because copper production is globally dispersed and is not limited to a single country or region. Because of its importance in construction and power transmission, however, the impact of any copper supply disruption would be high.

Copper is one of the most widely recycled of all metals; approximately one-third of all copper consumed worldwide is recycled. Recycled copper and its alloys can be remelted and used directly or further reprocessed to refined copper without losing any of the metal's chemical or physical properties.


Did you know?... Copper is one of the few metals that occur in nature in native form. Because of this, it was one of the first metals used by ancient peoples and it continues to be an important metal today



How Do We Ensure Adequate Supplies of Copper for the Future?

To help predict where *future* copper resources might be located, USGS scientists study how and where *known* copper resources are concentrated in the Earth's crust and use that knowledge to assess the potential for undiscovered copper resources. Techniques to assess mineral resource potential have been developed and refined by the USGS to support the stewardship of Federal lands and to better evaluate mineral resource availability in a global context.

In the 1990s, the USGS conducted an assessment of U.S. copper resources and concluded that nearly as much copper remained to be found as had already been discovered. Specifically, the USGS found that about 350 million tons of copper had been discovered and estimated that about 290 million tons of copper remained undiscovered in the United States.

Building on the success of the U.S. national mineral resource assessment, the USGS has undertaken a global copper resource assessment in collaboration with international partners. An assessment of undiscovered porphyry copper resources in the Andes Mountains of South America was recently released; the authors conclude that more copper remains to be found there than has already been discovered. Specifically, about 590 million tons of copper has been discovered and about 750 million tons of copper is estimated to remain as undiscovered porphyry copper deposits.

Mineral resource assessments are dynamic. Because they provide a snapshot that reflects our best understanding of how and where ore is located, the assessments must be updated periodically as better data and concepts are developed. Current research by the USGS involves updating mineral deposit models and mineral environmental models for copper and other important nonfuel commodities and improving the techniques used to assess for concealed mineral resource potential. The results of this research will provide new information to decrease uncertainty in future mineral resource assessments.

Did you know?... ***Every American born in 2008 will use an estimated 595 kilograms (1,309 pounds) of copper in his or her lifetime***

In 1886, the Statue of Liberty represented the largest use of copper in a single structure. To build the statue, about 80 tons of copper sheet was cut and hammered to a thickness of about 2.3 millimeters (3/32 inch), or about that of two U.S. pennies placed together. Photograph courtesy of National Park Service.

For More Information

For more technical information

- On production and consumption of copper:
  http://minerals.usgs.gov/minerals/pubs/commodity/copper/
- On porphyry copper deposit models:
  http://pubs.usgs.gov/of/2008/1321/
- On porphyry copper deposits of the world:
  http://pubs.usgs.gov/of/2008/1155/
- On sediment-hosted copper deposits of the world:
  http://pubs.usgs.gov/of/2003/of03-107/
- On the assessment of undiscovered deposits of gold, silver, copper, lead, and zinc in the United States:
  http://pubs.usgs.gov/circ/c1178/
- On the assessment of porphyry copper deposits in the Andes Mountains of South America:
  http://pubs.usgs.gov/of/2008/1253/

The USGS Mineral Resources Program is the sole Federal provider of research and information on copper and other nonfuel mineral resources.

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http://minerals.usgs.gov/minerals/pubs/commodity/copper/#contacts

Did you know?... ***Copper is necessary for human health; the best sources of dietary copper include seafood, organ meats, whole grains, nuts, raisins, legumes, and chocolate***

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ATTACHMENT 2

USGS critical minerals review

by Steven M. Fortier, Nedal T. Nassar, Warren C. Day, Jane M. Hammarstrom, Robert R. Seal, II, Garth E. Graham and Graham W. Lederer

Issues related to the security of the supply of critical minerals have received increasing attention from the White House, Congress, U.S. government agencies and other interested parties for more than 15 years. More widespread awareness of the importance of critical minerals began in 2008 following the publication of the report *Minerals, Critical Minerals, and the U.S. Economy* (National Research Council, 2008). International news media subsequently highlighted the vulnerability of the rare earth element (REE) supply chain when China threatened to cut off supply to Japan over a territorial dispute in the East China Sea (New York Times, 2010). This event set in motion a chain of responses by the U.S. government, and those of other market economies, to address these concerns. Important steps in the United States included the development of a critical minerals screening methodology, led by the U.S. Geological Survey (USGS). This ongoing collaborative effort with several interagency partners is conducted under the auspices of the Critical Minerals Subcommittee (CMS) of the National Science and Technology Council (NSTC) in the Office of Science and Technology Policy (OSTP) at the White House Executive Office of the President (EOP) (National Science and Technology Council, 2016). This methodology has become steadily more quantitative, with the most recent work focusing on the economic vulnerability component of the model (McCullough and Nassar, 2017; Nassar et al., 2020a; Manley et al., 2022a, 2022b).

The critical mineral screening methodology provided a framework for the development of the first U.S. critical minerals list (Fortier et al. 2018; Federal Register, 2018) as directed by Executive Order (EO) 13817 (Federal Register, 2017). It was also one of the inputs that informed the development of the Federal Strategy for Ensuring the Secure and Reliable Supply of Critical Minerals, mandated by the same order (Federal Strategy, 2019). Much of the language and directives in EO 13817 were incorporated into the Energy Act of 2020 (Energy Act) and codified

Figure 1

Imports of refined copper for the period 2000 through 2022. Data from USGS (2021, 2023) (kt = thousand metric tons).

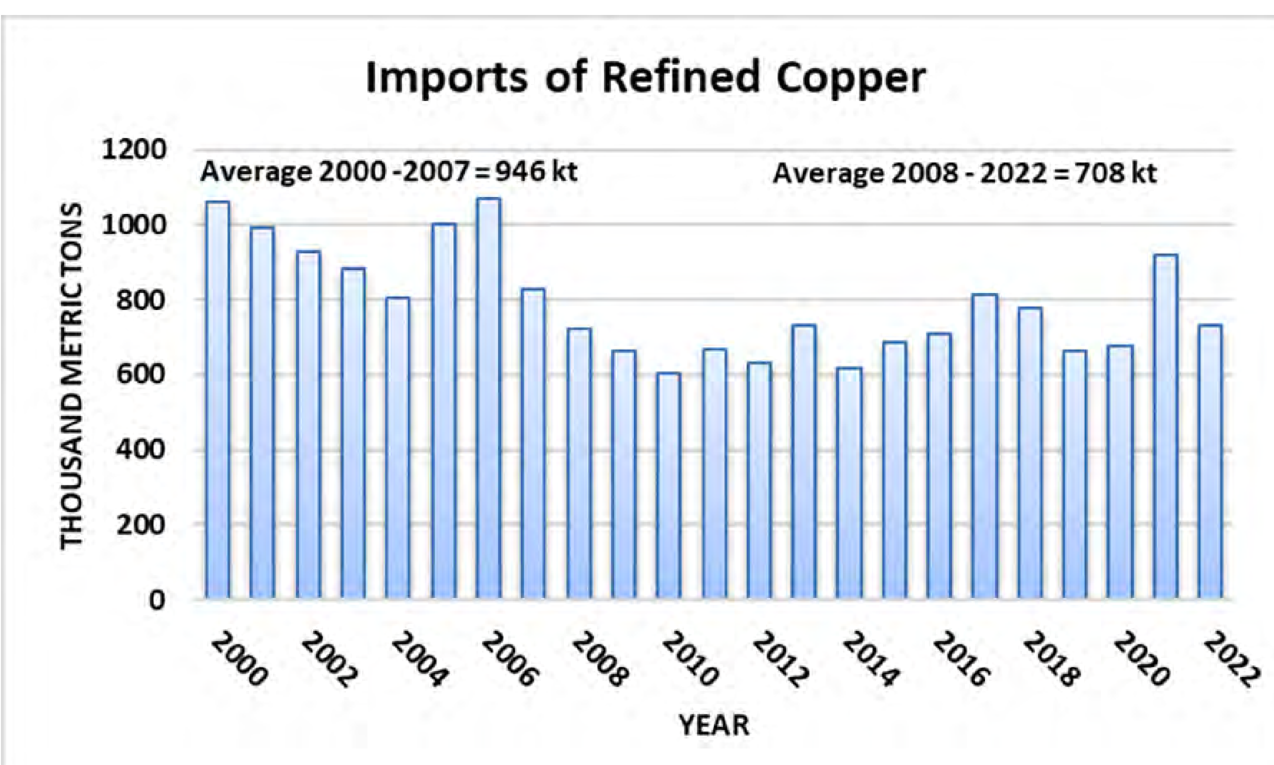
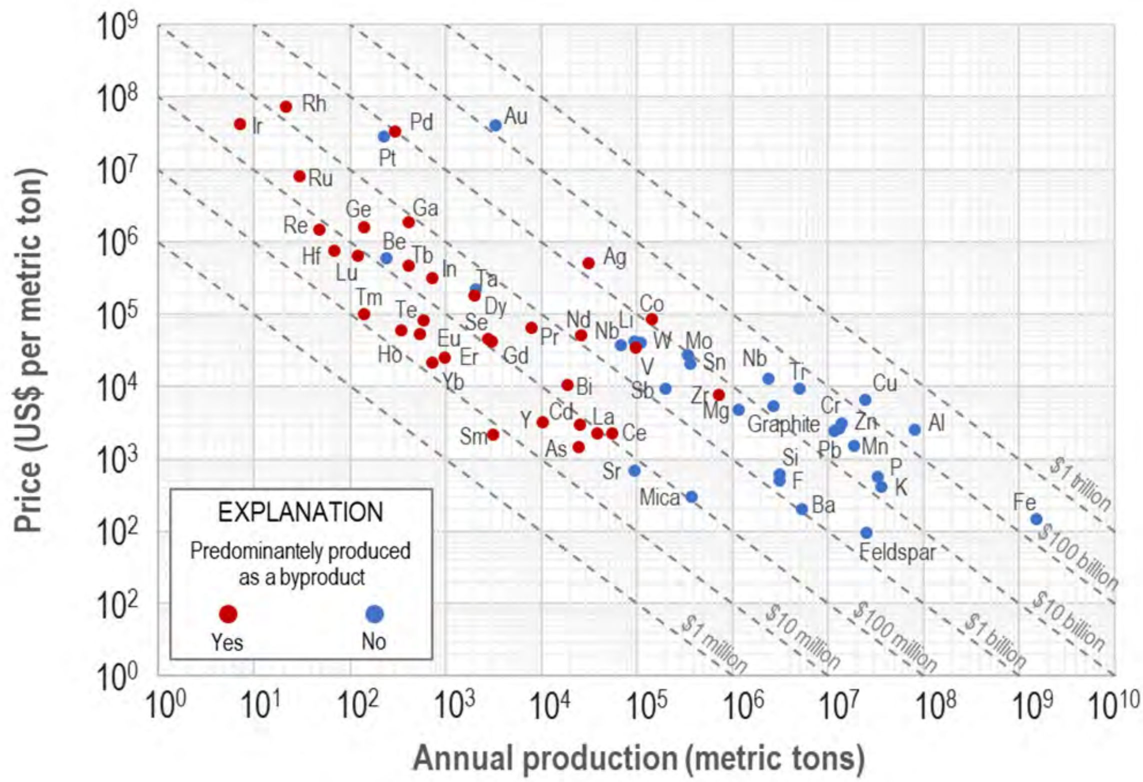


Figure 2

Log-log plot of annual production (in metric tons) versus annual average unit price (in U.S. dollars per metric ton) for 62 mineral commodities (identified by their elemental symbol or common name), circa 2018, based on information from Nassar and Fortier (2021). Diagonal lines represent constant monetary values at different intervals. See Nassar and Fortier (2021) regarding complexity and nuances of designating a critical mineral as a byproduct.



into statute. While the Energy Act directed (and in some cases authorized spending by) executive branch agencies, it did not appropriate funds to implement the objectives of the law. Additional executive orders (EO 13953 and EO 14017) and presidential determinations addressed specific issues relating to authorities and particular materials of interest (for example, rare earths and advanced battery materials). Appropriated funds, both regular and supplemental, have been brought to bear over the past two years, most notably in the Bipartisan Infrastructure Law (BIL) and the Inflation Reduction Act (IRA).

There has been a steady progression from studies to executive actions, followed by legislation, first resulting in authorizations, and most recently, appropriations. Federal appropriations, in the form of awards and loans, are being leveraged by the private sector to establish domestic capacity through mechanisms such as the Defense Production Act Title III program and the Department of Energy Loan Program (Department of Defense, 2020; Department of Energy, 2022).

After years of advancing research and interagency coordination, these new policies and funding opportunities are helping to address supply-chain vulnerabilities, and support numerous geoscience advances in critical minerals, including:

- Updating the whole-of-government list of critical minerals.
- Modernizing the nation's mapping of mineral resources.
- Innovation in serving and interpreting the data.
- Enabling and accelerating new types of mineral resource assessments.
- Quantifying the nation's domestic mineral wealth, both still in the ground and in mine waste.

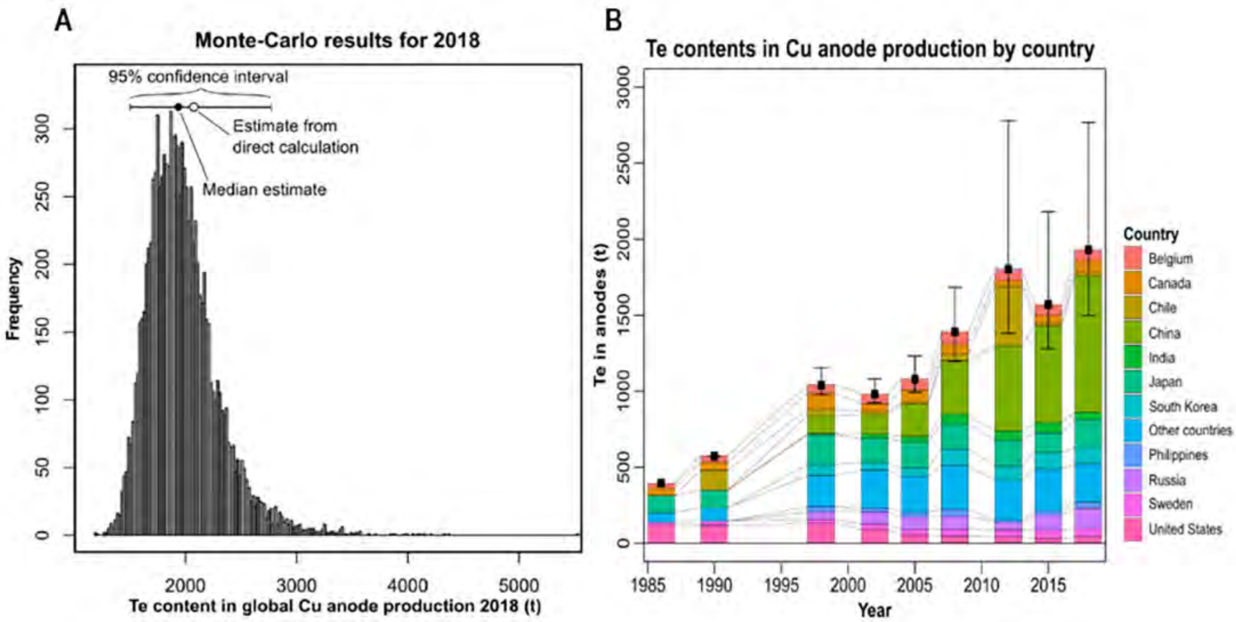
These efforts are directly informing federal strategies that prioritize domestic primary mineral development, domestic secondary mineral development through recycling and reprocessing waste, and strategic trade relationships with reliable partner nations.

U.S. list of critical minerals

For several mineral commodities, current sourcing (including domestic production and reliable trade arrangements) means that they

Figure 3

(A) Monte Carlo results indicating the probability distribution of tellurium contained in global copper anode slimes produced in 2018. (B) Modeled results for tellurium content of copper anode slimes by country and year with uncertainties (Nassar et al., 2022).



do not appear on the list of critical minerals — but their importance to the economy merits developing longer-term scenarios and projections through which to evaluate supply risk. One example is copper. The United States is a major producer of mined copper ores and concentrates, importing relatively small amounts of copper in this form. U.S. copper imports are dominated by refined copper which, after a recent spike in 2021, returned to prepandemic levels in 2022 and, in fact, are significantly lower than they were in the early 21st century (Fig. 1).

Refined copper imports averaged 946 kt/a (1,046 stpy) from 2000 through 2007, before the economic crisis in 2008; over the years since the economic crisis, refined copper imports have averaged only 708 kt/a (780 stpy). Despite the recent pandemic-related spike in imports in 2021, refined copper imports are not high by historical standards. Refined copper imported into the United States is predominantly from three countries: Chile, Mexico and Canada, listed in order of volume (USGS, 2023). All three countries have free-trade agreements with the United States (USTR, 2023) and hence would qualify as domestic content under the requirements of the IRA.

Copper is an essential mineral, not only in its own right but also as a source of several byproduct metals, many of which are on the critical minerals list. USGS is actively engaged in several aspects of the byproduct mineral challenge, such as material flow, mineral resource assessments and waste-product critical mineral potential as described in more detail in the sections below. The domestic copper industry is relatively robust compared to many of the other minerals on the critical minerals list. The United States has 25 mines where copper is recovered or processed, two smelters, two electrolytic refineries, and 14 electrowinning facilities. This domestic output stands in contrast to many other minerals of concern where the United States has virtually no production capacity (USGS, 2023).

The USGS is in the process of reviewing the critical minerals list as part of the normal cycle mandated in the Energy Act of 2020. Any revisions to the list will be the result of careful analysis of the most recent, complete sets of data, followed by peer review of the resulting conclusions, and will be issued through a public review and comment process in the Federal Register.

Byproduct mineral commodities

Many of the mineral commodities that are necessary for low-carbon energy generation and storage and other emerging technologies (for example, 5G wireless networks) are produced mainly or only as byproducts during the processing of other mineral commodities (Nassar et al., 2015). This includes cobalt in lithium-ion batteries for electric vehicles and consumer electronics; gallium, indium, selenium and tellurium, which are used in certain thin-film photovoltaics; and heavy rare earth elements that are used in permanent magnets for wind turbines, vehicle motors, air conditioners and consumer electronics. While some byproduct mineral commodities, such as cobalt, provide substantial value to producers, others like germanium, indium and tellurium provide limited monetary value. On a global scale, these commodities are produced in relatively low quantities (typically on the order of a few hundred to a few thousand metric tons per year), but unlike precious metals that also have low production quantities, their unit prices are not especially high. This is illustrated in Fig. 2, based on data from Nassar and Fortier (2021), which shows an inverse linear relationship on a log-log scatter plot between unit prices and production quantities, with minor mineral commodities generally occupying a lower region of the graph in relation to major mineral commodities and precious metals. Figure 2 also shows that the overall monetary value of their annual production is relatively small.

Examining these monetary values on a global scale may reveal the potential for investment risk. However, private-sector decisions on whether to recover certain byproduct mineral commodities typically consider the economics of individual operations. Consider a hypothetical electrolytic copper refinery that produces 300 kt/a (330,000 stpy) of copper cathode. Based on average reported tank house data, the refinery may have the potential to recover an annual average of 30 t (33 st) of tellurium from the anode slimes, which is where most of the tellurium reports — that is, very little goes to the cathode (Nassar et al., 2022). If the refinery recovered all this tellurium (and no other co- or byproducts), the value of the tellurium based on contemporary prices would represent less than 0.1 percent of the refinery's revenues, with the remaining greater than 99.9 percent coming from copper. Thus, the capital and operating expenses to recover tellurium or another minor mineral commodity may not be justified, especially if it has the potential to impact the production of the main, revenue-generating commodity.

These dynamics help explain why many minor byproduct mineral commodities are limited to a few producers. As a result of both these microeconomic factors, and national-level investments in specific supply chains, global production of these commodities is highly concentrated in a few countries (Nassar et al., 2020b), which increases their risk of supply disruption (Nassar et al., 2020a; Nassar and Fortier, 2021). Lists of "critical" minerals or raw materials are thus often populated with many byproduct mineral commodities (Blengini et al., 2020; Lusty et al., 2022; Nassar and Fortier, 2021).

While production of mineral byproducts is linked (by definition) to those of the host mineral commodity, it is not clear if and by how much that production can be increased without necessarily increasing the production of the host mineral commodities. Although many producers currently do not find the minor byproducts financially attractive, the potential to improve global recovery rates is likely high, but how high is it? In a recent study, Nassar et al. (2022) address that question for tellurium from copper electrolytic refineries. Using the best available data from tank house surveys and a Monte Carlo simulation, they show that, globally, the quantity of tellurium contained in copper anode slimes is roughly four times greater than the quantity that is currently recovered. They also indicate that while China has the largest potential to increase tellurium production, other countries including Canada, Japan, South Korea and the United States also have the potential to increase tellurium supplies. The results are summarized in Fig. 3.

In addition to notable recovery potential from the anode slimes, Nassar et al. (2022) reference previous works (Josephson, 2016; Ojebuoboh, 2008) that show that the vast majority (approximately 90 percent) of tellurium that is contained in the mined copper ores is lost to tailings, resulting in an overall recovery efficiency (from tellurium contained in the mined ores to a high-purity tellurium product) of less than 2 percent. Given the large flows of tellurium to tailings, it may be interesting to consider them as a future supply source. As illustrated in Fig. 4, the concentration of tellurium flowing into the tailings is, however, thought to be very low (0.01 to 0.3 parts per million) (Moats et al., 2021). While historical mine tailings may contain elevated levels of tellurium (Hayes and Ramos, 2019), there are likely numerous mineralogical, technological, social and legal challenges and complexities that may make its recovery difficult. Some of these complexities of recovering critical minerals from waste streams are being addressed by USGS research, as described below. For tellurium, however, the most accessible and likely the most economic source of tellurium from copper production thus remains in copper anode slimes.

Studies on gallium, germanium and indium show similarly large losses of these minor byproduct mineral commodities at different production stages from different sources (Frenzel et al., 2016b; Frenzel et al., 2016a; Frenzel et al., 2017; Licht et al., 2015). Utilizing data from Frenzel et al. (2017), as well as historical production data from the USGS (2021, 2023), Fig. 5 shows that the ratio of gallium-to-bauxite global production (solid line) has been much lower than the ratio of these elements in the ore. The data indicate that there is significant potential to increase gallium's global primary production from bauxite. Indeed, while the gallium-to-bauxite global production ratio has increased by more than an order of magnitude in the last few decades, it still has the potential to be increased by at least another order of magnitude. Frenzel et al. (2017) report similarly high potential to increase germanium supplies. In contrast, while the ratio of indium-to-zinc production is also well below the ratio of these elements in the ore, the potential to increase it further is much lower (perhaps only another two- to three-fold increase is possible) than that of gallium, germanium or tellurium. A quantitative assessment of the potential to increase the primary supply of other minor byproduct mineral commodities would be needed along with a better understanding of the technological and economic barriers to make such increases possible.

Earth MRI update

The USGS launched the Earth Mapping Resources Initiative (Earth MRI) in 2019 to modernize the surface and subsurface mapping of the United States. The Bipartisan Infrastructure Law (Infrastructure Investment and Jobs Act) funding is accelerating Earth MRI with an additional $320 million over five years, focused on identifying areas that may have the potential to contain critical mineral resources — both resources still in the ground and resources in mine waste. Earth MRI is a partnership with state geological surveys, other federal agencies and the private sector. The USGS and state geological surveys conduct geologic and reconnaissance geochemical mapping and produce interpretive reports of newly collected data. Earth MRI is also acquiring large regional airborne magnetic and radiometric surveys and focused electromagnetic surveys, along with lidar data in areas lacking such coverage. The applications of Earth MRI geoscience data and scientific interpretations go well beyond mapping critical mineral resources. The results are also being used to characterize geothermal energy resources, water resources, and to delineate areas prone to landslide, earthquake and flooding hazards.

In 2022, Earth MRI launched the mine-waste inventory and characterization called for in the Bipartisan Infrastructure Law, initiating pilot studies and broader partnering on nonfuel mine-waste materials. Since its inception in 2019, Earth MRI has funded 66 geologic and geochemical mapping projects with state geological surveys and 12 lidar surveys. Cumulatively, Earth MRI has contracted for 27 geophysical surveys, which has almost doubled the amount of high-quality magnetic data for the conterminous United States and quadrupled that for Alaska, covering an area approximately the size of Texas.

In partnership with state geological surveys, the USGS completed efforts to define focus areas for 23 mineral systems throughout the United States that could potentially host mineral deposits containing critical minerals as shown in Fig. 6a. These focus areas provide an initial, broad screening tool for targeting areas for new data acquisition (Dicken et al., 2022; Hammarstrom et al., 2023). The summary map shown in Fig. 6a and accompanying data in Dicken et al. (2022) provide a wealth of information on known deposits and geoscience information for critical mineral resources.

The focus areas are broad areas that contain lithologies that may contain critical minerals. They are used as guides to where more information and mapping are needed to refine the mineral potential for a given critical mineral commodity. An example of the application of focus areas for mafic magmatic mineral systems is shown in Fig. 6b, identifying broad areas within which deposits containing the critical minerals cobalt, nickel, chromium and platinum-group metals are known to occur, or could occur at depth or in places that have not been thoroughly evaluated for these types of mineral deposits.

Recent work in the Kentucky-Illinois fluorspar district and the Hicks Dome ultramafic intrusive complex located in southern Illinois, western Kentucky and southwestern Indiana demonstrates one of the goals for Earth MRI in developing an integrated geoscience data portfolio that facilitates modern geologic framework investigations. These studies are supported through geologic and geochemical investigations, airborne magnetic and radiometric surveys, and lidar data to help understand the regional geologic framework, location of known resources and mining history of this complex mineral district.

Detailed airborne magnetic and radiometric data were identified as critical to delineating the buried geologic and structural setting for the region. USGS geophysicists have led a sustained campaign to acquire modern, detailed airborne magnetic and radiometric data over the iron oxide apatite/iron oxide copper-gold and lead-zinc districts in southeast Missouri as well as the Illinois-Kentucky Fluorspar District, Hicks Dome area and associated mineral districts in southern Illinois, western Kentucky and southwestern Indiana (McCafferty, 2016a, 2016b; McCafferty and Johnson 2019; McCafferty and Brown, 2020; McCafferty and Connell, 2022). In addition, an Earth MRI-funded airborne magnetic and radiometric survey is being flown over a large part of Arkansas and southern Missouri (Fig. 7) that continues to add to our published data, enhancing our understanding of the southern midcontinent. These data and subsequent interpretations are leading to a new understanding of the three-dimensional crustal architecture of this important mineral-rich and seismogenic region (Lawley et al., 2022; McCafferty et al., 2016, 2019; McCafferty, 2022).

Denny et al. (2020) produced a detailed report and 1:50,000-scale map of the Illinois part of the Illinois-Kentucky Fluorspar District and companion detailed geologic map and report of Hicks Dome (Denny et al., 2021). The report includes information on noteworthy mineralization and resource calculations as well as the stratigraphy and geochemistry of the important rock units. Geochemical analyses for these projects, as well as for all Earth MRI projects, are published in periodic data releases (USGS, 2022). These products provide a wealth of information on the geologic setting, past mining and production history, and origin of the ore deposits. In addition to being an important source of fluorspar, lead and zinc, the district hosts the Midwest Permian Ultramafic District, including the Hicks Dome ultramafic igneous and breccia complex.

Lukoczki et al. (2022) of the Kentucky Geological Survey (KGS) recently released a regional geologic map of the Western Kentucky part of the Illinois-Kentucky Fluorspar District. The report and associated geologic map and data provide an in-depth review of mineral and rock specimens and KGS archived files. The work describes 39 probable igneous dikes that may be an economically viable source of REEs identified using a filtered aeromagnetic dataset provided by McCafferty and Brown (2020). These features were incorporated into a 1:50,000-scale geological map for the Western Kentucky Fluorspar District. The geochemistry of the newly identified igneous dikes shows elevated total REE concentrations. The various types of igneous dikes include alnöite, aillikite and rocks in which carbonate alteration predominates. The relatively high REE content in one massive calcite vein (280 ppm) suggests remobilization of REEs and warrants further study of fluid–rock interactions to better understand the mineral system of the Illinois-Kentucky Fluorspar District.

Ongoing efforts are underway by the Illinois State Geological Survey (ISGS) and KGS to integrate the recently published data and reports of the Illinois-Kentucky Fluorspar District and surrounding area. The goal is to better understand the resource potential for several known and suspected important base and critical mineral-bearing deposit types that include REEs, cobalt, barite, fluorspar, beryllium, uranium, strontium, gallium, germanium, indium and titanium. Additionally, the district is prospective for noncritical thorium, lead, zinc, silver, cadmium, and copper. The ISGS and KGS are developing three-dimensional geologic and geochemical models of the area. The modeling effort is a review of published data, integrating subsurface well, structural, geophysical, geochemical, mineralogical and historical mine footprint data to better understand the mineral endowment and regional geology. In addition, the KGS is compiling existing and new data on ultramafic alkaline igneous rocks that intrude the Paleozoic sedimentary strata that are likely to be genetically linked to epithermal fluid mixing associated with mineralization in the district. Furthermore, the KGS is refining the stratigraphic framework and correlation of the Ordovician and Devonian shales in the areas that are permissive for critical mineral accumulations. The goal is to explicitly connect the geologic maps to stratigraphy and to subhorizons that are likely to host REEs and other critical minerals in the shales. USGS scientists are following up with these studies to better understand the origin of ores at Hicks Dome and other similar alkaline igneous complexes (Andersen et al., 2020, 2021; Bennett et al., 2022).

Research on byproduct critical minerals

USGS Mineral Resources Program research on critical minerals continued in 2022 with an emphasis on byproduct critical minerals and mine waste as a potential source. Recent investigations on germanium related to zinc deposits in the Tri-State district including northeastern Oklahoma (White et al., 2022) demonstrated the importance of understanding the behavior of trace elements during the weathering of mine waste and how weathering processes redistribute germanium to secondary minerals formed during weathering. The weathering of sphalerite — the original source of germanium — in the chat piles (a mixture of historical gravity-separated gravel and traditional flotation tailings) produced secondary hemimorphite, a hydrous zinc silicate mineral that was found to sequester a higher concentration of germanium than the original sphalerite. This result highlights the fact that any strategy to reprocess the waste to recover germanium depends on understanding the current distribution of this commodity between the primary and secondary minerals of the waste material.

The Tri-State district project and related studies elsewhere have highlighted the challenges in characterizing the hosts of byproduct critical mineral commodities in ore and mine waste.

These byproduct elements commonly occur in trace minerals, or in trace quantities in more common minerals. In addition, their compositions can display complex zoning, their solid-solution mechanisms may require coupled substitutions with other elements, and many can occur in multiple oxidation states, which adds further complexity to substitutional mechanisms.

These intricacies mean that no single analytical method will yield all required information for ore genesis, ore processing or mine-waste reprocessing studies. Instead, multiple analytical techniques that span the spectrum from traditional techniques to more advanced, cutting-edge methods are needed to yield the desired insights, often in an iterative approach. The USGS has developed a streamlined workflow of mostly nondestructive techniques to understand the occurrence of critical minerals in ores and mine waste (Hayes et al., 2023), as shown in Fig. 8. The workflow, initially developed to better understand germanium in sphalerite, is being more broadly applied to several byproduct critical mineral commodities including cobalt, gallium, indium, nickel, tellurium, tin, tungsten and selenium, in a variety of sulfide and nonsulfide mineral hosts.

The workflow begins with traditional optical microscopy, with both transmitted and reflected light as appropriate. Scanning electron microscopy (SEM) follows, which permits finer detail to be discerned and greater information about compositional variations among mineral grains. Automated mineralogy, using advanced software integrated with SEM in systems, enables automated searches for rare minerals in samples that may host byproduct critical mineral commodities. A cathodoluminescence detector added to an SEM provides rapid, unparalleled qualitative insights into cryptic trace-element zonation in responsive minerals. Electron microprobe analysis (EMPA) — a traditional approach — provides quantitative information about major, minor and trace element compositions. However, laser ablation inductively coupled plasma mass spectrometry may yield better results for some of the critical mineral commodities because their concentrations can commonly extend down to the limits of detection for EMPA. Cutting-edge synchrotron-based techniques, such as in situ X-ray diffraction, X-ray fluorescence mapping and X-ray adsorption spectroscopy, provide unique information, much of which is not available from other techniques. For example, X-ray adsorption spectroscopy can be used to determine the valence (oxidation) state of many elements. As noted above, critical

Figure 4

Log-log plot of estimated annual flows of contained tellurium (horizontal axis) versus tellurium content of those flows (vertical axis) with uncertainties based on data reported by Josephson, 2016; Moats et al., 2021; Nassar et al., 2022 (Cu_2Te = copper telluride).

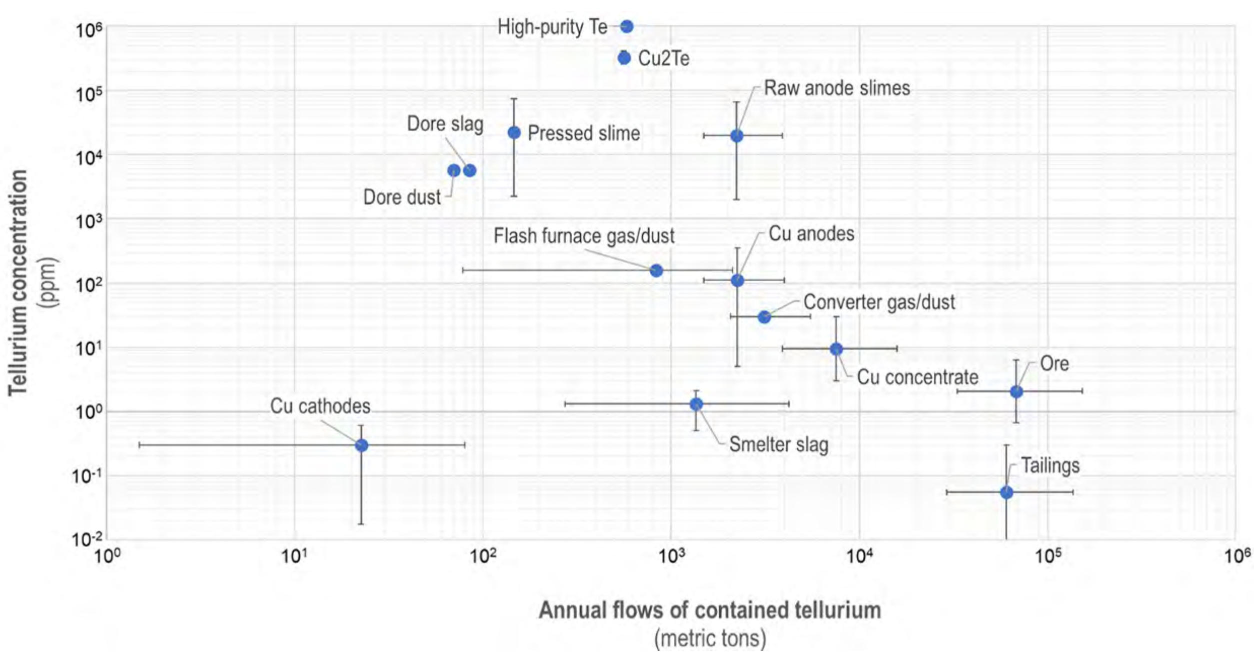
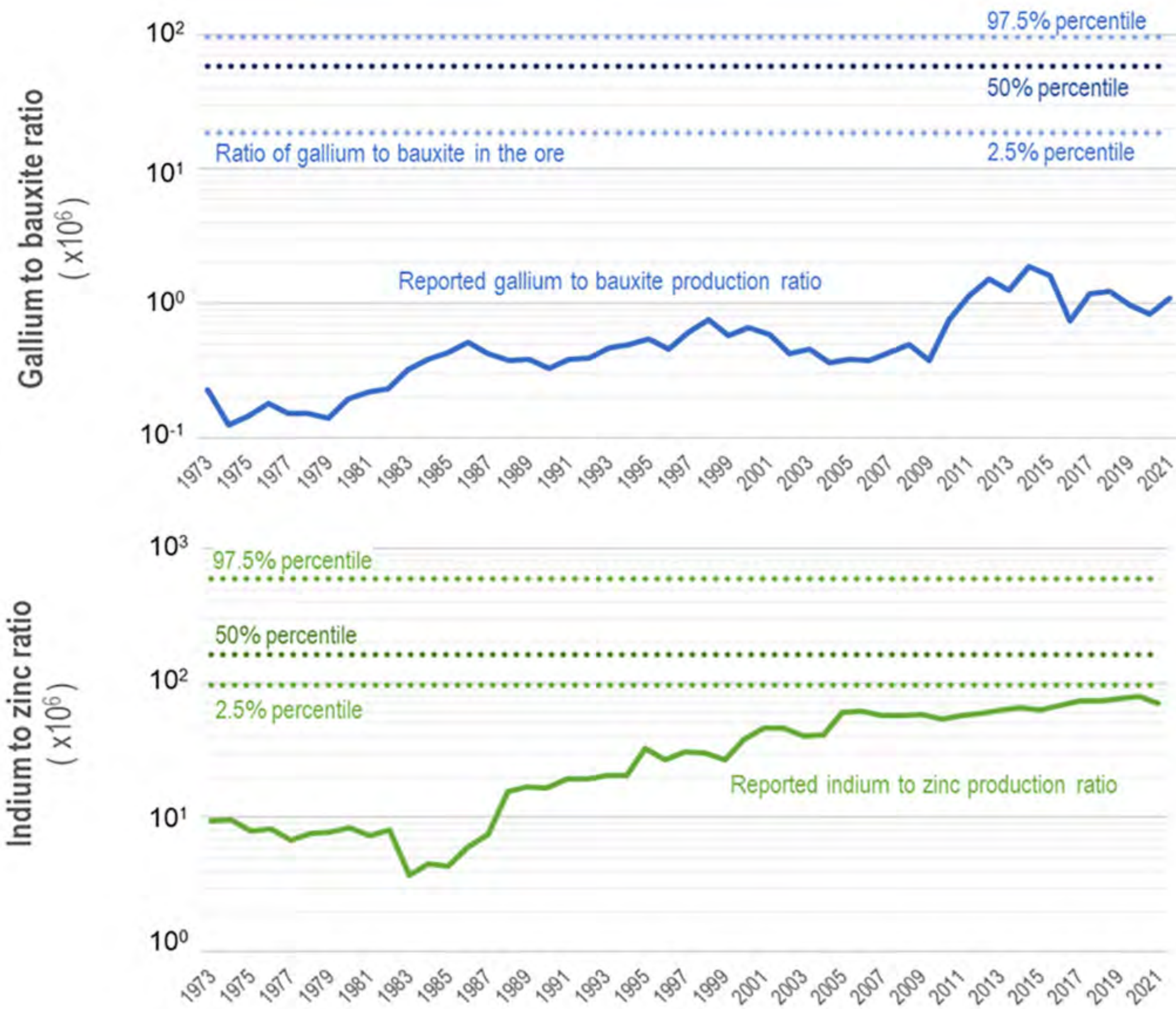


Figure 5

A time-series log plot of gallium-to-bauxite (top) and indium-to-zinc (bottom) production ratio from 1973 to 2021, with estimated dotted lines representing the 2.5 percent, 50 percent and 97.5 percent confidence interval for the ratios of these elements present in ores based on data from Frenzel et al. (2017) and the USGS (2021, 2023).



elements can occur in multiple oxidation states. The oxidation state of a critical mineral commodity influences its source, transport and fate in ore-forming environments, its weathering behavior in the surface environment, and its metallurgical processing.

The USGS has conducted a literature review of the exposure mechanisms and toxic effects of critical mineral commodities relevant to humans and surrounding ecosystems, in part to better inform their environmentally responsible recovery and handling (Jenkins et al., 2023). This initial literature review focused on nutritionally essential critical elements (cobalt, chromium, manganese, nickel and zinc) and the REEs. Improved knowledge of exposure pathways and adverse outcome pathways will lead to more effectively environmental management at mine sites and processing facilities as society seeks to meet its growing demand for critical minerals.

Under the BIL-funded focus on critical mineral potential in aboveground settings, the USGS and state geological surveys are conducting mine-waste characterization studies at sites that may have potential for critical minerals and assist in the development of a national mine-waste inventory. The first year of the program (2022) focused on developing a set of standard operating procedures and analytical methods to ensure that a nationally comparable dataset emerges from this effort. Three states were enlisted to help in this effort: Colorado, Florida and New Mexico. In 2023, the effort plans to expand to additional states with a focus on mill tailings and water sources that represent long-term liabilities, such as draining mine tunnels and large pit lakes, many of which require active treatment. The USGS's USMIN database has more than 5,500 features

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Figure 6a

A map showing focus areas for 23 mineral systems that could host critical mineral resources in the United States and Puerto Rico (Hammarstrom et al., 2023; Dicken et al., 2022). The number of identified focus areas for each mineral system is shown in parentheses.

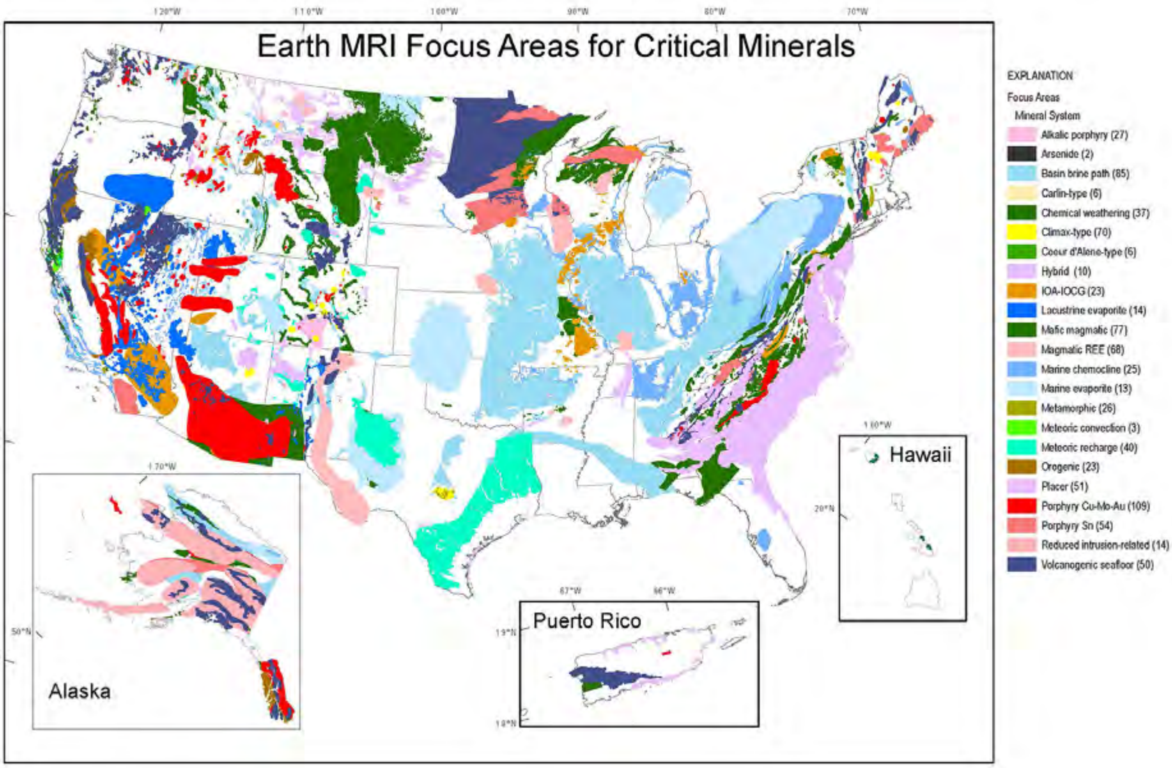
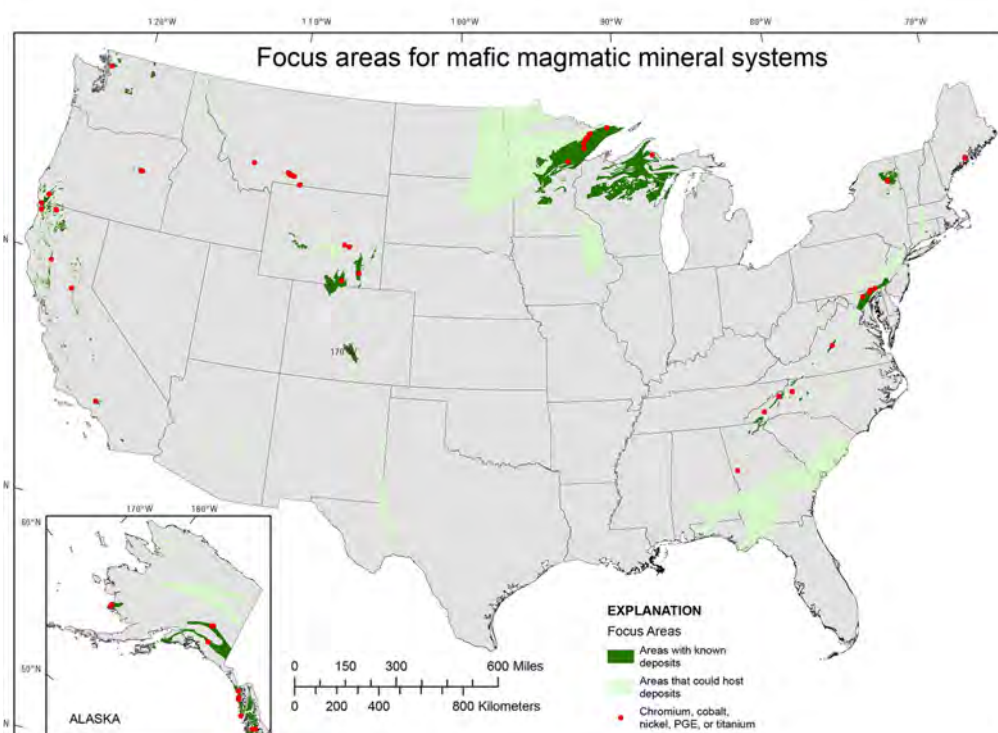


Figure 6b

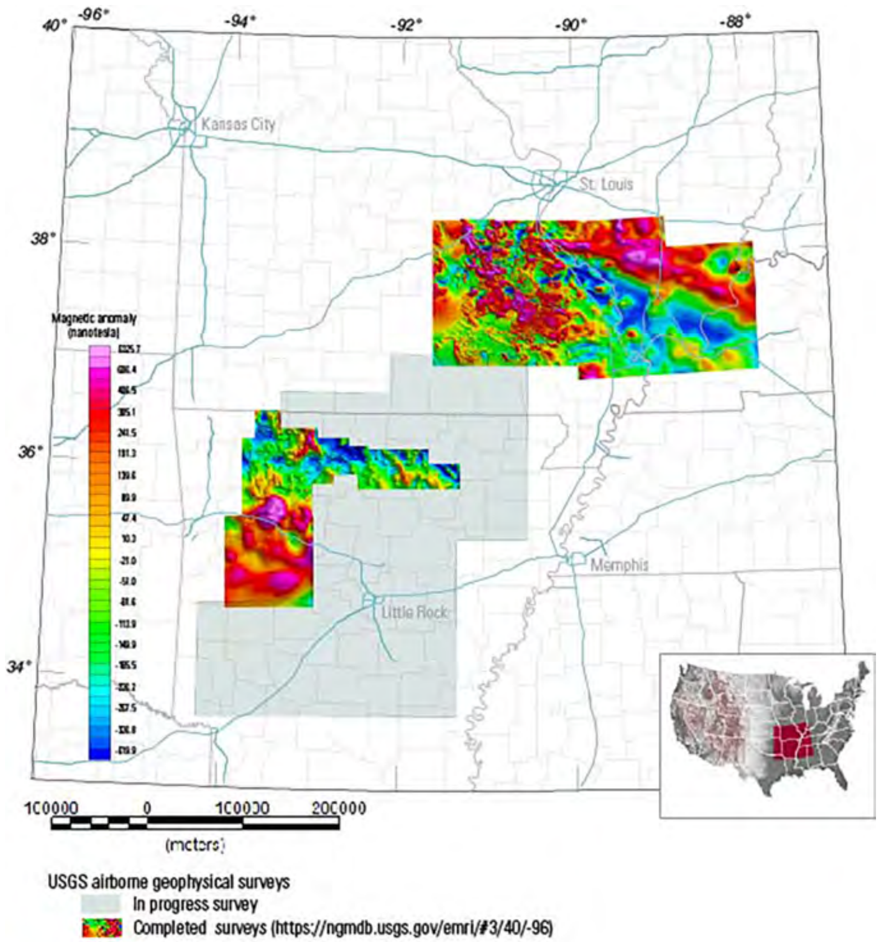
A map showing focus areas for mafic magmatic mineral systems that could host cobalt, nickel, chromium and platinum-group metals in the United States. Focus areas from Dicken et al. (2022). Known deposits shown as red dots.



in the United States identified as mill tailings. The areal footprints of these tailings range from as small as 130 m^2 to almost 23 km^2, as shown in Fig. 9 (Horton and San Juan, 2016). However, 90 percent of the areal extent of these is found in the upper quartile of the identified features, which can help guide site selection for mine-waste characterization projects by the states.

Figure 7

Footprint of USGS airborne magnetic surveys for the southern midcontinent. Areas shown in rainbow colors indicate published datasets, and the area in light gray represents an in-progress survey in spring 2023. All published data are available at Earth MRI (2023).



International collaboration

The USGS maintains active international collaborations that support the identification of options to mitigate strategic and critical mineral resource vulnerabilities in line with recent U.S. governmental policy guidance discussed in the introduction of this paper. The Critical Minerals Mapping Initiative (CMMI) is an ongoing example of such a collaboration with Geoscience Australia and the Geological Survey of Canada. The broad goals of this effort, initiated in 2019, are to advance understanding of critical mineral resources in the three partner countries, Australia, Canada and the United States (Kelley, 2020; Kelley et al., 2021; Emsbo et al., 2021). Through data and expertise sharing, CMMI partners can advance critical minerals science.

A unified Critical Minerals in Ores (CMiO) (Geoscience Australia, 2021) database (for example, Fig. 10) has been built to advance our collective understanding of critical mineral abundances in mineral systems and deposit types using the classification scheme of Hofstra et al. (2021). The CMiO database is being augmented with geochemical results released by the USGS (Granitto et al., 2021) and Geological Survey of Queensland. To fill in data gaps in the CMiO database, the trinational partners are actively seeking contributions from external sources, with a particular focus on obtaining geochemical data on deposits in foreign countries. The goal of this, and future updates to the CMiO global digital database is to progressively build a more holistic view of critical mineral distributions across systems and deposit types in partner nations and elsewhere around the globe.

The CMMI collaboration is also focused on the evaluation of critical mineral prospectivity and assessment methods that (1) combine geological, geophysical and temporal datasets, and (2) incorporate findings from the CMiO database. The primary focus remains on prospectivity modeling for basin-hosted Zn-Pb deposits (Mississippi Valley-type and clastic-dominated Zn-Pb) because these deposits, found in all three partner nations, can host significant concentrations of Zn and other critical minerals, such as Ga, Ge and In. Knowledge-driven modeling efforts and national-scale data layers used in the models are nearly complete for Zn-Pb deposits in siliciclastic-mafic and-carbonate systems (Coyan et al., 2022). Initial phases have begun to develop mappable criteria for Zn-Pb deposits in Mississippi Valley-type systems. This effort expands on the general methodology of Emsbo (2009) and others. Our collaboration has demonstrated empirical spatial associations of these mineral systems with features observed in geophysical and geochemical datasets (McCafferty, 2022). These relationships reduce the exploration search space and highlight areas of high prospectivity for Zn-Pb deposits (Huston et al., 2022). In the future, CMMI anticipates that

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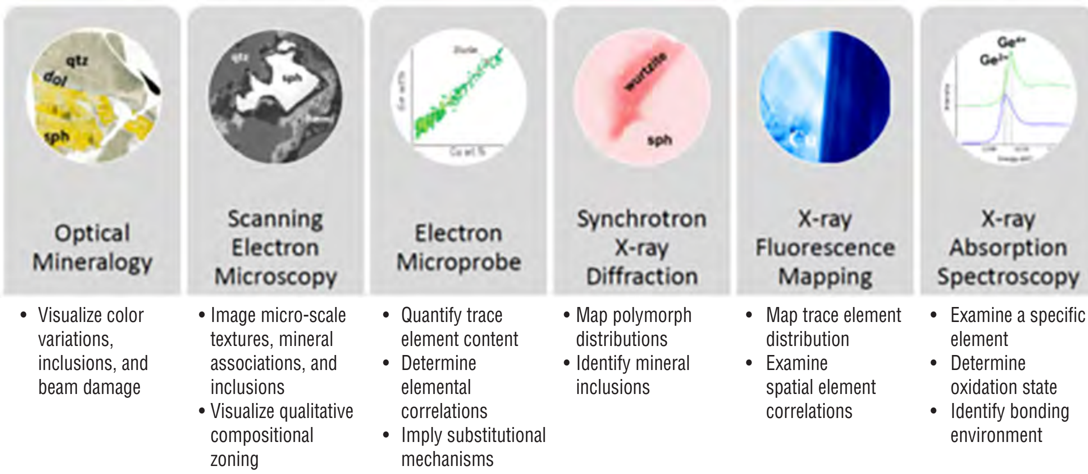
Figure 8

Schematic diagram showing the streamlined workflow to investigate critical mineral hosts in ore and mine-waste samples. Modified from Hayes et al. (2023).



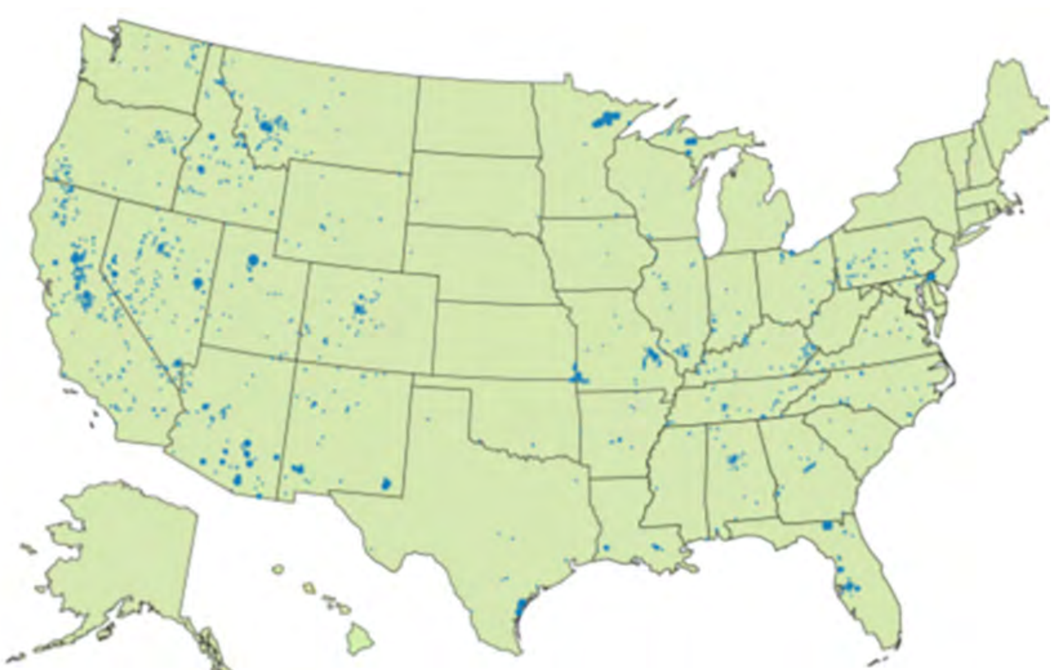
it will develop similar mappable criteria for the spectrum of deposit types that occur in other system types (for example, calc-alkaline porphyry-epithermal and metasomatic iron (oxide) alkali-calcic). Importantly, as CMMI investigations and outcomes continue, the approaches developed can guide ongoing prospectivity and assessments of the critical mineral resource potential in the partner countries.

Mineral resource assessments

The Energy Act of 2020 (Division Z of the Consolidated Appropriations Act of 2021) directs the USGS to accelerate national-scale resource assessments of all minerals on the whole-of-government list of critical minerals. Since the passage of the Energy Act, the USGS has launched initial regional critical mineral resource assessments in addition to partnering toward several methodological advances designed to accelerate the next assessments in the series. The mineral systems approach developed through the CMMI is accelerating the development of assessments by considering multiple minerals.

Figure 9

A map showing the distribution of tailings (blue circles) from the USMIN database (Horton and San Juan, 2016). The size of the blue circles is proportional to the areal footprint of the tailings features.



The new USGS regional assessments serve as the foundation for national assessments as new data and mapping become available through Earth MRI. In addition, the USGS is investing in both research, to update the deposit models that support assessments, and innovations in assessment methodologies. For example, current mineral resource assessment methodologies rely on human expertise and knowledge-driven workflows. Although these methodologies have proven effective, the increasing volumes of available data and the time required to process it present a significant barrier to rapidly conducting mineral resource assessments for the many deposit types that host critical mineral commodities.

The USGS partnered with the Defense Advanced Research Projects Agency (DARPA) to explore opportunities to make mineral resource assessment workflows more efficient and to fulfill its mission to map the distribution of critical mineral commodities (Lederer et al., 2023; DARPA, 2022). Compiling and preparing geoscientific information in a machine-readable and analysis-ready form consumes much of the time needed to conduct assessments. Whereas geochemical and geophysical data exist as structured or semistructured numerical datasets, most geologic maps and descriptive reports of mineralized areas remain in unstructured human-readable formats, thereby constraining their use in data-driven methodologies. This is especially true for nongeoreferenced maps held in historical collections which represent rich sources of input data that, if converted to digital form, could significantly aid in the prediction of the location of undiscovered deposits. Despite the usefulness of digital geologic maps, they are often not available at the requisite scales because it involves digitization of thousands of individual maps. Unlocking the information contained in text and images published in the predigital era could have a transformative impact on the ability to extract and integrate geoscientific information across disciplines.

With the goal of streamlining assessment workflows, a machine-learning competition was formulated that concentrated on two tasks related to processing geologic and mineral resource maps (Fig. 11). The first task focused on automatically identifying the location represented in a map and relating control points to geographic coordinates (that is, georeferencing). The second task utilized annotations in the map explanation or legend to automatically extract the corresponding points, lines and polygons that represent geological features such as mines, faults and lithologic units. Together, automation of these highly manual

Figure 10

Element concentration ranges (Se, Cu, Te, Mo and Re) for U.S. porphyry deposits where at least 10 samples are reported in the initial CMiO database. Total metric tons of ore from Hammarstrom et al. (2019) are also listed. These types of exploratory data can help with estimating tonnages of byproduct commodities relative to copper production. They can also guide research into why different deposits have disparate metal concentrations/ratios. For box plots: dot = average, central line = median).

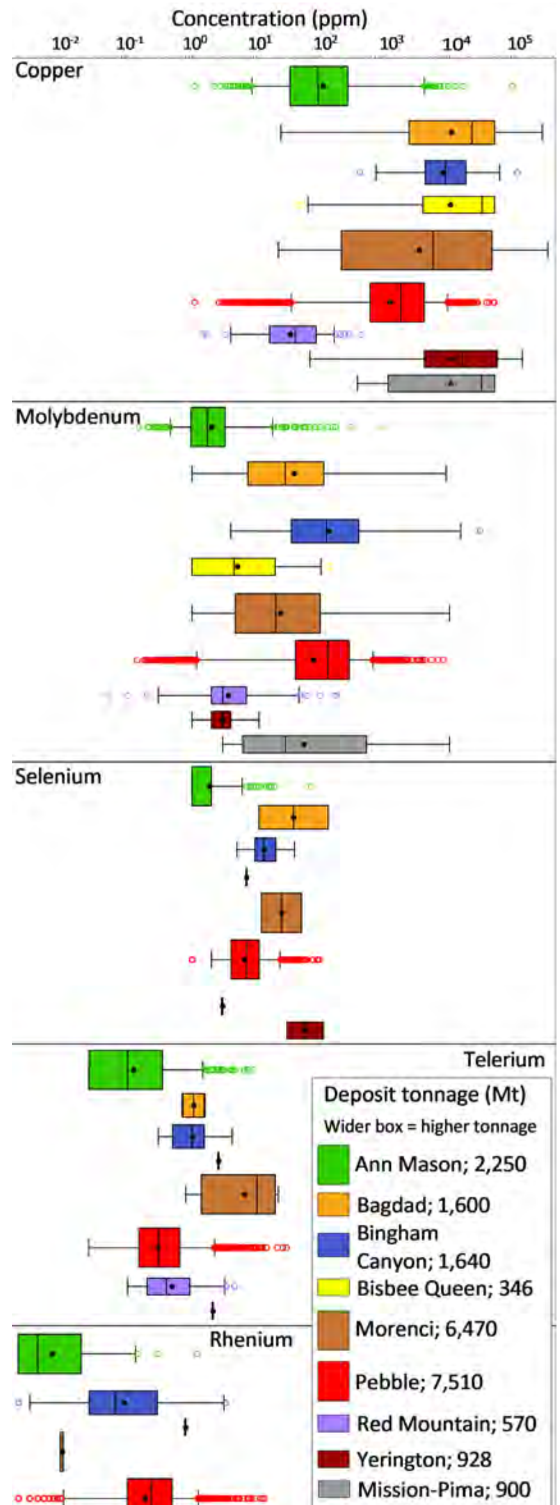


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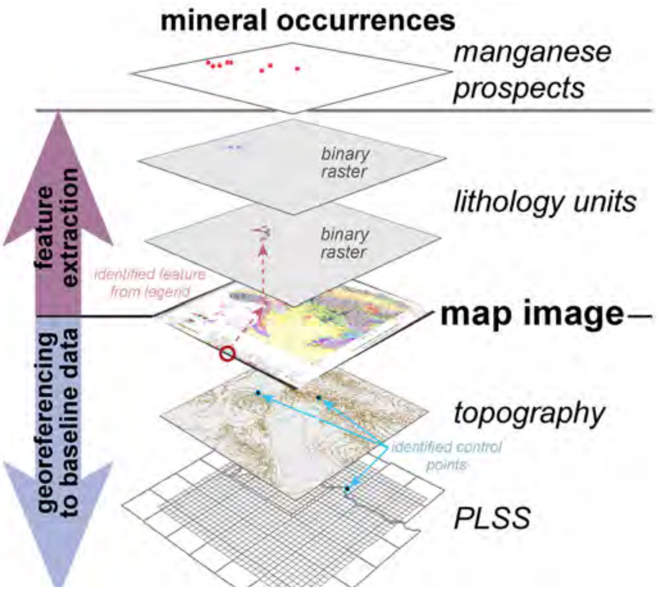
Figure 11

A diagram relating a map to the two DARPA challenges. (PLSS: Public Land Survey System) (Lederer et al., 2023; DARPA, 2022).



workflows can result in significant time and cost savings, prepare map data for use in geographical information systems in a format suitable to analysis, and effectively capture and preserve information currently locked in inaccessible formats.

Concluding remarks

As the United States moves past the lingering effects of the COVID-19 pandemic, the impacts on mineral commodity supply chains are visible in recent publications, particularly on domestic consumption (see Figs. 11 to 13 in USGS, 2023). While some commodities were not significantly impacted, others, including critical minerals such as rare earths and cobalt, saw large decreases in 2020, followed by large increases in 2021 and 2022. The consumption of most commodities now appears to be trending back to prepandemic levels. While the worst effects of the pandemic may be behind us, other large macroeconomic, and geopolitical factors exist. The global energy transition, an industrial revolution-scale transformation (Laurent, 2022), is picking up speed as renewables, energy storage and electric-vehicle adoption continue to accelerate. This transition has been accompanied by a growing recognition that the United States and other market economies may adopt technologies for which the mining and mineral processing stages of the supply chains are largely absent domestically (World Bank, 2017).

The invasion of Ukraine by Russia pressures mineral commodity supply chains (OECD, 2022) in at least two ways. Supply is constrained by economic sanctions on Russia, a major mineral commodity producer, which makes significant volumes of several mineral commodities off-limits to Western nations. Demand is simultaneously increased to supply the military consumption by Russia, Ukraine and supporting nations. In addition, China continues to dominate upstream critical mineral supply-chain nodes for important mineral commodities needed for semiconductors and other advanced technologies. These factors, and others, are likely to keep the security of critical mineral supply chains a highly visible challenge for U.S. policymakers for the foreseeable future. U.S. vulnerabilities to critical mineral supply chains resulting from import reliance, coupled with increasing concentration of production in countries which do not share the values of market economies is an ongoing challenge (Fortier et al., 2015, Nassar et al., 2020b). The USGS continues to play an important role in U.S. government efforts to address critical mineral concerns by providing fact-based, objective mineral information, mineral resource assessments, mapping and surveys, and basic research, in line with the Mineral Resources Program mission. ■

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ATTACHMENT 3

S&P Global

Copper in the US: Opportunities and challenges

Copper mining, recycling and trade in the US

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Copper in the US: Opportunities and challenges

About S&P Global

S&P Global (NYSE: SPGI) provides essential intelligence. We enable governments, businesses and individuals with the right data, expertise and connected technology so that they can make decisions with conviction. From helping our customers assess new investments to guiding them through ESG and energy transition across supply chains, we unlock new opportunities, solve challenges and accelerate progress for the world. We are widely sought after by many of the world's leading organizations to provide credit ratings, benchmarks, analytics and workflow solutions in the global capital, commodity and automotive markets. With every one of our offerings, we help the world's leading organizations plan for tomorrow, today. For more information visit www.spglobal.com.

This study offers an independent and objective assessment of the main ways in which the US can meet its projected copper demand in the coming years. The study was supported by the US Copper Development Association (CDA). The scope of the study was agreed with the CDA, but the association did not provide data or substantive input to the report. S&P Global Market Intelligence is solely responsible for the analysis and conclusions in the report.

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Executive summary

Executive summary

In this report S&P Global Market Intelligence considers the main ways in which the US can source copper, the opportunities it has and the challenges it faces. Ensuring the secure supply of materials for the energy transition has become an important aspect of industrial policy across most major economies. Copper — the “metal of electrification” — is used across all energy transition applications.

Key findings

Import dependence:

- The US is heavily reliant on imports for refined copper. It consumed an average of 1.7 million metric tons (MMt) of refined copper per year during 2019–23, and more than 44% of this was imported, mainly from Latin America. Chile accounts for almost 70% of the US’ refined copper imports. Like Peru (10%), Chile exports the vast majority of its production, but China — not the US — is the largest buyer. Regardless of US free-trade agreements (FTA) with Latin American producers, the US bargaining power is likely less than Chinese.
- Reliance on Latin America is also likely to become a logistical challenge as climate change puts pressure on water levels. Almost 95% of seaborn US refined copper imports arrive in US East Coast and Gulf Coast ports via the Panama Canal. Transit through the Canal has been impeded since last year by low water levels in Gatun Lake (which feeds the Canal’s lock system). Climate change is likely to at least sustain pressure on water levels. In addition to disrupting the Panama Canal, this could intensify civil opposition in Latin America to the industrial use of water. In a scenario under which these pressures led to a 10% reduction in imports, roughly a third of the US’ refined copper consumption would have to be met by either increased domestic production or alternative sources.
- Securing additional imports, however, is not easy. Canada and Mexico, FTA and US-Mexico-Canada Agreement (USMCA) partners, keep most of their refined production for domestic consumption — and the US already accounts for most of their refined copper exports. Japan is the only other major refined copper producer with an FTA with the US but accounted for just 0.24% of US imports. Beyond FTA partners, China accounts for more than two-fifths of global refined copper production — but is a geopolitical rival to the US. The Democratic Republic of Congo (DRC) accounts for 6% of global production but exports most of this to China.

Executive summary (continued)

Long development times:

- This reliance on imports is against a background of a substantial copper endowment. The US has more than 70 MMt of untapped copper reserves and resources that could be developed, in addition to production from already operating mines. This is comparable to the endowment of Canada and Australia combined. It could satisfy more than 20 years of US copper demand, even at the level projected for 2035, once energy transition-related demand peaks.
- Exploiting these reserves, however, would require a substantial increase in new investment. During 2019–23, mines in Canada and Australia — mineral-endowed, advanced economies with comparable environmental standards under federal and state/ provincial systems — received 54% and 47% more in exploration budgets than the US, respectively. This, in turn, is likely owing to the long development times from discovery to production in the US. Several major projects have been stagnated for years, e.g., Pebble and Resolution, which, together, account for more than half of the US endowment. Even optimistically assuming that currently nonoperating mines in the US come online by 2030, mines typically take almost 29 years to begin producing in the US, according to an S&P Global study. This compares with 23 years internationally. Canada is not far behind the US, at 27 years. However, it has received far more in exploration budgets because of lower uncertainty that a project will actually come into production. Post-development litigation risk in the US is likely another obstacle.
- Under a scenario in which the Pebble, Resolution and Santa Cruz copper projects in the US come online this decade and the mined copper from these properties is processed domestically, US reliance on imports for refined copper would fall from 47% in 2023 to a little more than 30% by 2035 — even as energy transition demand accelerates US demand. Additional projects, such as New Range and Twin Metals, among others, would push import reliance even lower by 2035. Import reliance rises to nearly 60% by 2035 in all other scenarios.

Recycling:

- Copper is fully recyclable, but recycling seems an unlikely solution on its own. US copper secondary refined recycling input rates* reached 16% in the mid-1990s but fell to 3% by 2007 and have remained below 6% since. US copper scrap, the “feedstock” of recycling, has been increasingly exported to China, Canada, India and Malaysia. (Even a return to 16% recycling rates would not close the projected shortfall in the US’s energy transition demand.)

* Secondary refined input recycling input rate is defined here by secondary refined production as a share of total refined production. Copper can also be recovered from new scrap derived from fabricating operations.

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Executive summary (continued)

Conclusions

- **The US copper opportunity.** The US has an unusual opportunity to fully secure the supply of a key material of the energy transition. The "metal of electrification" is abundant under US soil. Exploiting that opportunity — in time to achieve net-zero carbon emissions by 2050 — is a historic challenge. The complex permitting requirements involving multiple authorities have led to development times approaching three decades for US mines, and many major projects remain stuck in the process. Reducing development times —while respecting environmental, indigenous and other local concerns — and reducing the uncertainty around permitting and post-permit litigation would likely attract investment, bringing US exploration budgets closer to those in Canada and Australia. The number of projects to focus on is relatively small: 20 projects account for nearly 90% of the US' enormous copper endowment. A focused effort on even just three of the largest projects — Pebble, Resolution and Santa Cruz — would increase US primary production by 70% and by 2035 reduce the US external reliance from 47% to 30%. Other projects, such as New Range and Twin Metals, would decrease import reliance even more. Increasing recycling rates from 5% of refined production in 2023 to the 15% achieved in the mid-1990s would have a positive, compounding effect.
- **Refining.** Since 2000, the number of copper refineries in the US and their total capacity have fallen, even while primary mined production has slightly increased. It is refined copper that the US imports, not copper ore or concentrates. Realizing US copper opportunity requires developing downstream processing capacity so that any increase in primary mining production is not shipped overseas for processing, reinforcing the US' external reliance for refined product. However, increasing ore production by shortening development times could generate incentives for more refining capacity utilization and new capacity in the US to process that ore. The downstream begins at the upstream.
- **"Whole chain" perspective.** The implication is broader than refining. If the US is to realize its copper opportunity, all the auxiliary industries and skills needed to do so must be developed — quickly. Permitting authorities must be able to train and retain experienced staff; geologists and engineers will be needed to develop projects and innovate increasingly efficient, sustainable ways of processing the additional copper ore. A competitive domestic supply chain will need to displace those that currently bring end-use copper products to the US: indeed, these account for more of the total copper imported into the US than the intermediate good of refined copper.
- Nonetheless, the US has an opportunity to secure its supply of the "metal of electrification" for generations to come between mining and refining, recycling and continued trade.

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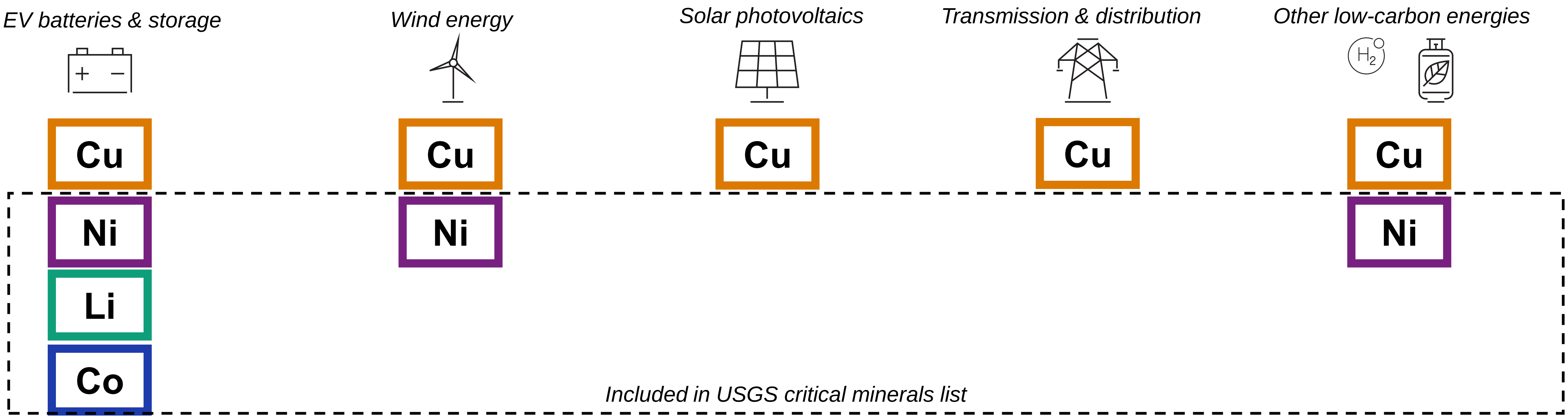
Introduction: Copper in the energy transition

Energy transition and the ‘metal of electrification’

- The accelerating global energy transition is toward applications that harness a range of natural forces to produce electrical energy. Copper is the “metal of electrification.” Only silver — which is far rarer and typically trades at around five times the price of copper —has a higher coefficient of conductivity. Aluminum is occasionally used as a substitute for copper in electrical transmission, but is significantly less conductive.
- Ensuring the secure supply of “critical minerals” has become an important aspect of industrial policy across most major economies. Elements such as nickel, lithium and cobalt are required for the lithium-ion batteries that will green the global vehicle fleet — transportation accounts for roughly a third of global carbon emissions. However, the “metal of electrification” is used across all energy transition applications.



Cu = copper; Ni = nickel; Li = lithium; Co = cobalt, USGS = US Geological Survey.

This study is focused on copper, but the energy transition applications listed above also require other metals, including rare earths, chromium, platinum group metals, aluminum, zinc and steel. The subject of this study, however, is copper. Its role is arguably more universal than any other metal.

Source: S&P Global.

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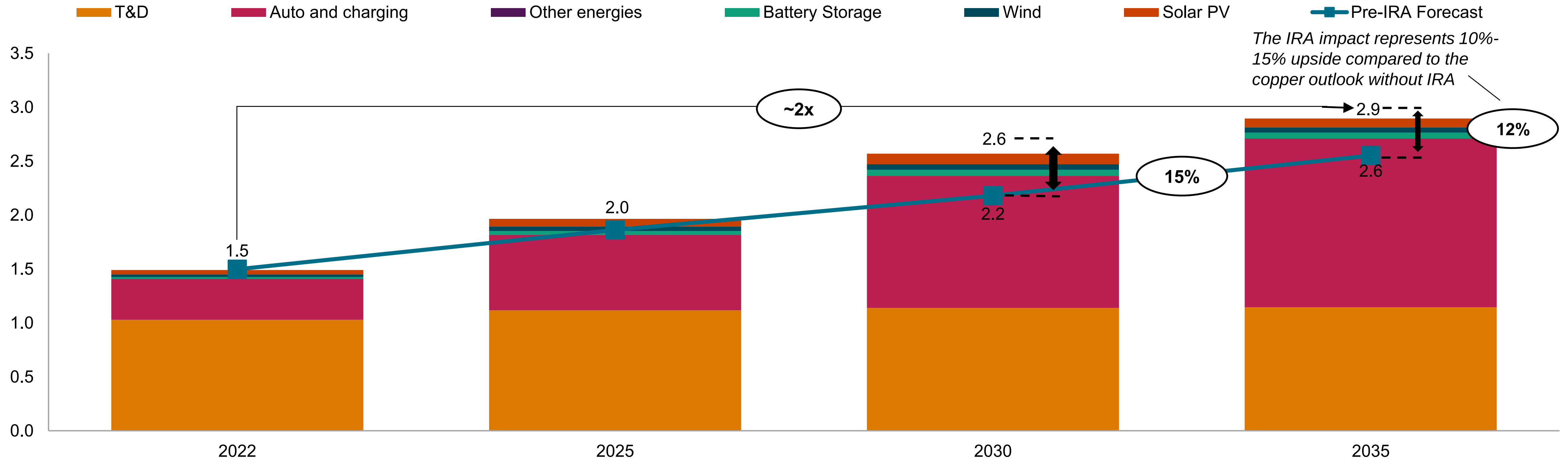
Projected US demand

In 2023, S&P Global projected the increased demand for copper in the US since the enactment of the Inflation Reduction Act in 2022. We built on our work in The Future of Copper report (2022), projecting demand “bottom-up” across all major energy transition applications. The US will require twice as much copper to satisfy this “energy transition demand” by 2035, an additional 1.5 MMt. Adding conventional, nonenergy transition demand, US consumption will reach 3.5 MMt by 2035, an increase of 112% or a compounded annual growth rate of 6.5%.

US gross (end-use) copper demand by energy transition application (MMt of Cu)



Data compiled Aug. 10, 2023.

Source: S&P Global Commodity Insights.

Because copper is not defined as a “critical mineral,” IRA-driven upside will not necessarily mean upside for domestic copper supply.

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Sourcing copper for the US

- To satisfy this demand, the US can either:
  - Mine and refine its own copper endowment
  - Recycle copper scrap for domestic use
  - Import refined copper[1]
- This report considers each of these options in turn. The US has an enormous copper endowment, but the time taken from first discovery to first production for major new projects — as well as in litigation — means exploiting this endowment in time for net zero by 2050 will be very challenging. Furthermore, the fall in US refining capacity means that much newly mined ore would have to be exported overseas and imported as refined product.
- Copper is fully recyclable and US copper recycling rates have increased in recent years. However, they remain far below the levels of the late-1990s and most US copper scrap — the feedstock for recycling — is exported, rather than turned to domestic use. Recycling more copper in the US for the domestic market is an attractive sourcing option, but recycling capacity must be increased to accommodate this retained scrap.
- There are no special sourcing requirements and/ or incentives for importing copper products into the US, beyond trade tariffs and sanctions in place. Despite its widespread conventional use and fundamentality to the energy transition, copper is not currently designated a “critical mineral” by the US Geological Survey. Nor is it defined as an “applicable critical mineral” in the Inflation Reduction Act (Section 45X(6)).[2] Nonetheless, 98% of copper imports to the US are from countries with which the US has an FTA. Almost two-thirds come from Chile alone. The US, then, is likely to remain reliant on external sources for copper for years to come.

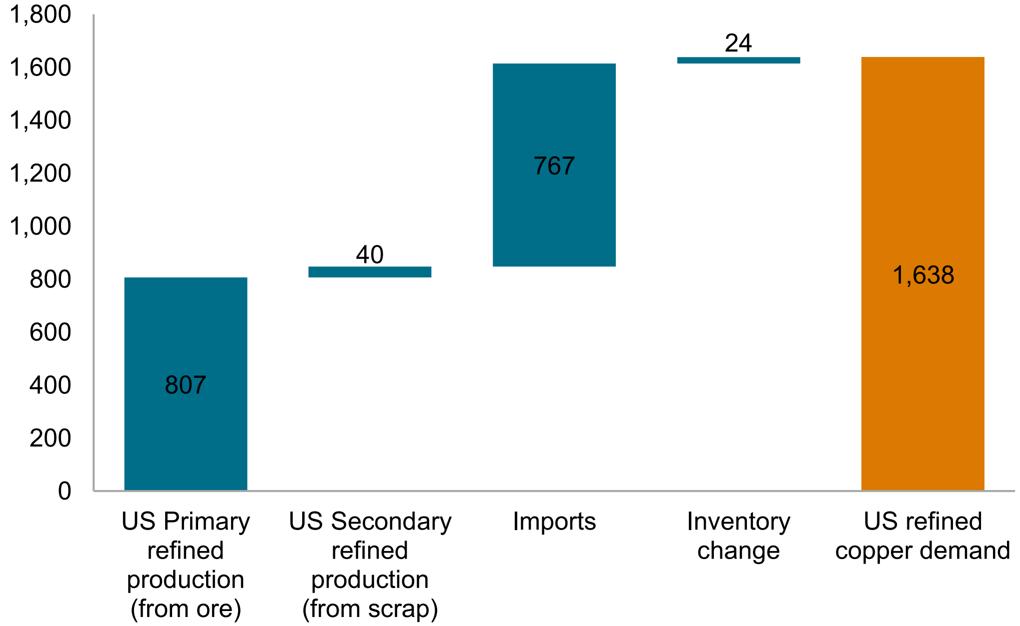
[1] The US also imports fabricated products that include copper as an input. Note that if the US substantially increased refined copper production domestically, it could stimulate the development of domestic industry for downstream products that uses this refined production, potentially reshoring significant parts of the full US copper value chains. That analysis, however, is out of the scope of this report.

[2] In contrast, the EU’s 2023 list of critical raw materials (CRMs) effectively includes copper. (The list contains 34 CRMs. Materials qualify as CRMs based on criteria for economic importance and supply risk. While copper does not meet these criteria, the EU’s Critical Raw Materials Act provides for their inclusion as strategic raw materials.) Canada also lists copper as a critical mineral. Copper is listed as “near critical in the medium term” in the US Department of Energy’s Critical Materials Assessment 2023.

How the US currently sources copper

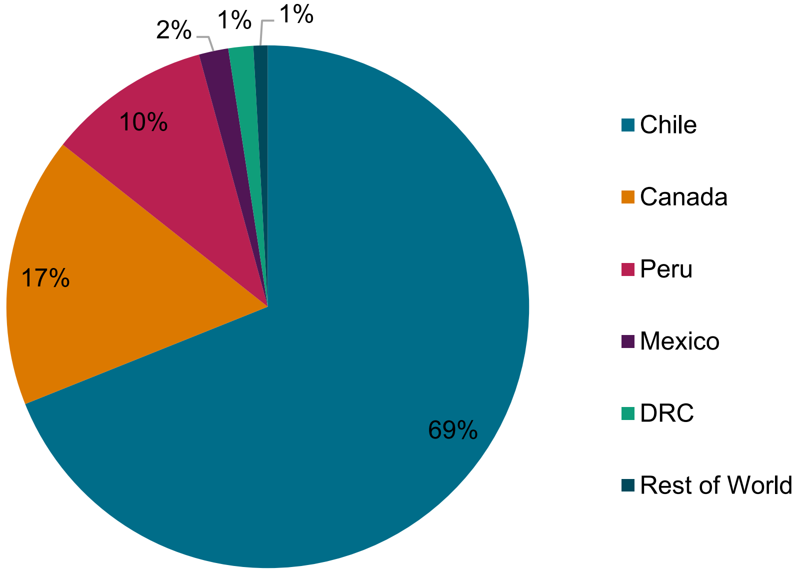
The US currently relies on imports and domestic primary production from ore to meet its appetite for refined copper. In 2023, secondary production (from scrap) comprised of only 5% of total refined copper production in the US. Imports accounted for 47% of refined copper demand. Chile is the dominant trading partner, representing nearly 70% of total US refined copper imports. Combined with Canada, Peru and Mexico, these four countries account for 98% of US imports.

US refined copper supply and demand, 2023 (thousand metric tons)



Data compiled Feb. 28, 2024.

US refined copper imports by trade partner, 2023



Data compiled Feb. 27, 2024.

Source: S&P Global Market Intelligence.

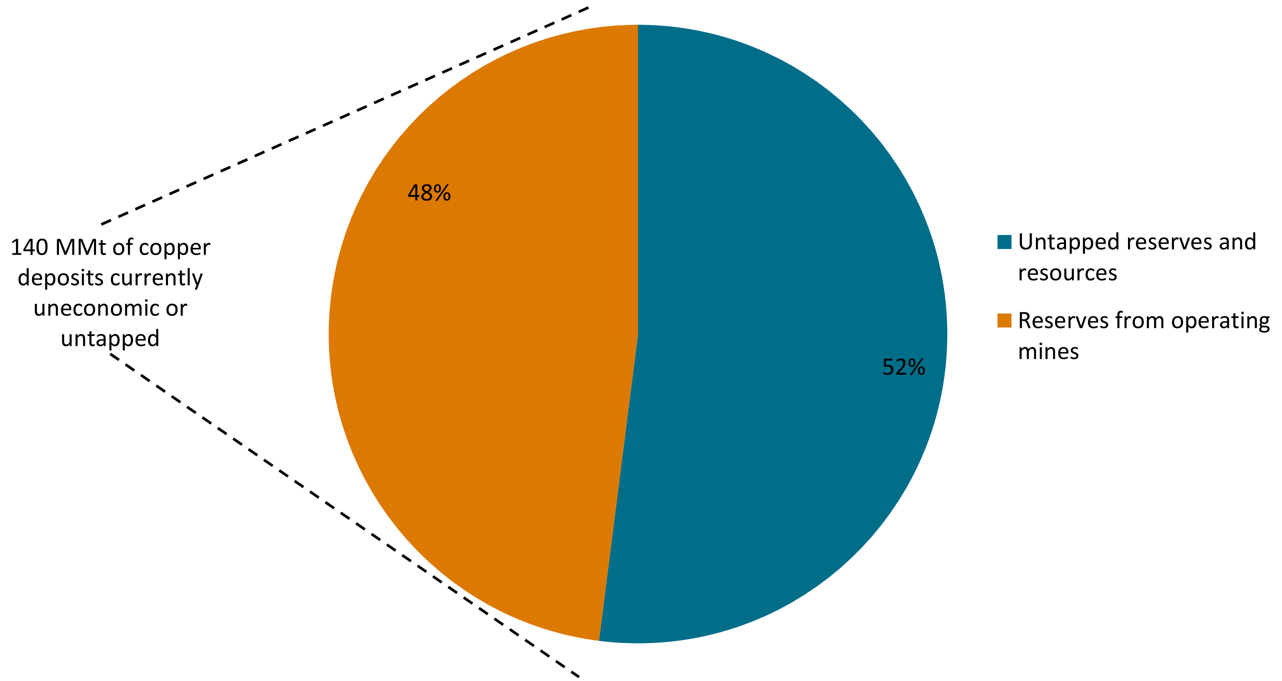
The US copper opportunity

Mines

The US copper endowment

- Copper presents a substantial opportunity for the US. The country has roughly 275 MMt of copper reserves and resources, with 140 MMt coming from mines not yet in production. This means that there is enough copper in the ground for the US to be self-reliant to meet copper demand for the foreseeable future — if that material can be accessed.
- These deposits could also contribute to producing additional critical minerals such as molybdenum, nickel, cobalt or precious metals.

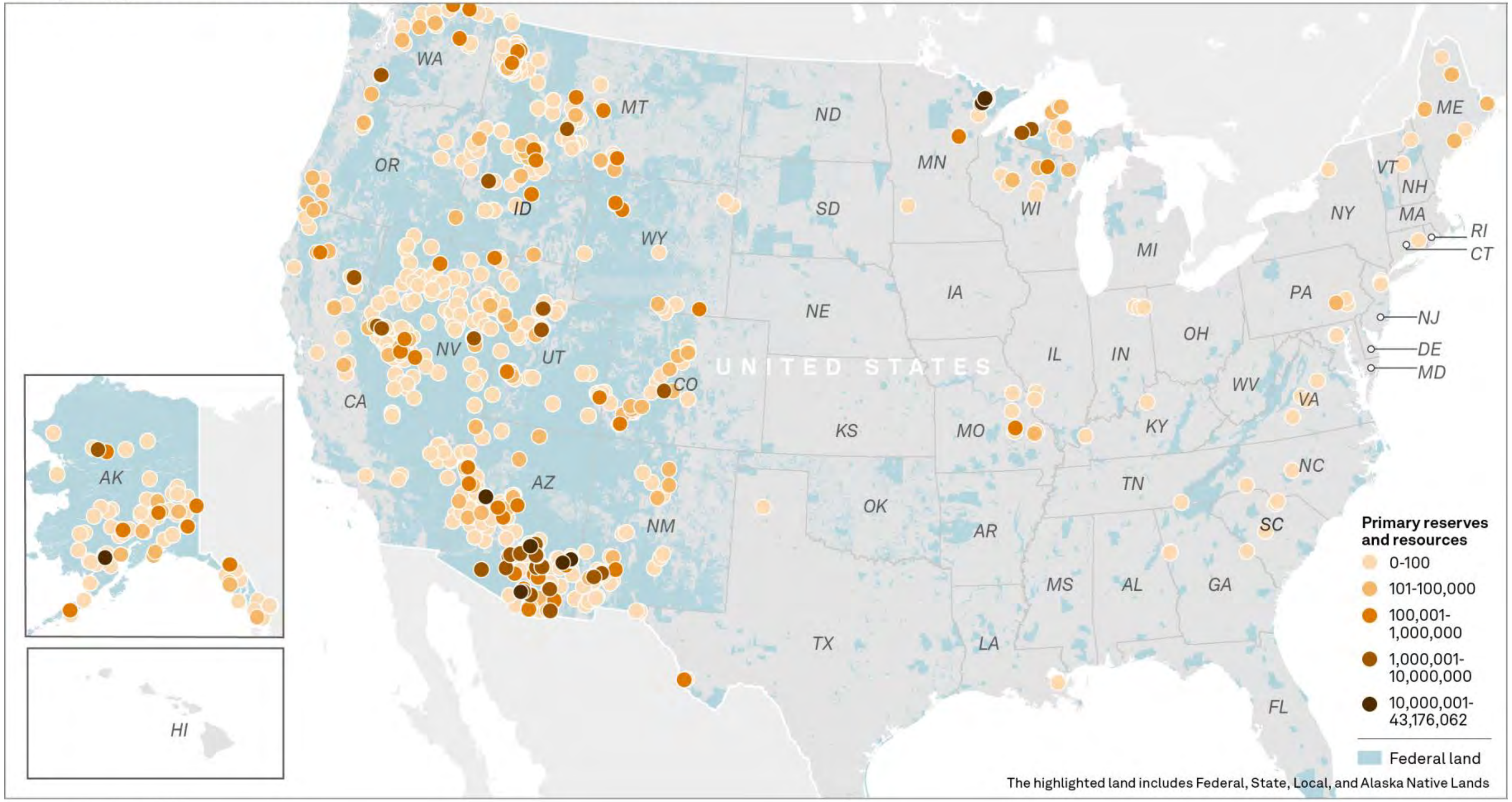
US primary copper mine reserves and resources by status



Data compiled April 2023.
Source: S&P Global Commodity Insights.

The US copper landscape: The most productive mines are all on or within two miles of government land

Many copper mines in the United States are on federal land



Data compiled Dec 4, 2023.
Sources: The United States Bureau of Land Management; S&P Global: 2014135.

- The 20 largest copper properties in the US in terms of reserves and resources account for 245 MMt of the 275 MMt (89%) of copper resources and reserves in the US.
- **All 20 properties** were either on government (federal, state, local or Alaska native land) property or within two miles of government property. This adds an added layer of complexity that increases the length of permitting.

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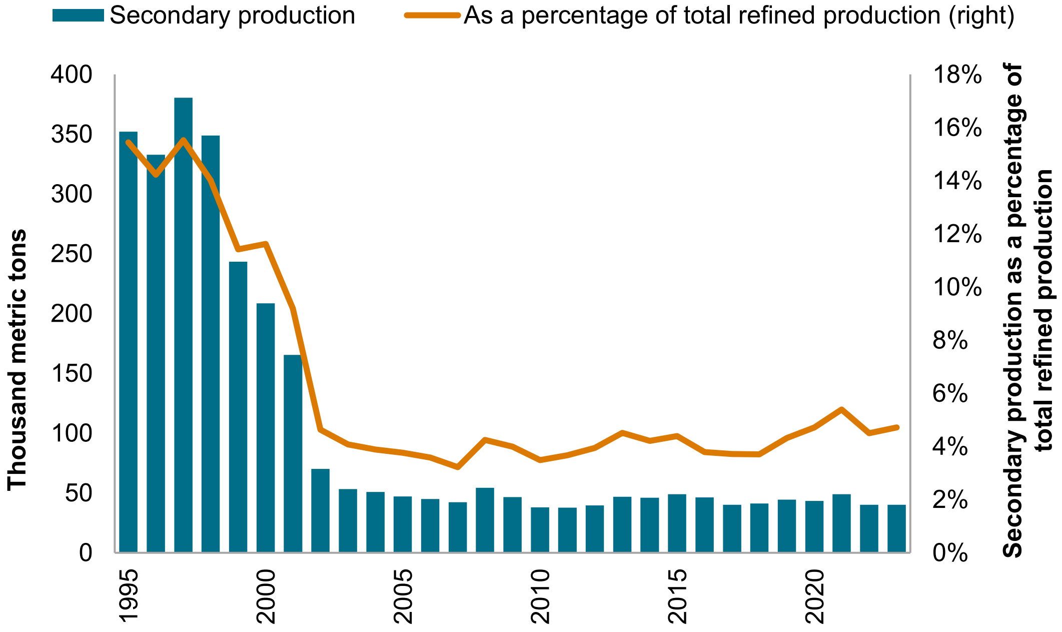
The US copper opportunity

Recycling

Trends in recycling rates

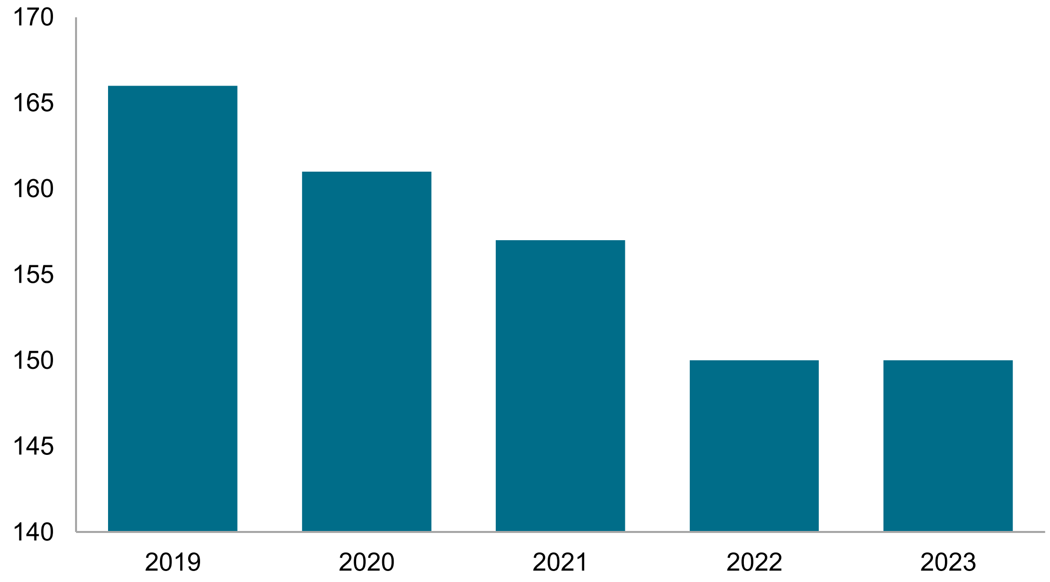
Recycling's share of refined copper production in the United States has declined markedly since the late 1990s, when major smelters closed. Old post-consumer copper scrap is also used directly to create refined metal, alloys, and other forms. However, this type of scrap recovery has been trending down in the United States over the last five years.

US secondary refined production of copper



Source: S&P Global Market Intelligence.

US copper recovered from old (post consumer) scrap (thousand metric tons)



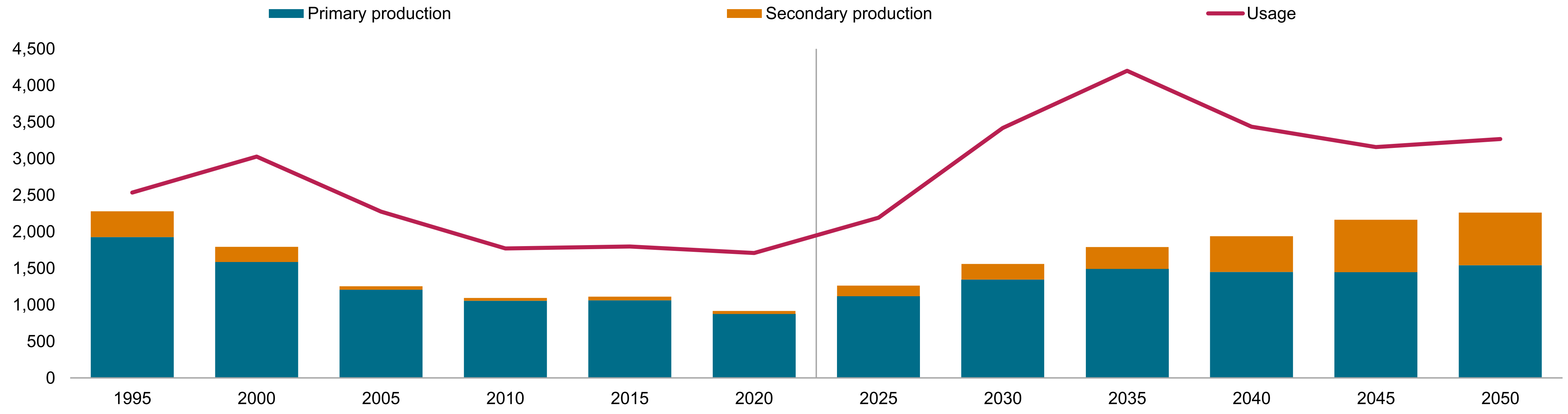
Source: US Geological Survey.

Data compiled Feb. 27, 2024.

Compounding effects

Copper scrap recovery is generally a function of lagged copper usage. As copper usage increases in the US with more adoption of renewables, electric vehicles, and other energy transition-related demand, this will result in higher scrap recovery and recycling in the future. Copper is long-lasting and durable. Copper used in automobiles lasts 18 years, for example, and that used in plumbing and electrical wiring in building and construction estimated at 40 years.[1] So increases in copper demand now increase recycled supply only decades in the future.

US refined copper usage and production: High-ambition scenario from 2022 "Future of Copper" study (thousand metric tons)



Data compiled July 14, 2022.

1 See, for example, estimates in Glöser, Simon, Marcel Soulier, and Luis a. Tercero Espinoza. "Dynamic Analysis of Global Copper Flows. Global Stocks, Postconsumer Material Flows, Recycling Indicators, and Uncertainty Evaluation." *Environmental Science & Technology* 47, no. 12 (May 31, 2013): 6564–72. https://pubs.acs.org/doi/10.1021/es400069b. (Accessed Aug. 9, 2024.)

Source: International Copper Study Group; S&P Global.

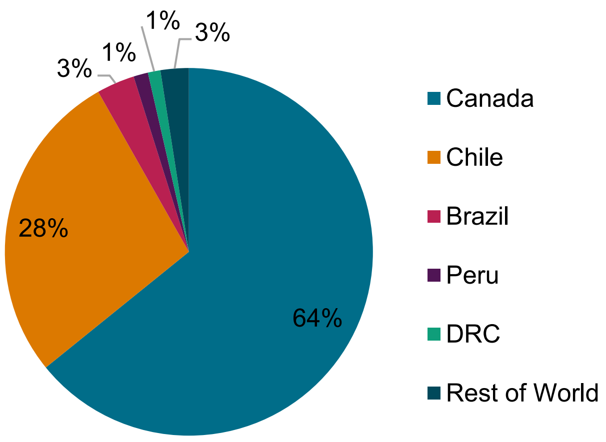
The US copper opportunity

Trade

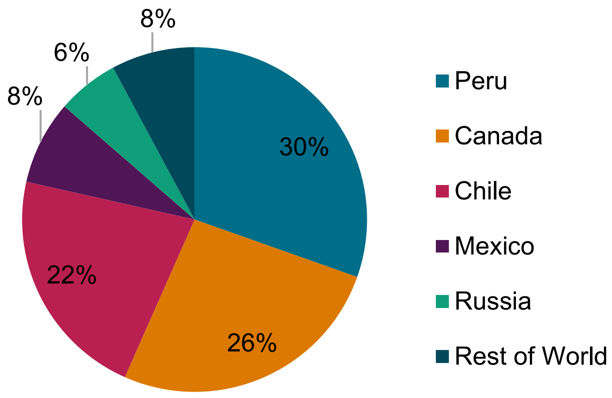
Key import partners: From Canada to Chile

Canada, Chile, Peru, and Mexico have long been reliable trade partners with the US, though each country's share of overall US imports has changed over time. In 1990, Canada was the dominant trading partner of refined copper with the United States, representing over 60% of US refined copper imports. Now, Chile accounts for nearly 70% of US refined copper imports.

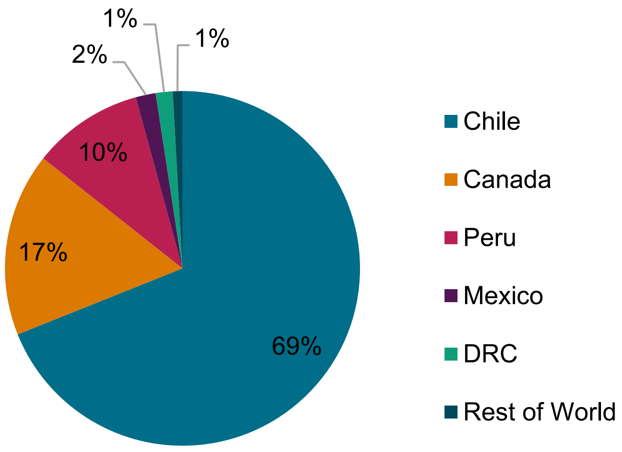
US refined copper imports by trade partner, 1990



US refined copper imports by trade partner, 2000



US refined copper imports by trade partner, 2023

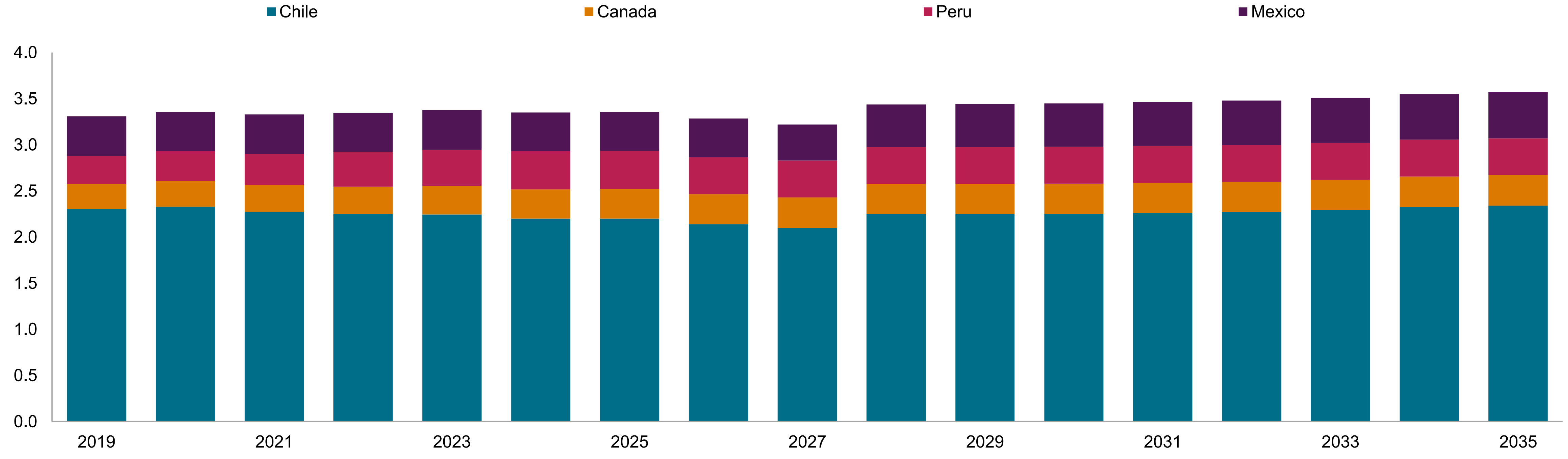


Data compiled Feb. 27, 2024.
Source: S&P Global Market Intelligence.

Key import partners: FTA partners

Chile, Canada, Peru and Mexico all have FTAs with the US and together accounted for 98% of US refined copper imports in 2023. However, these countries' production is forecast to increase only 6% between 2023 and 2035. Modest capacity additions will outweigh declining ore grades, which are forecast to drive production declines in 2026 and 2027.

Refined copper production for major US trading partners (MMt)



Data compiled Feb. 27, 2024.
Source: S&P Global Market Intelligence.

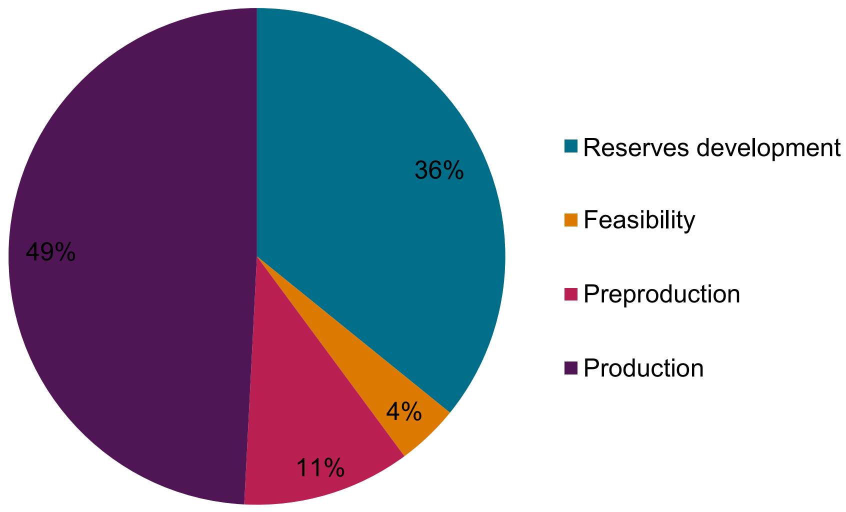
The US copper challenge

Mines

Discovery to production: Long development times and multiple authorities

- More than half of the US' copper reserves and resources — 140 MMt — are in properties that are not yet in production. This endowment is concentrated in a handful of key projects. The reserves and resources from the five-largest projects not yet operating account for roughly 35% of all US reserves and resources and nearly 70% of the endowment of properties not yet in operation.
- Apart from permitting, other challenges, such as social license to operate and infrastructure constraints, can inhibit or prevent this supply from coming into production. This means some of the untapped projects are at least 3-4 years from first production of concentrate (for large-scale developments) and further still from reaching run-rate production levels.
- A key challenge in the US is that most copper deposits are located on federal land. This means several authorities —including the Bureau of Land Management, the Forest Service, the US Army Corps of Engineers and the Fish and Wildlife Service — may be required to review aspects of an environmental impact statement. These agencies, whose capacity is often stretched, may request revisions to the impact statement.
- This multiple-agency process in the US is in contrast to that in peer countries such as Canada and Australia, whose more extractives-intensive economies have developed more streamlined processes. Importantly, they also have dedicated ministerial briefs for mining: the minister of energy and natural resources in Canada and the minister for mines and petroleum in Australia. (The US Bureau of Mines was abolished in 1996 — and was a research agency, not an executive office.)

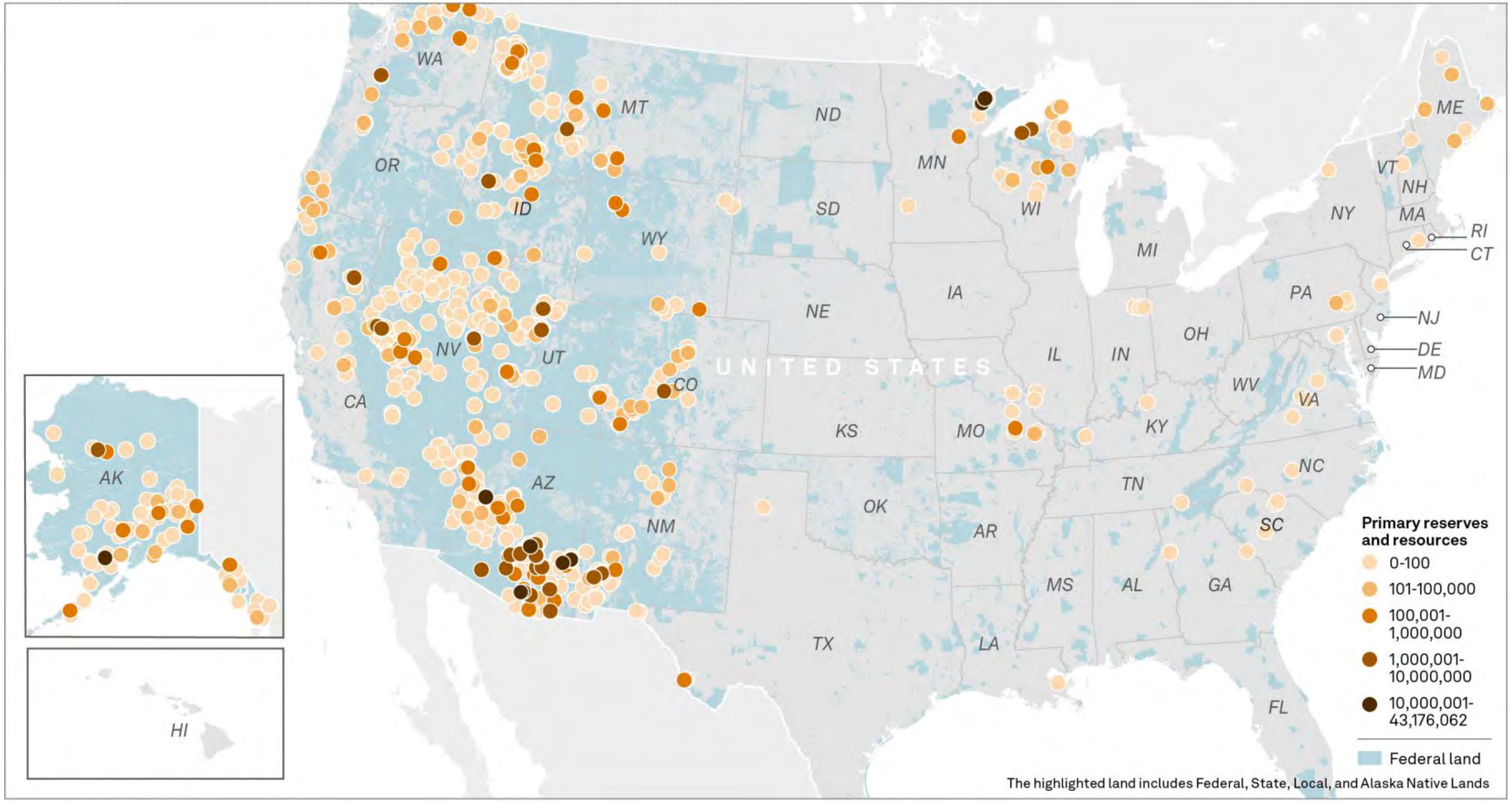
US copper reserves and resources by development stage



Data compiled Jan. 24, 2024.
Source: S&P Global Market Intelligence.

Discovery to production: Copper on federal land

Many copper mines in the United States are on federal land



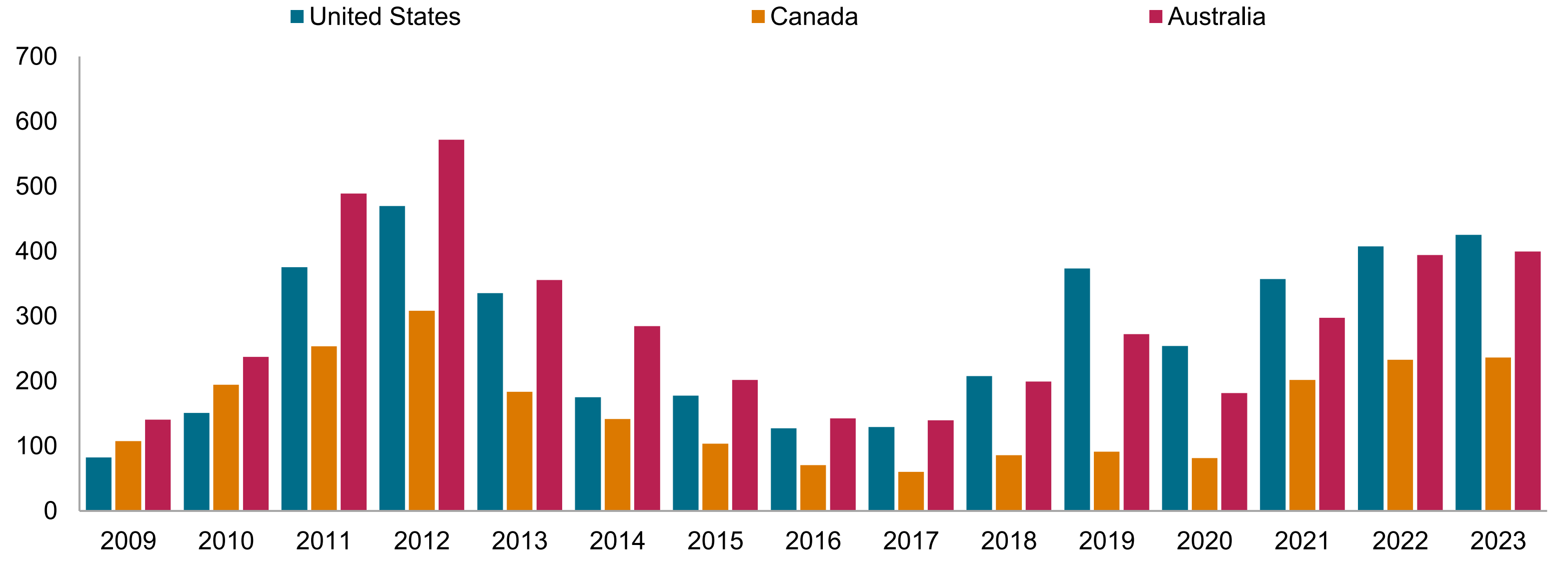
Data compiled Dec 4, 2023.
Sources: The United States Bureau of Land Management; S&P Global: 2014135.

S&P Global

Operational challenges: Investment versus endowment in US, Canada and Australia

- The average copper exploration budgets over the last 15 years (2009–23) for the US has been in line with that of Australia — even though the US has as much copper reserves and resources as both Australia and Canada combined.
- In terms of dollars per metric ton of copper endowment, Canada received 55% more than the US in exploration budget during this period. Australia received more than double the budget received by the US.
- There are likely various reasons, including Canada and Australia's sales of ores to China, the world's largest refining country. However, one reason is likely the uncertainty that surrounds mine development in the US.
- Several major projects have been in development for decades — and typically face litigation risks once they come online.

Comparison of copper exploration budgets by country, 2009–23 ($M)



Exploration budget per metric ton of resources and reserves

2009–23	US	Canada	Australia
Exploration budget dollars per metric ton of resources and reserves	$0.98	$1.52	$2.00
vs. US	–	+55%	+104%

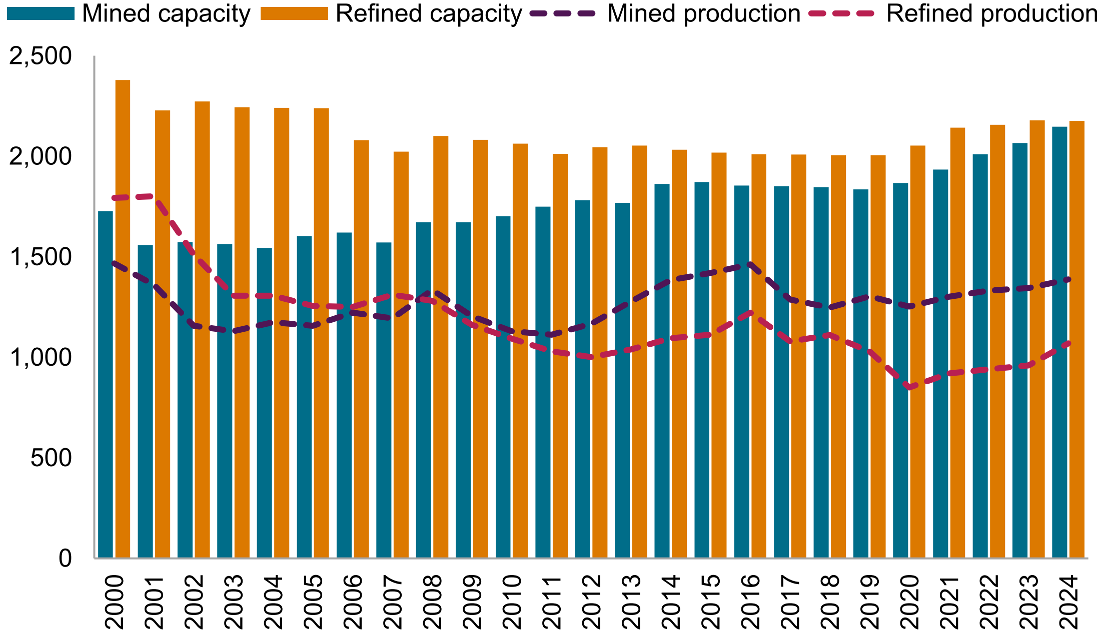
Data compiled Feb. 29, 2024.
Source: S&P Global Market Intelligence.

S&P Global

Falling refining capacity

Despite these challenges, US copper mine capacity has grown slowly since 2000, from around 1.7 MMt to an expected 2.1 MMt in 2024. Refining capacity, however, has fallen by about 9%, from nearly 2.4 MMt to less than 2.2 MMt, as the number of copper refineries declined from nine to five. Refined production fell much more sharply, from nearly 1.8 MMt to less than 1.1 MMt — a reduction of over 40%. This means US mined copper is increasingly exported rather than refined domestically.

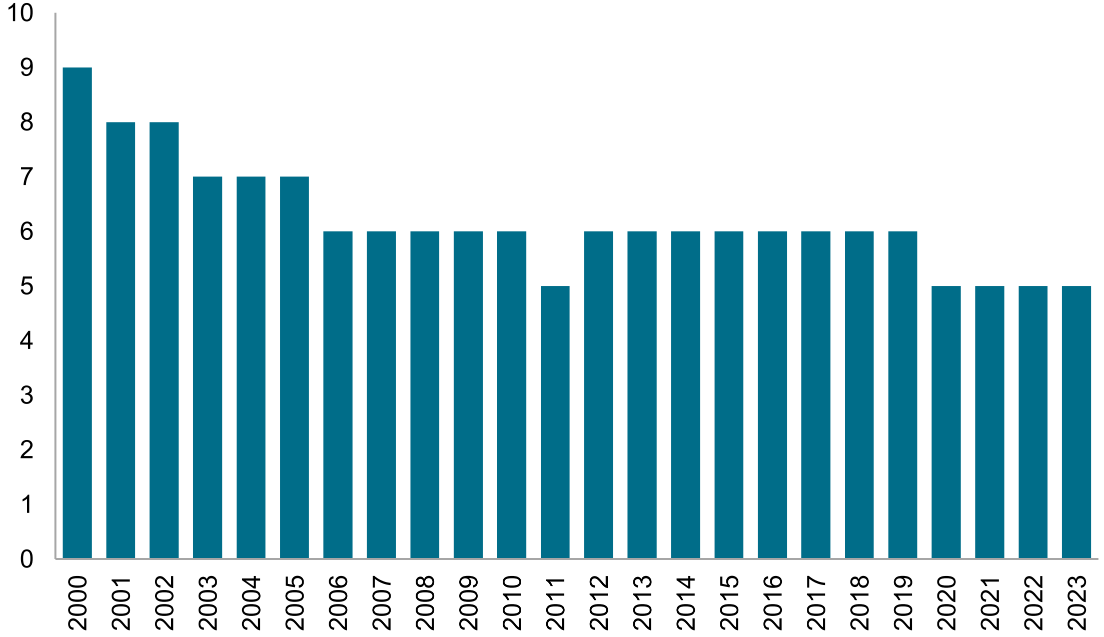
US copper capacity and production (thousand metric tons)



Data compiled Feb. 24, 2023.

Source: S&P Global Commodity Insights.

Number of US copper refineries[1]



Data compiled Jan. 24, 2024.

[1] The US' five remaining refineries are: Indiana, Garfield, El Paso, Reading and New Haven.

Source: S&P Global Commodity Insights.

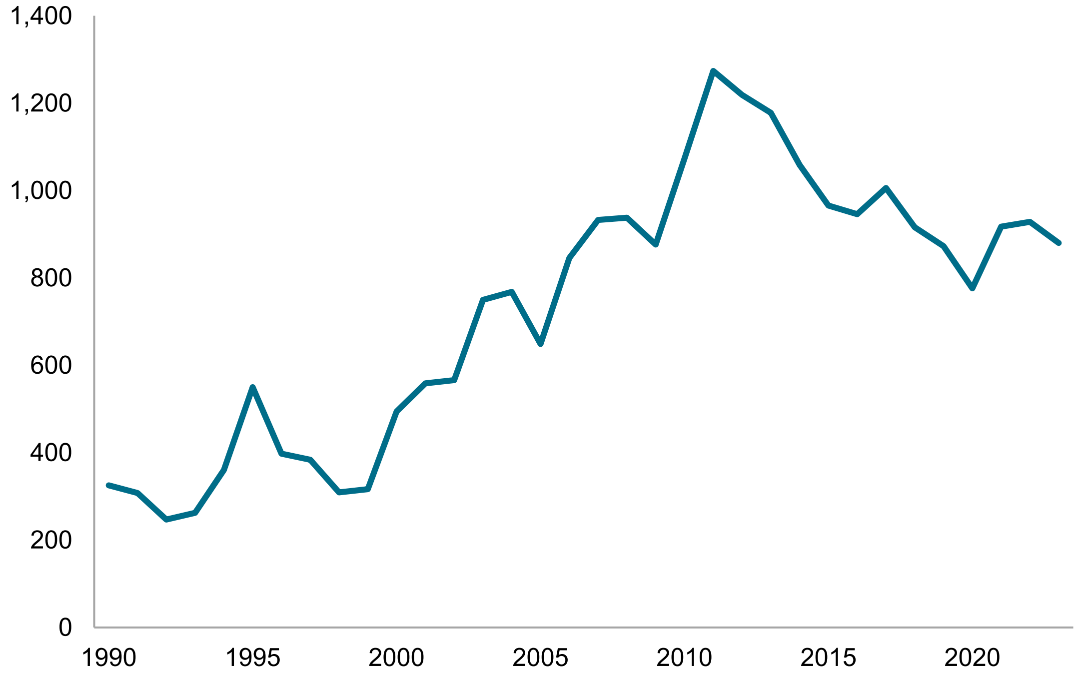
The US copper challenge

Recycling

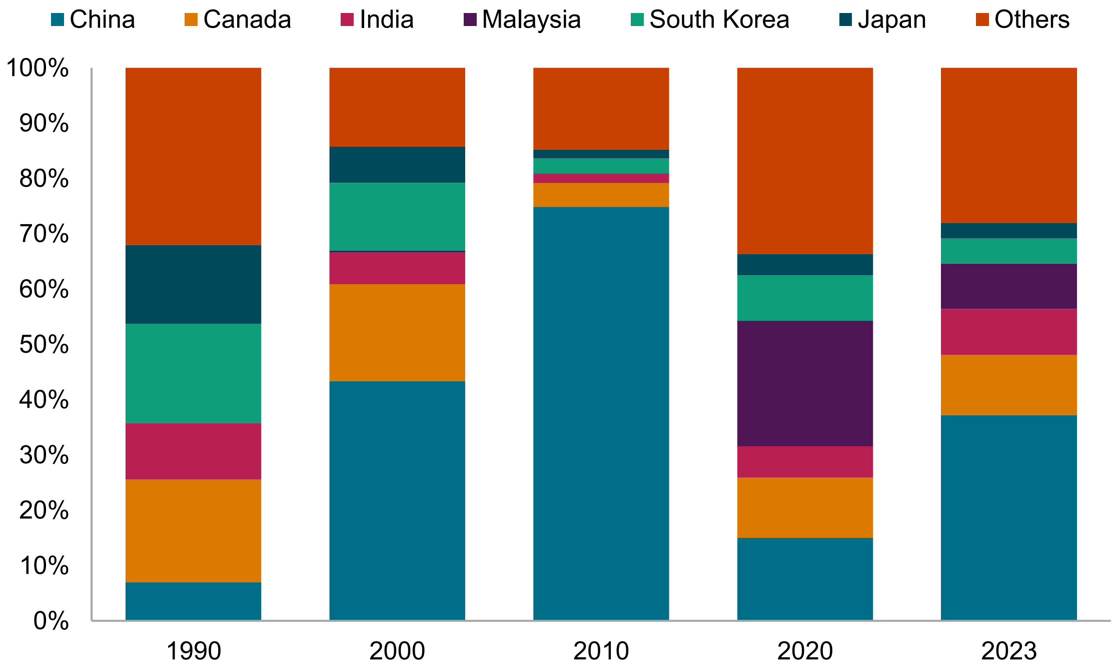
Export of scrap: Selling the recycling feedstock

As with US mined copper production, US copper scrap has been increasingly exported since the last “commodity super-cycle” (2003–07 — although exact dates are debated). These exports are increasingly going to China and Canada, although India and Malaysia have also emerged as major trading partners. While some recycling capacity is coming online in the US, it is only aimed at certain types of scrap and semis. Thus, these may not stop future scrap exports.

US copper scrap exports (thousand metric tons)



Destinations of US copper scrap exports

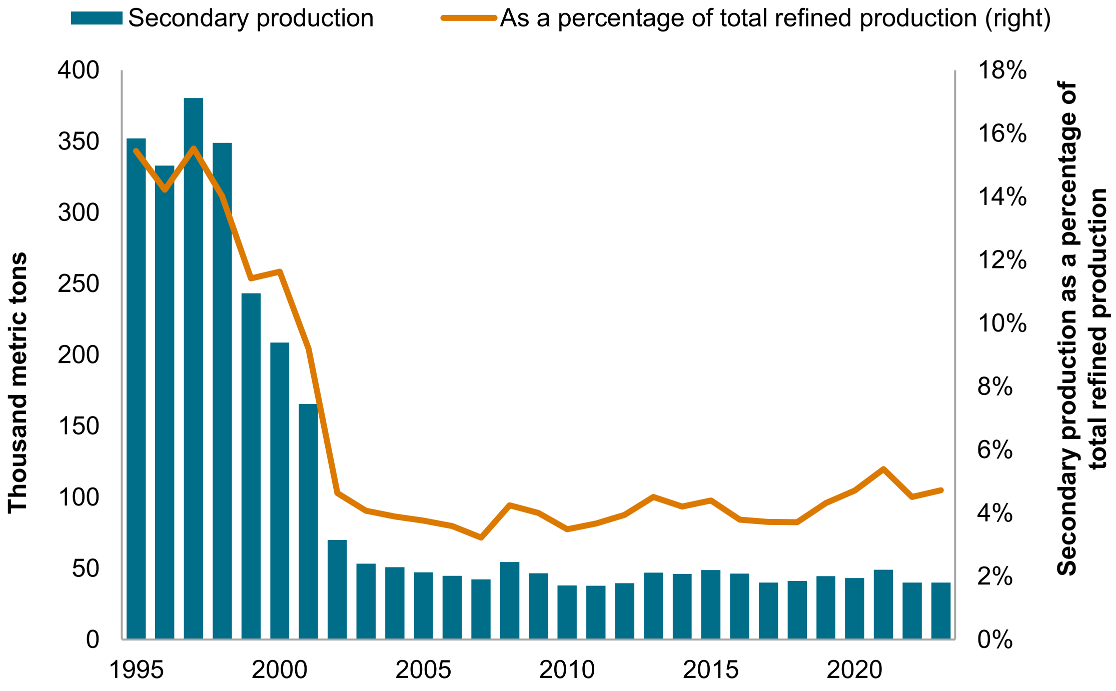


Data compiled Feb. 20, 2024.
Source: S&P Global Market Intelligence.

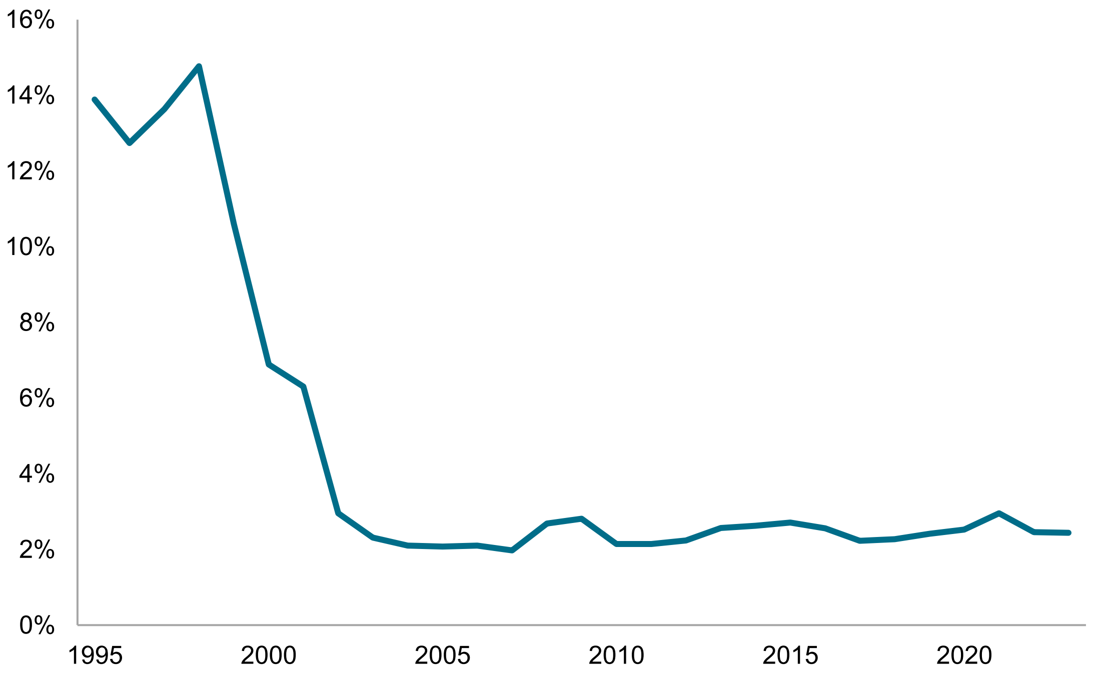
Export of scrap: Slowing recycled production

This has led to a slowdown in US recycled production. Secondary production has fallen secularly over the last 30 years in the US both on its own and as a percentage of total refined production. Additionally, copper recovered from old (post-consumer) scrap has also been trending down.

US secondary refined copper production



US secondary refined copper production as percentage of consumption



Data compiled Feb. 27, 2024.
Source: S&P Global Market Intelligence.

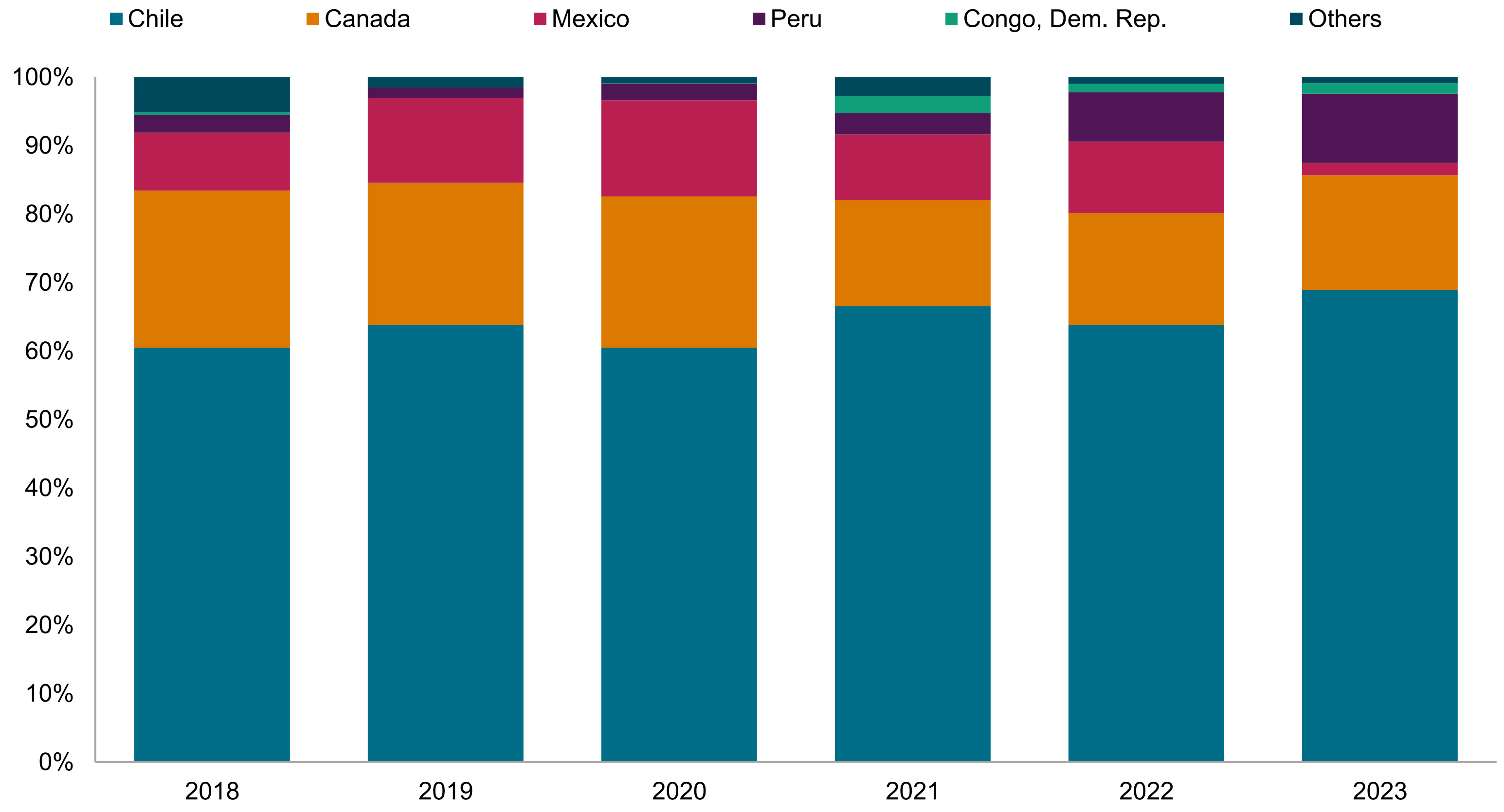
The US copper challenge

Trade

Geopolitics of trade: Politics versus commercial relations

- More than 98% of US imports of refined copper are from FTA partners. Almost two-thirds of imports are from a single country: Chile.
- However, for Chile, the US represents a little over a fifth of its refined copper exports. This compares to more than two-fifths that are exported to China.
- If forces outside of Chile's control were to drive a decline of Chilean copper exports to the US or a decline in the US share of Chilean exports, the US would need to replace that supply with either domestic resources or supply from other trading partners.

US imports of refined copper by share of trade partner



Data compiled Feb. 20, 2024.
Source: S&P Global Market Intelligence.

Geopolitics of trade: Politics versus commercial relations (continued)

- In providing a forward-looking estimate of imports, we examine:
  i. What percentage of each country's refined copper production is exported?
  ii. What percentage of each country's refined copper exports go to the US?
- According to data from 2019 to 2022, Chile exports virtually all its refined copper, while Peru exports more than 80% of its production. For both countries, the US makes up a small share of exports, with China records a higher share of exports for both countries.
- Meanwhile, the US has a dominant market share of Mexican and Canadian exports. However, both countries export less than 50% of their refined production.
- Between rising copper demand internationally, logistics risk in Latin America and small forecasted increases in refined supply, growth in US imports from these top four countries is limited. **This means that the US may need to seek imports from other trade partners.**

Refined copper trade and production for key US trade partners

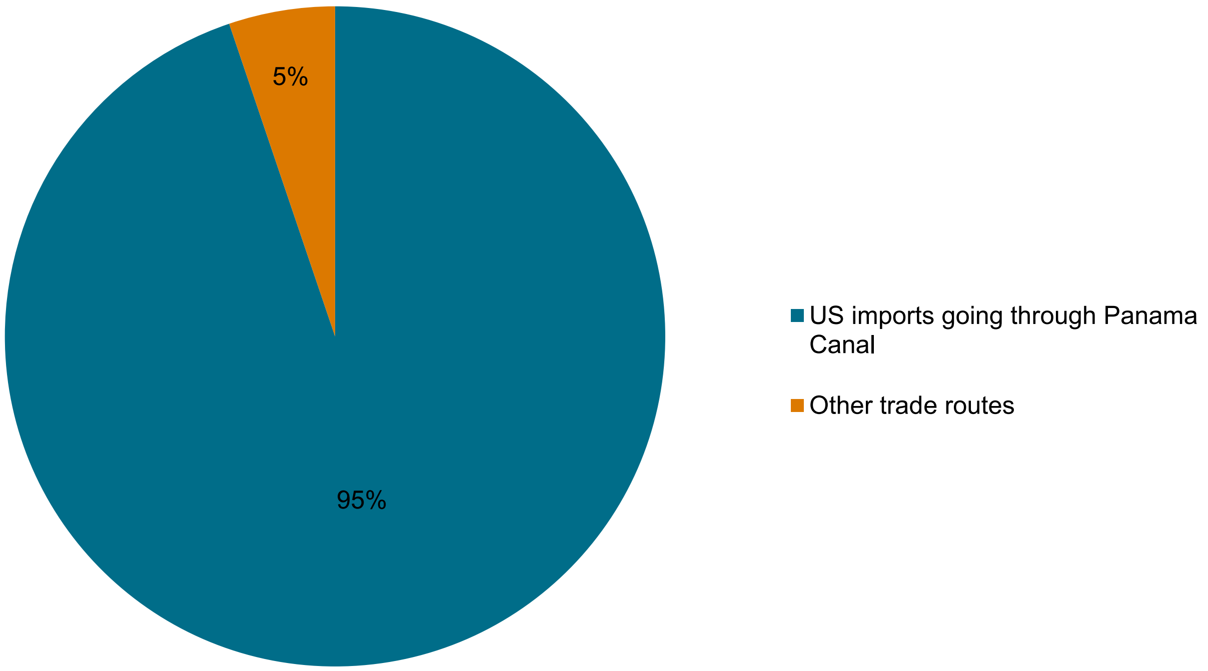
Category	Chile	Canada	Peru	Mexico
Exports share of refined production, 2019–22	100%	40%	81%	31%
US share of refined copper exports, 2019–22	20%	97%	12%	70%
US exports, 2023 (thousand metric tons)	529	128	77	14
Refined copper production, 2023 (thousand metric tons)	2,073	310	400	480
Refined copper production, 2035F (thousand metric tons)	2,339	330	400	503

Data compiled Feb. 28, 2024.
Source: S&P Global Market Intelligence.

Logistics of trade: Reduced capacity in the Panama Canal

- Logistics is another US trade vulnerability. Around 95% of 2023 seaborn refined copper imports into the US were via the Panama Canal. Transport through the Panama Canal has been disrupted by low water levels in Gatun Lake, which feeds the canal's lock system. Since June 2023, the Panama Canal Authority (ACP) has reduced the number of transits through the canal steadily to 22 vessels, compared with the typical 36 vessels per day during winters. Waiting times have risen to 2.5 days. This could have a substantial effect on US imports of refined copper.
- The US relies on the Panama Canal for its small volume of refined copper exports too. In 2023, these exports from the US East Coast and the US Gulf Coast to Asia accounted for 45.2% and 1.7% of total refined copper exports, respectively.

US seaborn imports of refined copper, 2023



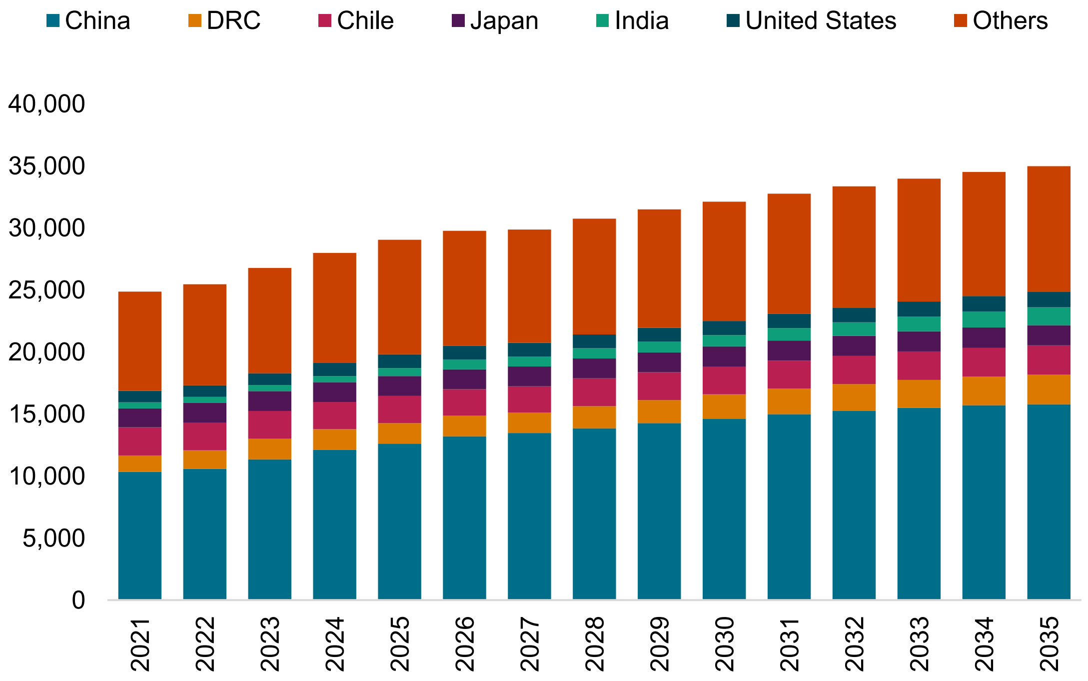
Data compiled Feb. 27, 2024.

Source: S&P Global Market Intelligence.

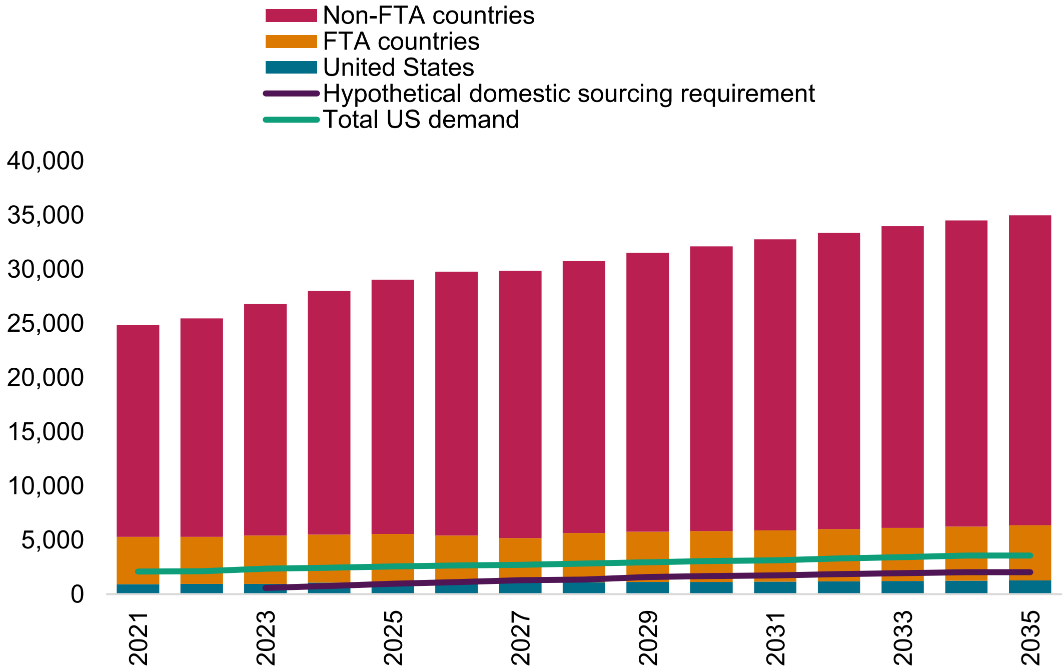
External reliance: Non-FTA partners for new sourcing

The vast majority of refined copper is produced in countries that do not have an FTA with the US. China is the largest refiner of copper, accounting for over 40% of global production. If the US is unable to source all its copper domestically or from its “Big 4” trade partners, it will need to explore increasing sourcing from non-FTA countries — with the DRC and China being the largest producing countries.

Top countries for refined copper production (thousand metric tons)



Refined copper production by country grouping (thousand metric tons)



Data compiled Feb. 24, 2023.
Source: S&P Global Market Intelligence.

Three US copper scenarios

Three scenarios: US copper sourcing tested

Given the challenges above, we can imagine three scenarios under which US copper supply will be hindered. In this section, we consider the impact on the US' external reliance under three scenarios parameterized in terms of production, trade and recycling. These are plausible scenarios that underscore the real challenges the US faces.

Narrative		US parameters under scenario versus baseline	
		US refined copper production	**Refined copper imports**
Geopolitical competition	Latin American producers export more of their refined copper to China, whether because they opt to themselves or because Chinese buyers demand more.	+ 5%	- 10%
Expedited permitting	New copper projects in the US are quickly brought online, including major projects that have long been delayed. This would also create the policy certainty that would drive investment in processing, allowing copper from these projects to be processed domestically.	+ 70%	No change
Water stress	Climate change and pressure on water levels jeopardizes US imports of copper products from Latin America in particular.	No change	- 10%

Data compiled Feb. 28, 2024.
Source: S&P Global Market Intelligence.

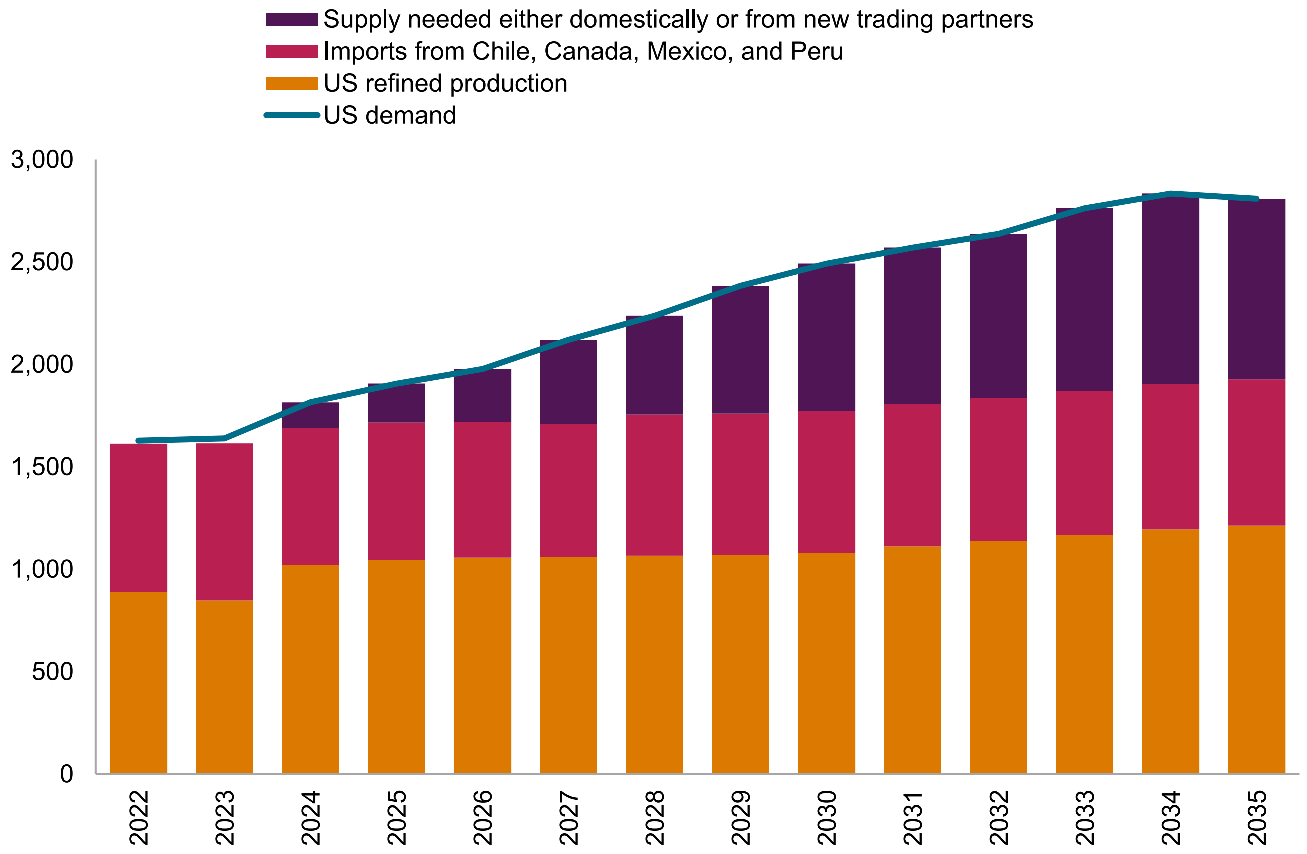
Three US copper scenarios

Geopolitical competition

Scenario 1: Geopolitical competition

- Latin American producers of copper already export more to China than they do to the US — despite FTAs with the US. Chile, for example, accounts for nearly 70% of US refined copper imports.
- However, from Chile's perspective, the US accounts for around 20% of its refined copper exports, whereas China accounts for more than twice that. Similarly, 18% of Peru's refined copper exports went to the US in 2022 while China's share was 53%.
- In this scenario, Chile and other Latin American exporters to the US expand their trade relations with China by reducing exports to the US.
- Alternatively, Chinese buyers demand more refined product and, as the largest buyers, have the bargaining power to secure these increased volumes. Either way, the volume of refined copper reaching the US falls.
- It is assumed that in this scenario, US copper scrap exports will decrease and recycling will increase, driving an increase to US primary production. However, this will not offset the loss of Latin American supply, and leaves the US needing to secure supply from other non-FTA countries.

Scenario 1: US refined copper supply and demand (thousand metric tons)



Data compiled Feb. 28, 2024.
Source: S&P Global Market Intelligence.

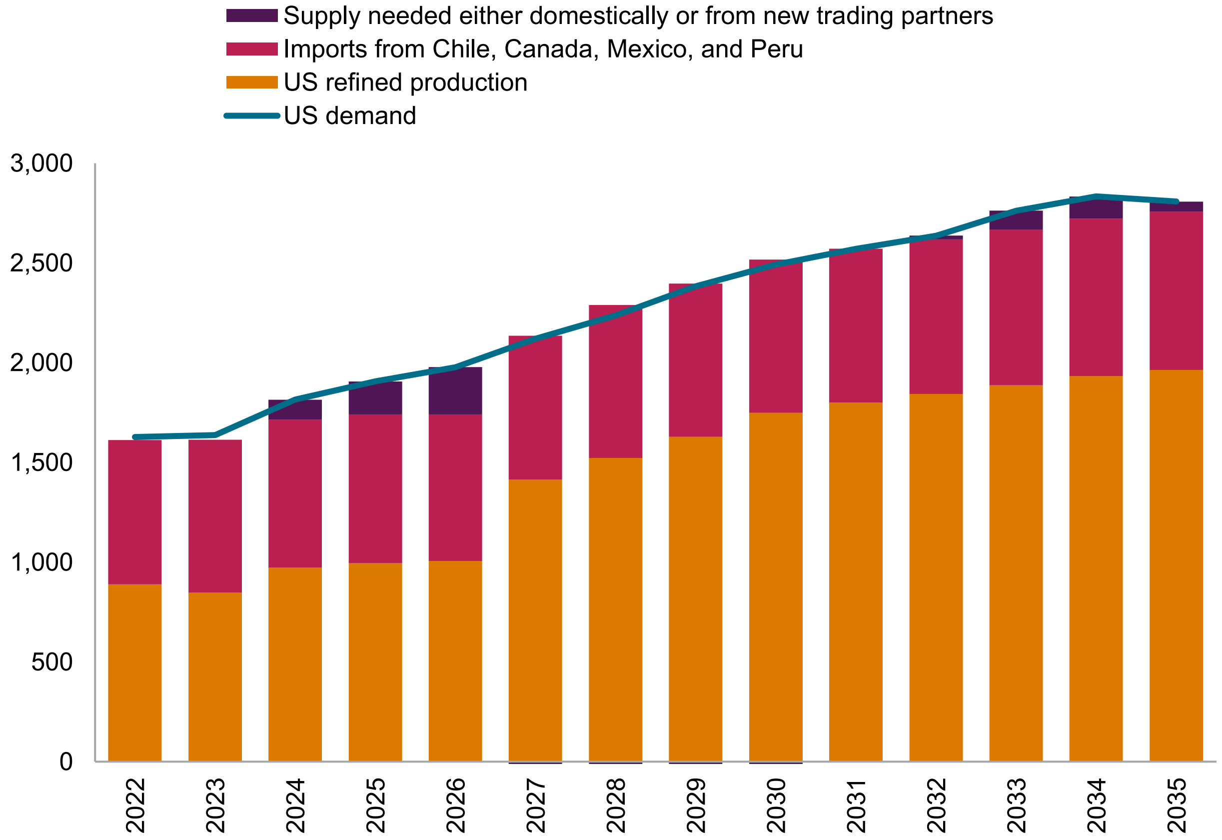
Three US copper scenarios

Expedited permitting

Scenario 2: Expedited permitting

- New copper projects in the US are quickly brought online and post-permit litigation is suppressed.
- Regulatory obstacles to major projects, which have long been delayed, are resolved:
  - Pebble and Resolution make up roughly half of the US copper reserves and resources for nonoperating mines
  - Pebble reaches full production in 2030, adding 200,000 metric tons of copper per year, or 15% of 2023 total US mined copper production. In this scenario, Pebble begins partial production in 2028.
  - Santa Cruz reaches full production in 2029, adding 60,000 metric tons of copper per year, or 5% of 2023 total US mined copper production. In this scenario, Santa Cruz begins partial production in 2027.
  - Resolution reaches full production in 2029, adding 450,000 metric tons of copper per year, or 34% of 2023 total US mined copper production. In this scenario, Resolution begins partial production in 2027.
  - The assumption is that the removal of policy uncertainty at the mine permitting level drives investment at the refining level, allowing the mined copper from Resolution, Pebble and Santa Cruz to be processed in the US.
- This boosts domestic production in the US, exploiting its considerable copper endowment — enough to meet its refined copper demand for the foreseeable future.

Scenario 2: US refined copper supply and demand (thousand metric tons)



Data compiled Feb. 28, 2024.
Source: S&P Global Market Intelligence.

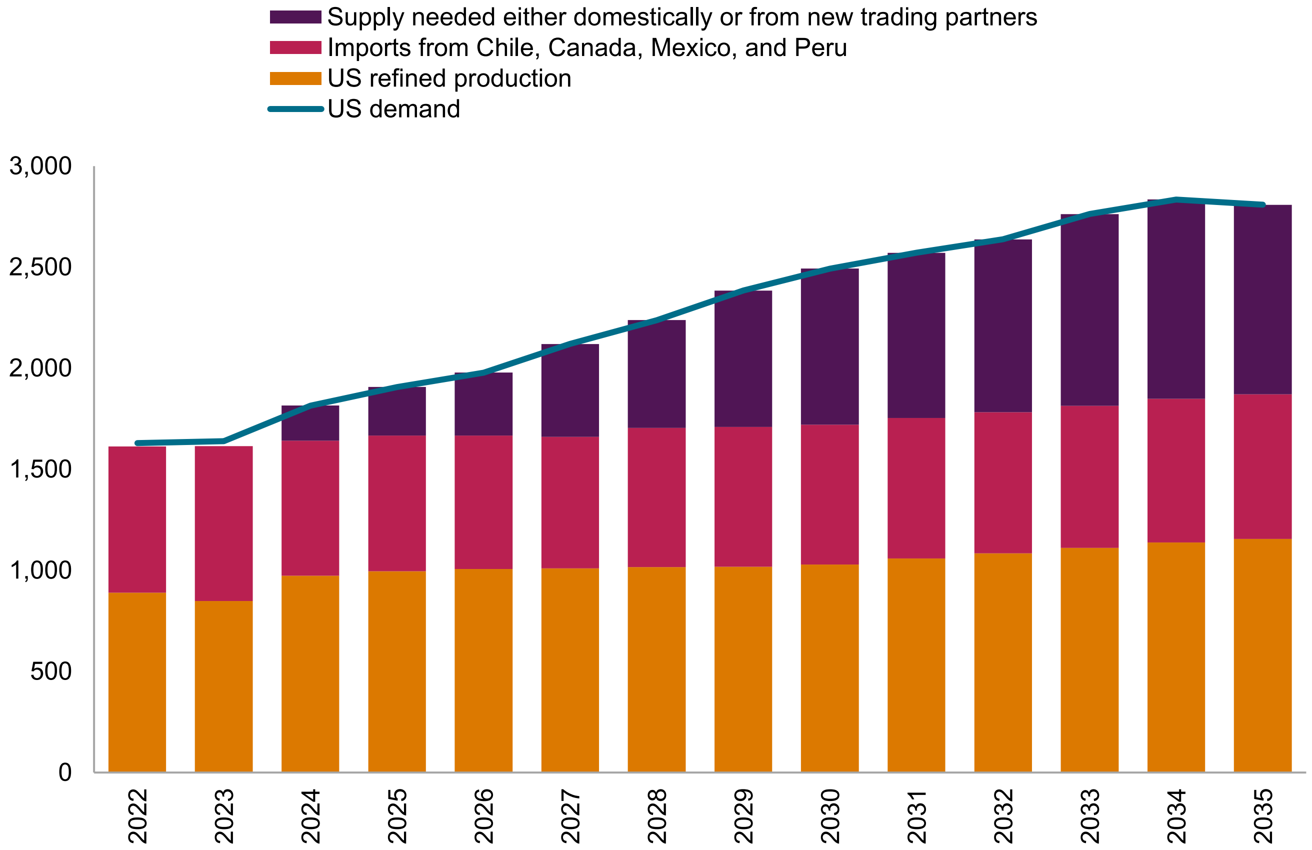
Three US copper scenarios

Water stress

Scenario 3: Water stress

- Global pressure on water levels continues and jeopardizes US imports of copper products from Latin America in particular.
- As water tables fall, Latin American households are increasingly concerned about diversion of water to industrial projects, including mining. Under political pressure/new regulations, miners are forced to reduce their consumption of water and this depresses their production.
- Second, low water levels continue to blight the Panama Canal. Its throughput, already significantly reduced in 2023, remains low, affecting imports of refined copper into the US. Since almost all refined copper shipments from Chile and Peru to the US travel through the Panama Canal, there is a risk that low water levels in the canal drive more Chilean and Peruvian exports to China

Scenario 3: US refined copper supply and demand (thousand metric tons)

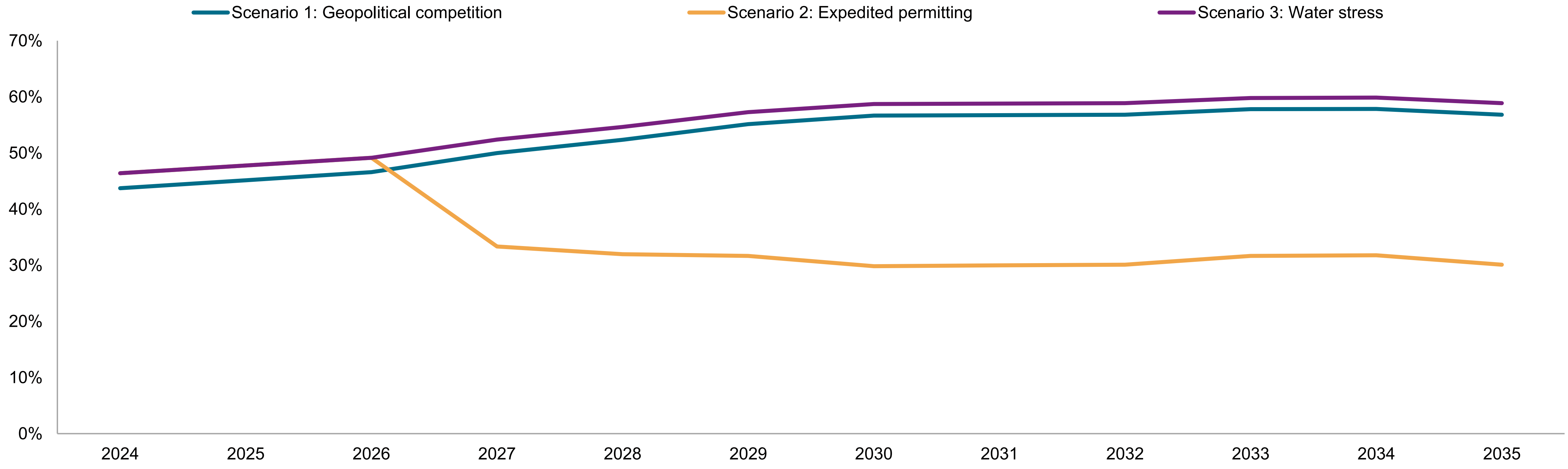


Data compiled Feb. 28, 2024.
Source: S&P Global Market Intelligence.

Scenario comparison: Import reliance

Imports accounted for 47% of US refined copper supply in 2023. This reliance continues to increase under both the Geopolitical competition and Water stress scenarios, approaching 60% in the 2030s. Meanwhile, reliance on imports falls during the Expedited permitting scenario to 30%. Over 98% of 2023 US refined copper imports came from Chile, Canada, Peru, or Mexico, but more than half of US imports under both the Geopolitical competition and Water stress scenarios will need to come from other countries.

US share of refined copper demand reliant on imports: scenario comparison



Data compiled Feb. 28, 2024.

Source: S&P Global Market Intelligence.

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ATTACHMENT 4

PUBLIC VERSION

Copper Development Association Inc.

COPPER SUPPLY & CONSUMPTION 2003 – 2023

COPPER.ORG

Copper Development Association Inc.

Preface

Statistical data on the supply and consumption of copper and copper alloys in the United States are available from many governmental and private sources. In this report, original data from these sources are brought together and rationalized by CDA to provide a set of data on U.S. copper supply and consumption that is both consistent and accurate in all aspects from mine to end-use market.

The main sources of information assembled here include, the U.S. Department of the Interior's, U.S. Geological Survey, National Minerals Information Center; the U.S. Department of Commerce's, Bureau of the Census; the U.S. International Trade Administration and Copper Development Association Inc. Where data from different sources are conflicting, and where original data appear to be in error, the best judgment has been applied. General sources are shown in the tables throughout the report. Those interested to know the specific sources of any of the data should contact CDA.

The statistics are arranged in a logical sequence to trace the flow of copper in the U.S. economy from mining and scrap collection through smelting, refining and ingot making to wire rod mills to wire mills, brass mills, and foundries to the final end-use markets. This flow is shown schematically on pages 4 and 5. On this schematic flow sheet the major statistics of copper supply and consumption in the United States for 2023 appear. Along with each major statistic on the chart, a reference is shown. This reference identifies the table in the report where details on that item, from 2003 through 2023, will be found. Most data for 2023 are preliminary.

There are four major tables in the report. **Table 1** covers the supply of primary copper. **Table 2** presents data on the supply of copper from secondary sources. In **Table 3**, statistics on the consumption of primary and secondary metals by mills, foundries and other industries are summarized.

Finally, **Table 4** details the supply of mill, foundry and powder products and their consumption in five end-use market areas. In each of these tables, additions to the flow (such as net imports) are indicated as positive numbers, while subtractions from the flow (such as melting losses or net additions to stocks) are shown in parentheses.

The arrangement of the data in the report can be illustrated with an example. Consider Mine Production, the upper left-hand box in the flow sheet on **page 4**. As shown in the box, mine production of copper in the United States totaled 1,227 thousand tons in 2023. Beneath this figure a number appears referring to Table 1, abbreviated 1 (1). This means that in **Table 1**, on Line (1), mine production is shown for the full period 2003 through 2023. In **Table 1**, on Line (1), a further reference will be found after the item heading Mine Production, directing the reader elsewhere on page 6. In fact, on page 6, a table entitled **Table 1, Item 1** presents the data on mine production by state for 2003 through 2023. In this way all the data on supply and consumption appear in logical sequence proceeding through the report, eliminating the need for explanatory text.

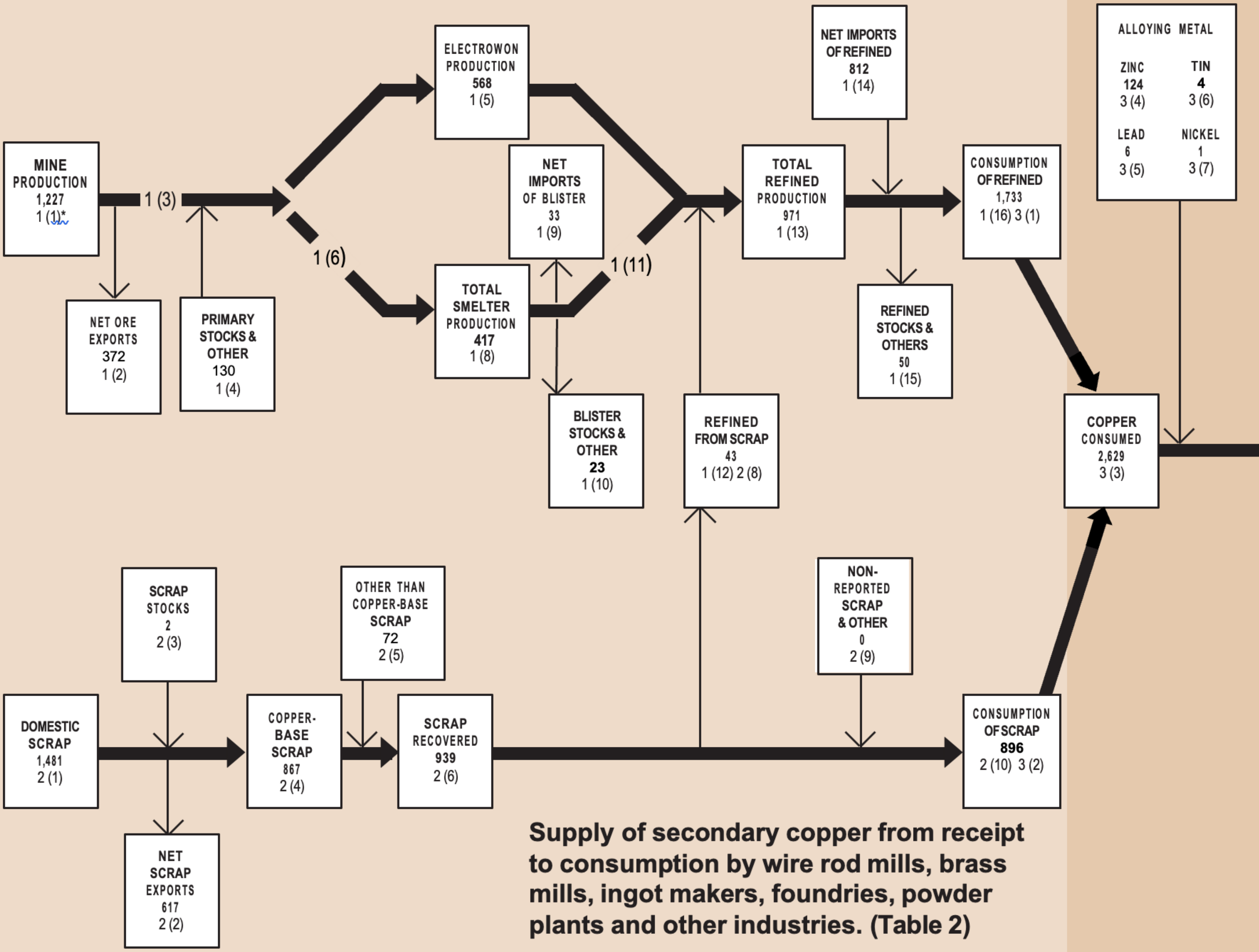
Copper Development Association Inc.

Contents

Copper Development Association Inc.

Supply of primary copper from mine to consumption by wire rod mills, brass mills, ingot makers, foundries, powder plants and other industries. (Table 1)

COPPER CONTENT, thousands of short tons



Supply of secondary copper from receipt to consumption by wire rod mills, brass mills, ingot makers, foundries, powder plants and other industries. (Table 2)

COPPER CONTENT, thousands of short tons

*1 (1) Refers to table and item in report where data for 2003 through 2023 appear.

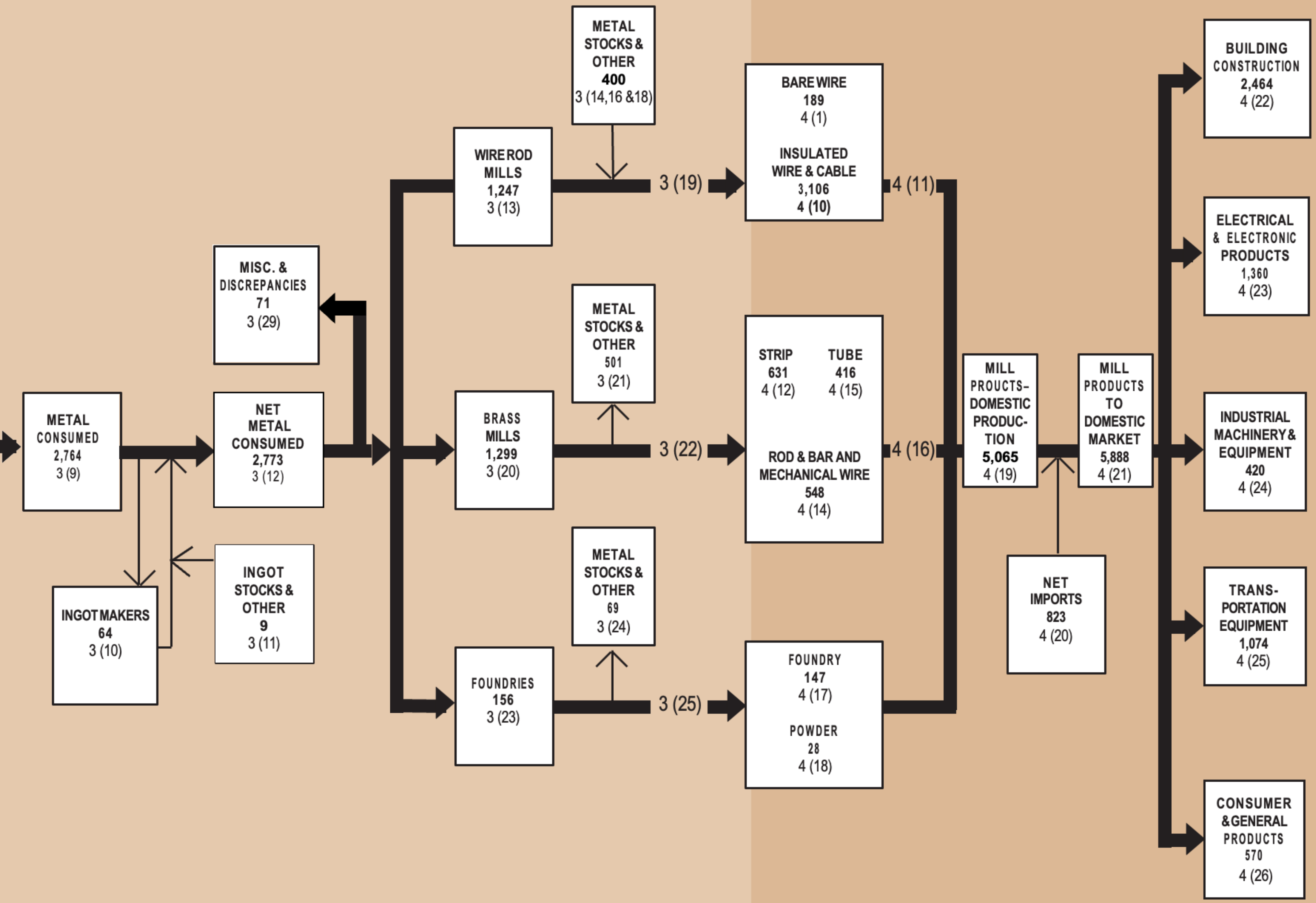
Copper Development Association Inc.

Consumption of metals by wire rod mills, brass mills, ingot makers, foundries, powder plants and other industries. (Table 3)

METAL CONTENT, thousands of short tons

Supply of wire mill, brass mill, foundry and powder products and their consumption in the end-use markets. (Table 4)

METAL CONTENT, millions of pounds



Copper Development Association Inc.

Table 1.

Supply of primary copper from mine to consumption by wire rod mills, brass mills, ingot makers, foundries, powder plants and other industries

	Copper Content, thousands of short tons																					
		2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022r	2023p
(1)	Mine Production (page 6)	1,230	1,275	1,257	1,319	1,287	1,444	1,302	1,224	1,227	1,290	1,376	1,490	1,551	1,576	1,388	1,347	1,386	1,325	1,356	1,359	1,227
(2)	Net Ore/Conc./Matte Imports (page 8)[(a)]	4	(24)	(195)	(222)	(214)	(381)	(166)	(150)	(261)	(325)	(379)	(452)	(432)	(365)	(246)	(243)	(370)	(420)	(371)	(376) r	(372)
(3)	Total Primary	1,234	1,251	1,062	1,097	1,074	1,063	1,136	1,074	966	965	997	1,038	1,119	1,212	1,142	1,104	1,015	905	984	983	855
(4)	Primary Stocks and Other	12	(10)	126	39	162	127	46	62	120	89	96	104	110	87	(10)	74	77	58	32	19 r	130
(5)	Electrowon Production..	652	644	611	584	556	560	525	474	493	519	524	567	648	678	614	586	581	616	620	612 r	568
(6)	Smelter Production from Primary	594	597	577	552	680	630	658	662	593	535	569	575	581	621	518	591	511	347	397	390 r	417
(7)	Smelter Production from Scrap	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
(8)	Total Smelter Production (page 8)	594	597	577	552	680	630	658	663	593	535	569	575	581	621	518	591	511	347	397	390 r	417
(9)	Net Imports of Blister/Anode (page 8)	144	115	100	167	152	110	49	10	(15)	(15)	(11)	(12)	(11)	(10)	(10)	(10)	(8)	(7)	(26)	(13)	(33)
(10)	Blister/Anode Stocks and Other (page 9)	(9)	27	45	24	23	51	(9)	22	23	21	14	28	(16)	12	24	12	1	7	77	22 r	(23)
(11)	Refined Production from Blister/Anode	729	740	721	744	855	791	699	694	601	541	571	591	553	623	532	593	505	347	448	399 r	360
(12)	Refined Production from Scrap.	59	56	52	49	51	60	51	42	41	44	52	51	54	51	44	45	49	48	54	44	43
(13)	Total Refined Production (page 9)	1,440	1,439	1,384	1,378	1,462	1,411	1,275	1,210	1,135	1,104	1,146	1,208	1,255	1,352	1,191	1,225	1,135	1,011	1,121	1,055 r	971
(14)	Net Imports of Refined (page 9)	622	636	1,023	1,117	861	776	643	581	734	519	685	543	661	633	792	648	593	700	961	776	812
(15)	Refined Stocks and Other (page 10)	462	587	99	(168)	33	41	(101)	157	68	317	182	181	66	12	2	123	299	172	(164)	57 r	(50)
(16)	Consumption of Refined (page 10	**2,524**	**2,662**	**2,506**	**2,327**	**2,356**	**2,228**	**1,817**	**1,947**	**1,936**	**1,940**	**2,013**	**1,933**	**1,982**	**1,996**	**1,985**	**1,996**	**2,026**	**1,883**	**1,917**	**1,888**	**1,733**

Source: U.S. Department of the Interior, U.S. Geological Survey, National Minerals Information Center

p - preliminary, r - revised

(a) - Included with domestic ore.

Numbers may not sum due to rounding.

Table 1, Item 1.

Copper content of mine production in the United States[1]

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022r	2023p
Arizona	817	797	761	785	806	923	784	775	828	843	876	980	1,086	1,068	957	883	947	970	956	942	874
Other States[(a)]	413	478	496	535	482	521	518	448	399	446	499	510	465	508	431	464	439	355	400	417	353
TOTAL...	**1,230**	**1,275**	**1,257**	**1,319**	**1,287**	**1,444**	**1,302**	**1,224**	**1,227**	**1,290**	**1,376**	**1,490**	**1,551**	**1,576**	**1,388**	**1,347**	**1,386**	**1,325**	**1,356**	**1,359**	**1,227**

Source: U.S. Department of the Interior, U.S. Geological Survey, National Minerals Information Center

p - preliminary, r - revised

(a) - Includes California, Colorado, Idaho, Illinois, Kentucky, Maine, Michigan, Missouri, Montana, Nevada, New Mexico, Oregon, Pennsylvania, Tennessee, Utah and Washington.

(1) Copper content of concentrates, precipitates, or electrowon.

Numbers may not sum due to rounding.

Copper Development Association Inc.

Table 1, Item 1a.

Copper content of world mine production (1)

	Copper Content, thousands of short tons																				
	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022r**	**2023p**
Australasia																					
Australia	915	941	1,010	947	960	974	941	959	1,058	1,015	1,100	1,070	1,062	1,045	948	1,079	1,034	969	875	911 r	877
Papua New Guinea	216	191	213	214	187	176	184	176	144	138	116	84	53	88	116	106	116	91	72	84 r	96
Total Australasia.	**1,131**	**1,133**	**1,223**	**1,161**	**1,147**	**1,150**	**1,125**	**1,135**	**1,202**	**1,153**	**1,217**	**1,153**	**1,115**	**1,134**	**1,064**	**1,185**	**1,150**	**1,060**	**947**	**994 r**	**973**
Americas																					
Argentina	219	194	206	199	199	173	158	155	129	150	121	113	68	90	37	19	0	-	-	-	-
Brazil	30	109	144	158	227	243	228	236	238	244	299	324	382	369	424	425	398	402	372	331	419
Canada.	615	620	656	665	657	669	540	579	624	638	697	767	769	780	668	598	631	648	604	573	551
Chile.	5,406	5,966	5,865	5,909	6,125	5,873	5,941	5,973	5,801	5,990	6,367	6,338	6,363	6,121	6,067	6,428	6,380	6,320	6,200	5,876 r	5,788
Ecuador.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	132	137
Mexico.	394	447	473	368	372	272	263	298	485	551	531	568	655	845	818	828	847	808	809	831 r	801
Panama.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	386	365
Peru.	929	1,142	1,113	1,156	1,312	1,398	1,407	1,375	1,362	1,431	1,516	1,521	1,875	2,595	2,696	2,686	2,707	2,370	2,564	2,695 r	3,037
United States..	1,230	1,275	1,257	1,319	1,288	1,444	1,302	1,224	1,227	1,290	1,376	1,488	1,551	1,576	1,576	1,389	1,412	1,325	1,356	1,356 r	1,389
Total Americas.	**8,823**	**9,754**	**9,715**	**9,774**	**10,180**	**10,072**	**9,838**	**9,839**	**9,866**	**10,294**	**10,907**	**11,118**	**11,662**	**12,377**	**12,285**	**12,374**	**12,375**	**11,872**	**11,905**	**12,180.2 r**	**12,486**
Europe																					
Bulgaria..	103	104	104	122	121	116	116	116	126	119	121	121	121	121	121	121	121	121	121	116 r	116
Finland..	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	30	22
Poland.	546	585	564	548	498	473	484	469	470	471	473	464	469	468	462	442	440	433	431	433	436
Portugal..	85	105	99	87	99	99	96	82	88	81	84	83	90	84	75	54	46	35	42	35	37
Scandinavia	108	108	112	110	84	78	76	101	107	119	134	135	129	139	174	169	151	149	132	128	104
Serbia....	23	13	14	13	18	21	21	0	—	—	—	—	—	—	48	50	51	58	133	225	263
Spain....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	13	127
Total Europe.	**865**	**916**	**893**	**880**	**821**	**786**	**793**	**767**	**791**	**790**	**812**	**803**	**810**	**813**	**880**	**836**	**808**	**796**	**860**	**980.1 r**	**1,105**
Asia																					
Russian Federation	694	694	705	744	761	777	745	775	799	794	799	816	769	755	796	852	871	971	989	986	954
Armenia	—	—	—	—	—	—	—	—	—	—	—	56	91	113	124	84	116	109	108	89	84
China....	816	977	998	1,126	1,043	1,205	1,171	1,300	1,402	1,642	1,891	1,963	1,881	2,095	1,881	1,754	1,795	1,900	2,004	2,023 r	1,929
India	32	33	25	32	36	31	33	36	40	33	43	32	33	34	35	38	31	25	29	26 r	28
Indonesia	1,106	929	1,174	900	870	717	1,098	962	599	439	561	418	638	802	686	718	398	557	829	1,064	1,030
Iran..	162	161	181	238	269	273	289	283	334	271	246	239	272	319	333	349	344	346	374	379	359
Kazakhstan.	535	509	443	479	448	465	448	419	479	460	493	484	489	535	535	699	767	774	702	836	868
Laos	—	—	—	—	—	—	—	—	—	—	171	176	185	185	169	167	156	97	44	41	56
Mongolia (2)	—	—	—	—	146	143	142	139	137	137	219	295	366	387	343	336	322	321	335	295	345
Philippines..	22	18	18	19	24	24	52	65	70	72	102	99	93	92	75	72	78	67	56	66	68
Serbia	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	324	263
Turkiye	—	—	—	—	—	—	—	—	—	—	—	134	119	110	91	88	81	118	121	133 r	140
Total Asia..	**3,367**	**3,322**	**3,544**	**3,538**	**3,598**	**3,634**	**3,976**	**3,979**	**3,859**	**3,848**	**4,525**	**4,711**	**4,937**	**5,426**	**5,067**	**5,157**	**4,958**	**5,284**	**5,591**	**6,263 r**	**6,126**
Africa																					
Botswana	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	38	**80**
Congo DR	70	82	111	141	157	236	332	401	529	619	925	1,008	1,002	1,084	1,169	1,370	1,415	1,679	2,057	2,529	3,017
Namibia..	18	15	12	7	11	10	—	—	4	6	5	6	15	18	17	7	17	12	1	0 r	0
South Africa	99	96	98	99	107	120	119	113	127	89	84	87	85	72	72	53	58	32	56	55	55
Zambia	384	443	477	523	561	612	614	756	864	766	838	776	791	841	875	941	879	940	928	852 r	793
Total Africa	**571**	**636**	**697**	**769**	**836**	**977**	**1,065**	**1,270**	**1,524**	**1,480**	**1,852**	**1,877**	**1,893**	**2,015**	**2,134**	**2,371**	**2,369**	**2,662**	**3,042**	**3,474 r**	**3,945**
Other(3)..	**320**	**520**	**548**	**600**	**476**	**509**	**741**	**686**	**720**	**856**	**828**	**716**	**673**	**675**	**881**	**813**	**995**	**1,072**	**1,109**	**319 r**	**186**
TOTAL WORLD.	**15,077**	**16,281**	**16,620**	**16,721**	**17,057**	**17,127**	**17,539**	**17,676**	**17,962**	**18,421**	**20,141**	**20,380**	**21,090**	**22,439**	**22,309**	**22,736**	**22,655**	**22,748**	**23,455**	**24,210 r**	**24,820**

Sources: International Copper Study Group
p - preliminary r -revised
(1) Copper content of concentrates, precipitates, or electrowon.
(2) Mongolia no longer included with China starting in 2007.
(3) Includes countries from various continents, making the continent totals somewhat low.
Numbers may not sum due to rounding.

Copper Development Association Inc.

Table 1, Item 2.

Imports and exports of copper ore, concentrates, matte, ash and preciptates in the United States

Copper Content, thousands of short tons

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022r	2023p
Imports (Ore, Cencentrate, Matte, Ash)	32	27	2	2	3	2	0	2	17	7	5	0	0	0	16	35	30	2	12	13	4
Exports (Ore, Cencentrate, Matte, Ash)	(28)	(51)	(197)	(224)	(217)	(383)	(166)	(151)	(278)	(332)	(384)	(452)	(432)	(365)	(261)	(279)	(400)	(422)	(384)	(389) r	(376)
Net Imports (Ore, Concentrate, Matte, Ash)(a).	**4**	**(24)**	**(195)**	**(222)**	**(214)**	**(381)**	**(166)**	**(150)**	**(261)**	**(325)**	**(379)**	**(452)**	**(432)**	**(365)**	**(246)**	**(243)**	**(370)**	**(420)**	**(371)**	**(376) r**	**(372)**

Source: U.S. Department of the Interior, U.S. Geological Survey, National Minerals Information Center
p - preliminary, r - revised
(a) - ( ) sign denotes net exports.
Numbers may not sum due to rounding.

Table 1, Item 8.

Smelter production of copper in the United States

Copper Content, thousands of short tons

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022r	2023p
Smelter Production - Domestic Ore																					
(Table 1, Item 6)...	594	597	577	552	680	630	658	662	593	535	569	575	581	621	518	591	511	347	397	390 r	417
Smelter Production - Foreign Ore	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Smelter Production - Scrap (Table 1, Item 7)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
TOTAL SMELTER PRODUCTION	**594**	**597**	**577**	**552**	**680**	**630**	**658**	**662**	**593**	**535**	**569**	**575**	**581**	**621**	**518**	**591**	**511**	**347**	**397**	**390 r**	**417**

Source: U.S. Department of the Interior, U.S. Geological Survey, National Minerals Information Center
p - preliminary, r - revised
(a) - Included with domestic ore.
Numbers may not sum due to rounding.

Table 1, Item 9.

Imports and exports of blister and anode copper in the United States

Copper Content, thousands of short tons

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022r	2023p
Imports of Blister/Anode Copper.	173	166	146	188	169	136	75	29	1	1	1	1	0	0	1	0	0	0	0	0	0
Exports of Blister/Anode Copper.	(29)	(51)	(46)	(21)	(17)	(26)	(26)	(19)	(16)	(15)	(12)	(13)	(12)	(10)	(11)	(10)	(8)	(7)	(27)	(13)	(33)
Net Imports of Blister/Anode Copper	**144**	**115**	**100**	**167**	**152**	**110**	**49**	**10**	**(15)**	**(15)**	**(11)**	**(12)**	**(11)**	**(10)**	**(10)**	**(10)**	**(8)**	**(7)**	**(26)**	**(13)**	**(33)**

Source: U.S. Department of the Interior, U.S. Geological Survey.
p - preliminary, r - revised
Numbers may not sum due to rounding.

Table 1, Item 10.

Blister and anode stocks and other

	Copper Content, thousands of short tons																				
	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022r**	**2023p**
End-of-Year Blister/Anode Copper Stocks..	63	57	49	21	29	27	17	29	14	14	14	11	15	16	14	10	18	10	18	15	12
Net Change(a)..	14	(6)	(8)	(28)	8	(2)	(10)	12	(15)	(1)	0	(3)	4	1	(2)	(4)	8	(8)	7	7	4
Apparent Change(b)	9	(27)	(45)	(24)	(23)	(51)	9	(22)	(23)	(21)	(14)	(28)	16	(12)	(24)	(12)	(1)	(7)	(77)	(22) r	23

Source: U.S. Department of the Interior, U.S. Geological Survey, National Minerals Information Center
p - preliminary, r - revised
(a) - Net Change - the year-to-year increase (+) or decrease ( ) of blister copper stocks as reported.
(b) - Apparent Change - the difference between Line 11 and the sum of Lines 8 & 9 in Table 1, required to rationalize the CDA flow sheet. Factors other than changes in stocks are included in the apparent change.
The sign of the data + or ( ) is opposite that shown in Table 1.
Numbers may not sum due to rounding.

Table 1, Item 13.

Production of refined copper in the United States

	Copper Content, thousands of short tons																				
	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022r**	**2023p**
Refined Production - Primary Sources																					
(Table 1, Items 1,2,4,9 and 10).	1,381	1,383	1,332	1,328	1,411	1,351	1,224	1,168	1,093	1,060	1,095	1,157	1,202	1,301	1,146	1,179	1,086	963	1,067	1,011 r	928
Refined Production - Scrap at Smelters																					
(Table 1, Item 7)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Refined Production - Scrap at Refiners																					
(Table 1, Item 12)	59	56	52	49	51	60	51	42	41	44	52	51	54	51	44	45	49	48	54	44	43
TOTAL REFINED PRODUCTION..	**1,440**	**1,439**	**1,384**	**1,378**	**1,462**	**1,411**	**1,275**	**1,210**	**1,135**	**1,104**	**1,146**	**1,208**	**1,255**	**1,352**	**1,191**	**1,225**	**1,135**	**1,011**	**1,121**	**1,055 r**	**971**

Source: U.S. Department of the Interior, U.S. Geological Survey, National Minerals Information Center
p - preliminary, r - revised
Numbers may not sum due to rounding.

Table 1, Item 14.

Imports and exports of refined copper in the United States

	Copper Content, thousands of short tons																				
	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022r**	**2023p**
General Imports of Refined Copper 1	758	776	1,077	1,184	917	798	732	667	739	694	809	683	756	780	896	858	731	745	1,013	807	850
Total Exports of Refined Copper	(136)	(140)	(54)	(67)	(56)	(22)	(89)	(86)	(5)	(175)	(125)	(140)	(95)	(148)	(104)	(209)	(138)	(45)	(52)	(30)	(38)
Net Imports of Refined Copper	**622**	**636**	**1,023**	**1,117**	**861**	**776**	**643**	**581**	**734**	**519**	**685**	**543**	**661**	**633**	**792**	**648**	**593**	**700**	**961**	**776**	**812**

Source: U.S. Department of the Interior, U.S. Geological Survey, National Minerals Information Center
p - preliminary, r - revised
[1] General Imports measure the total physical arrivals of merchandise from foreign countries, whether such merchandise enters consumption channels immediately or is entered into bonded warehouses or Foreign Trade Zones under Customs custody.
Numbers may not sum due to rounding.

Copper Development Association Inc.

Table 1, Item 15.

Refined stocks and other

Copper Content, thousands of short tons

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022r	2023p
End-of year Refined Copper Stocks at:																					
Refineries......	13	11	9	31	24	17	26	11	9	14	17	11	13	5	6	4	8	4	6	10	8
Wire Rod Mills.......	33	22	22	24	23	25	28	22	26	31	36	46	40	29	31	24	22	12	13	20	19
Brass Mills..	22	24	27	38	11	9	8	7	8	7	7	7	8	8	9	9	8	9	10	12	11
Other Processors	5	4	6	6	6	4	5	5	5	5	5	5	8	8	6	6	8	8	8	7	7
Government...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Commodity Exchange.	281	48	7	34	15	36	99	65	88	71	17	27	70	88	211	110	38	77	70	35	19
London Metal Exchange ..	369	39	1	83	67	117	312	313	315	132	204	112	92	109	30	115	39	20	22	8	77
End-of Year Total...	**723**	**148**	**73**	**216**	**146**	**207**	**478**	**423**	**451**	**260**	**285**	**208**	**232**	**248**	**292**	**268**	**122**	**130**	**130**	**91**	**140**
Net Change (a)...	(413)	(575)	(75)	144	(70)	61	271	(56)	29	(191)	25	(77)	24	14	46	(24)	(146)	8	(1)	(38)	49
Apparent Change (b)	(462)	(587)	(99)	168	(33)	(41)	101	(157)	(68)	(317)	(182)	(181)	(66)	(12)	(2)	(123)	(299)	(172)	164	(57) r	50

Source: U.S. Department of the Interior, U.S. Geological Survey, National Minerals Information Center

p - preliminary, r - revised

(a) - Net Change - the year-to-year increase (+) or de

(b) - Apparent Change - the difference between Line 16 and the sum of Lines 13 and 14 in Table 1, required to rationalize the CDA flow sheet. Factors other than changes in stocks are included in the apparent change. The sign of the data (+) or ( ) is opposite that shown in Table 1.

Numbers may not sum due to rounding.

Table 1, Item 16.

Consumption of refined copper in the United States

Copper Content, thousands of short tons

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022r	2023p
Consumption of Refined Copper by:																					
Wire Rod Mills	1,809	1,962	1,852	1,731	1,775	1,642	1,257	1,378	1,400	1,411	1,444	1,400	1,455	1,455	1,455	1,466	1,499	1,356	1,422	1,378	1,224
Brass Mills.	647	632	582	540	525	528	500	506	474	467	504	467	465	464	463	462	455	455	457	463	462
Ingot Makers..	5	5	5	5	5	3	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Foundries and Other Industries (a)...	63	63	67	51	51	55	60	63	62	62	65	65	62	77	67	68	72	72	38	47	47
Powder Plants (a)..	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Other Industries	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
TOTAL REFINED CONSUMPTION	**2,524**	**2,662**	**2,506**	**2,327**	**2,356**	**2,228**	**1,817**	**1,947**	**1,936**	**1,940**	**2,013**	**1,933**	**1,982**	**1,996**	**1,985**	**1,996**	**2,026**	**1,883**	**1,917**	**1,888**	**1,733**

Source: U.S. Department of the Interior, U.S. Geological Survey, National Minerals Information Center

p - preliminary, r - revised

(a) - Starting with 1995 Powder Plants data are included with Foundries. Starting in 2009 Ingot Makers data are also included with Foundries.

Numbers may not sum due to rounding.

1

Copper Development Association Inc.

Table 2.

Supply of secondary copper from receipt to consumption by brass mills, ingot makers, foundries, powder plants and other industries

Copper Content, thousands of short tons

		2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022r	2023p
(1)	Receipts of Domestic Scrap	1,511	1,557	1,511	1,623	1,570	1,755	1,648	1,810	2,064	2,023	1,978	1,857	1,730	1,824	1,809	1,699	1,532	1,595	1,689	1,725 r	1,481
(2)	Net Scrap Imports (page 12)(a)	(538)	(549)	(512)	(628)	(653)	(883)	(850)	(1,033)	(1,246)	(1,202)	(1,158)	(1,024)	(930)	(901)	(925)	(832)	(658)	(730)	(854)	(880)	(617)
(3)	Scrap Stocks (page 12).	3	(11)	(9)	(2)	20	0	5	31	0	0	1	(2)	0	(54)	(15)	(0)	(0)	24	27	2 r	2
(4)	Recovery from Copper-Base Scrap (page 13)	977	996	990	992	937	873	803	808	818	821	821	830	800	868	870	868	874	890	863	848	867
(5)	Recovery from Other Scrap (page 13)	64	68	61	77	83	67	51	57	67	70	71	76	74	74	76	76	81	60	62	74 r	72
(6)	Total Scrap Recovery (page 13)..	1,041	1,064	1,051	1,069	1,020	940	854	865	885	891	892	906	873	943	946	944	954	950	925	922 r	939
(7)	Smelter Production from Scrap	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
(8)	Refined Production from Scrap	(59)	(56)	(52)	(49)	(51)	(60)	(51)	(42)	(41)	(44)	(52)	(51)	(54)	(51)	(44)	(45)	(49)	(48)	(54)	(44)	(43)
(9)	Non-Reported Scrap & Other.	8	8	8	8	9	10	9	0	0	0	0	1	1	1	(5)	(0)	(0)	20	37	0 r	0
(10)	Consumption of Scrap (page 13)	990	1,016	1,006	1,027	978	890	812	823	843	847	841	856	820	893	897	898	905	922	908	878 r	896

Source: U.S. Department of the Interior, U.S. Geological Survey, National Minerals Information Center

p - preliminary, r - revised

(a) - ( ) sign denotes net exports.

Numbers may not sum due to rounding.

Copper Development Association Inc.

Table 2, Item 2.

Imports and exports of copper-base scrap in the United States

	Copper Content, thousands of short tons																				
	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022r**	**2023p**
Imports of Copper-Base Scrap	78	88	100	101	124	117	79	106	121	115	117	129	123	138	182	174	152	126	157	142	131
Exports of Copper-Base Scrap	(616)	(637)	(612)	(729)	(777)	(1,000)	(929)	(1,139)	(1,367)	(1,317)	(1,275)	(1,153)	(1,053)	(1,039)	(1,107)	(1,005)	(810)	(855)	(1,011)	(1,022)	(747)
Net Imports of Copper-Base Scrap[(a)]	**(538)**	**(549)**	**(512)**	**(628)**	**(653)**	**(883)**	**(850)**	**(1,033)**	**(1,246)**	**(1,202)**	**(1,158)**	**(1,024)**	**(930)**	**(901)**	**(925)**	**(832)**	**(658)**	**(730)**	**(854)**	**(880)**	**(617)**

Source: U.S. Department of the Interior, U.S. Geological Survey, National Minerals Information Center

p - preliminary, r - revised

(a) - The ( ) sign for each year is used to be consistent with the convention used in Tables 1, 2 and 4, namely that imports are **additions** to the domestic flow, and therefore (+), while exports are **subtractions** from the flow, and therefore ( ).

Numbers may not sum due to rounding.

Table 2, Item 3.

Copper-base scrap stocks

	Copper Content, thousands of short tons																				
	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022r**	**2023p**
Scrap Copper-Base Stocks at:																					
Brass Mills.	40	51	56	58	40	40	36	1	1	2	4	5	5	2	2	2	2	2	2	2 r	2
Secondary Smelters & Primary Producers	7	7	12	12	10	11	8	12	10	11	9	9	9	66	81	81	81	58	33	30 r	28
Foundries Other Processors.	5	4	4	4	4	3	5	5	7	5	5	5	5	5	5	5	5	4	2	3 r	2
End-of Year Total	**52**	**63**	**72**	**74**	**54**	**54**	**49**	**18**	**18**	**18**	**17**	**19**	**19**	**73**	**88**	**88**	**88**	**64**	**36**	**34 r**	**32**
Net Change(a)	(3)	11	9	2	(20)	(0)	(5)	(31)	(0)	(0)	(1)	2	(0)	54	15	0	0	(24)	(27)	(2) r	(2)

Source: U.S. Department of the Interior, U.S. Geological Survey, National Minerals Information Center

p - preliminary, r - revised

(a) - Net Change - the year-to-year increase (+) or decrease ( ) of stocks as reported. The sign of the data (+) or ( ) is opposite that shown in Table 2.

Numbers may not sum due to rounding.

1

Copper Development Association Inc.

Table 2, Item 6.

Recovery of copper from scrap

	Copper Content, thousands of short tons																				
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022r	2023p
Copper Recovered from Copper-Base Scrap.....																					
New Scrap..	773	810	805	851	797	726	670	675	681	669	657	685	662	725	743	741	741	756	713	707	731
Old Scrap.	204	186	185	141	140	147	132	133	137	152	164	145	138	143	127	127	133	133	150	141	136
Total (Table 2, Item 4)	**977**	**996**	**990**	**992**	**937**	**873**	**803**	**808**	**818**	**821**	**821**	**830**	**800**	**868**	**870**	**868**	**874**	**890**	**863**	**848**	**867**
Copper Recovered from Scrap other than Copper-Base																					
New Scrap...	40	43	44	52	50	42	32	33	35	36	37	40	40	41	42	42	45	35	39	40 r	39
Old Scrap.	24	25	17	25	33	26	19	24	32	34	34	36	33	33	34	34	36	25	22	34 r	33
Total (Table 2, Item 5)....	**64**	**68**	**61**	**77**	**83**	**67**	**51**	**57**	**67**	**70**	**71**	**76**	**74**	**74**	**76**	**76**	**81**	**60**	**62**	**74 r**	**72**
Copper Recovered from All Scrap																					
New Scrap...	813	853	848	902	846	768	703	708	716	706	694	726	702	766	786	783	786	792	752	746 r	770
Old Scrap...	228	211	202	166	173	172	151	158	169	186	198	181	171	176	161	161	169	158	172	175 r	169
Total Copper Recovered (Table 2, Item 6)	**1,041**	**1,064**	**1,051**	**1,069**	**1,020**	**940**	**854**	**865**	**885**	**891**	**892**	**906**	**873**	**943**	**946**	**944**	**954**	**950**	**925**	**922 r**	**939**

Source: U.S. Department of the Interior, U.S. Geological Survey, National Minerals Information Center

p - preliminary, r - revised

Numbers may not sum due to roundi

Table 2, Item 10.

Consumption of copper scrap in the United States

	Copper Content, thousands of short tons																				
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022r	2023p
Consumption of Copper Scrap by:																					
Wire Rod Mills.	28	29	29	30	28	26	24	25	25	20	20	21	20	22	23	23	23	24	23	23	24
Brass Mills...	717	748	739	763	710	651	605	608	615	611	604	647	608	663	688	697	697	713	699	693	714
Ingot Makers....	101	99	104	91	100	87	83	84	86	84	83	62	62	80	63	63	64	64	64	44	44
Foundries.....	80	72	74	66	57	59	49	50	51	63	62	50	54	52	52	40	41	41	41	44	44
Powder Plants (a)....	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Chemical Plants (b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)
Non-copper based scrap..	64	68	61	77	83	67	51	57	67	70	72	77	72	72	76	76	76	80	62	62	62
Miscellaneous Adjustments	—	—	—	—	—	—	—	—	—	—	—	—	3	3	(4)	0	5	2	20	12 r	9
TOTAL COPPER CONSUMED.....	**990**	**1,016**	**1,006**	**1,027**	**978**	**890**	**812**	**823**	**843**	**848**	**841**	**856**	**820**	**893**	**897**	**898**	**905**	**922**	**908**	**878 r**	**896**

Source: U.S. Department of the Interior, U.S. Geological Survey, National Minerals Information Center

p - preliminary, r - revised

(a) - Starting with 1995 Powder Plants data are included with Foundries.

(b) - Chemical Plants data included with Foundries.

Numbers may not sum due to rounding.

Copper Development Association Inc.

Table 3.

Consumption of metals by wire rod mills, brass mills, ingot makers, foundries, powder plants and other industries

	Copper Content, thousands of short tons																					
		2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022r**	**2023p**
(1)	Consumption of Refined Copper (Table 1, Item 16)	2,524	2,662	2,506	2,327	2,356	2,228	1,817	1,947	1,936	1,940	2,013	1,933	1,982	1,996	1,985	1,996	2,026	1,883	1,917	1,888	1,733
(2)	Consumption of Copper in Scrap (Table 2, Item 10)	990	1,016	1,006	1,027	978	890	812	823	843	848	841	856	820	893	897	898	905	922	908	878 r	896
(3)	**Total Copper Consumed (page 15)**	**3,514**	**3,678**	**3,512**	**3,354**	**3,334**	**3,118**	**2,628**	**2,771**	**2,780**	**2,788**	**2,854**	**2,789**	**2,802**	**2,889**	**2,882**	**2,894**	**2,932**	**2,806**	**2,826**	**2,766 r**	**2,629**
(4)	Consumption of Zinc..	266	284	273	268	253	226	238	236	186	196	166	162	145	134	134	134	133	143	139	129	124
(5)	Consumption of Lead.	13	14	11	11	11	13	12	11	13	10	10	12	11	10	7	7	10	7	6	6	6
(6)	Consumption of Tin.	8	8	9	9	9	8	8	7	11	9	8	7	6	6	5	5	6	4	4	4	4
(7)	Consumption of Nickel...	6	7	7	6	6	5	5	5	2	1	1	2	1	1	0	0	0	0	1	1	1
(8)	**Total Alloying Metal Consumed (page 16)**	**293**	**314**	**300**	**295**	**278**	**252**	**263**	**259**	**212**	**217**	**186**	**183**	**164**	**151**	**145**	**145**	**150**	**155**	**150**	**140**	**135**
(9)	**Total Metal Consumed**	**3,807**	**3,992**	**3,812**	**3,649**	**3,611**	**3,371**	**2,891**	**3,030**	**2,991**	**3,004**	**3,040**	**2,972**	**2,966**	**3,040**	**3,027**	**3,039**	**3,081**	**2,961**	**2,976**	**2,906 r**	**2,764**
(10)	Ingot Consumed (page 17)[(a)]	112	109	102	97	90	84	85	83	68	68	65	65	62	65	65	65	65	65	61	64	64
(11)	Ingot Stocks & Other (a,b)	(14)	(17)	(27)	(20)	(38)	(30)	(28)	(23)	(41)	(40)	(38)	(17)	(18)	(32)	(14)	(13)	(16)	(12)	(13)	9	9
(12)	**Net Metal Consumed (page 17).**	**3,793**	**3,974**	**3,785**	**3,629**	**3,573**	**3,341**	**2,863**	**3,007**	**2,950**	**2,965**	**3,002**	**2,956**	**2,948**	**3,008**	**3,013**	**3,027**	**3,066**	**2,949**	**2,963**	**2,915 r**	**2,773**
(13)	Wire Rod Mills - Net Metal Consumed (p 17)	1,837	1,991	1,881	1,760	1,802	1,668	1,281	1,403	1,425	1,431	1,464	1,421	1,475	1,477	1,478	1,489	1,522	1,379	1,445	1,401	1,247
(14)	Wire Rod Mills - Metal Stocks & Other	(29)	(30)	(201)	(13)	(40)	7	(24)	(36)	(47)	(20)	(9)	1	(31)	(44)	(23)	(32)	(67)	(13)	54	65	43
(15)	Wire Rod Mills - Shipments..	1,808	1,961	1,680	1,747	1,763	1,676	1,257	1,367	1,378	1,411	1,455	1,422	1,444	1,433	1,455	1,466	1,455	1,367	1,499	1,466	1,290
(16)	Wire Rod - Net Imports..	241	208	486	446	159	77	1	(43)	36	(5)	15	10	(19)	(20)	(52)	32	84	70	302	542	437
(17)	Wire Mills - Net Metal Consumed	2,049	2,169	2,166	2,193	1,922	1,753	1,257	1,324	1,414	1,406	1,470	1,432	1,425	1,413	1,403	1,498	1,539	1,436	1,801	2,008	1,727
(18)	Wire Mills - Metal Stocks & Other.	(197)	(151)	(109)	(304)	(181)	(207)	151	77	(134)	16	(15)	(10)	30	72	115	72	59	121	(97)	(291)	(79)
(19)	Wire Mills - Metal Contained in Products Supplied (Table 4, Item 11)	1,852	2,018	2,057	1,889	1,741	1,546	1,408	1,401	1,280	1,422	1,455	1,422	1,456	1,486	1,518	1,571	1,598	1,557	1,704	1,717	1,648
(20)	Brass Mills - Net Metal Consumed (p 17)	1,609	1,637	1,571	1,547	1,455	1,368	1,285	1,298	1,272	1,260	1,297	1,273	1,215	1,258	1,279	1,286	1,284	1,309	1,295	1,284	1,299
(21)	Brass Mills - Metal Stocks & Other	(21)	82	128	74	(7)	(94)	(344)	(260)	(261)	(276)	(252)	(224)	(232)	(263)	(299)	(284)	(368)	(426)	(311)	(367)	(501)
(22)	Brass Mills - Metal Contained in Products Supplied (Table 4, Item 17).	1,588	1,720	1,699	1,621	1,448	1,274	941	1,038	1,011	983	1,018	1,049	983	995	980	1,003	916	882	984	916	798
(23)	Foundries - Net Metal Consumed (page 17)	274	270	264	238	223	230	242	250	186	204	196	184	182	198	185	175	179	179	141	156	156
(24)	Foundries - Metal Stocks & Other	(127)	(130)	(127)	(108)	(103)	(123)	(149)	(159)	(96)	(117)	(109)	(98)	(99)	(112)	(98)	(85)	(90)	(101)	(58)	(71)	(69)
(25)	Foundries - Metal Contained in Products Supplied .	148	140	138	130	120	108	93	91	90	87	87	87	83	86	87	91	90	78	83	85	87
(26)	Powder Plants - Net Metal Consumed (c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)
(27)	Powder Plants - Metal Stocks & Other(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)
(28)	Powder Plants - Metal Contained in Products Supplied (c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)
(29)	Other Industries - Net Metal Consumed Miscellaneous and Discrepancies	73	77	70	86	84	67	51	57	67	70	72	77	75	75	71	76	80	82	82	74 r	71

Source: U.S. Department of the Interior, U.S. Geological Survey, National Minerals Information Center

p - preliminary, r - revised, NA - not available

(a) - Direct consumption only; not including consumption of copper in ingots from ingot makers.

(b) - Ingot makers consume refined copper, scrap copper and alloying metal and ship to foundries, brass mills, powder plants and other industries.

(c) - Starting with 1995 Powder Plants are combined with "Foundries."

Numbers may not sum due to rounding.

Copper Development Association Inc.

Table 3, Item 3.

Consumption of copper by wire rod mills, brass mills, ingot makers, foundries, powder plants and other industries

Copper Content, thousands of short tons	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022r	2023p
Consumption of Copper by:																					
Wire Rod Mills																					
Refined	1,809	1,962	1,852	1,731	1,775	1,642	1,257	1,378	1,400	1,411	1,444	1,400	1,455	1,455	1,455	1,466	1,499	1,356	1,422	1,378	1,224
Scrap.	28	29	29	30	28	26	24	25	25	20	20	21	20	22	23	23	23	24	23	23	24
Total.	1,837	1,991	1,881	1,760	1,802	1,668	1,281	1,403	1,425	1,431	1,464	1,421	1,475	1,477	1,478	1,489	1,522	1,379	1,445	1,401	1,247
Brass Mills[(a)]																					
Refined.	647	632	582	540	525	528	500	506	474	467	504	467	465	464	463	462	455	455	457	463	462
Scrap.	717	748	739	763	710	651	605	608	615	611	604	647	608	663	688	697	697	713	699	693	714
Total.	1,364	1,380	1,321	1,303	1,235	1,179	1,105	1,114	1,089	1,078	1,108	1,114	1,073	1,127	1,151	1,158	1,153	1,168	1,156	1,156	1,176
Ingot Makers[(b)]																					
Refined.	5	5	5	5	5	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Scrap.	101	99	104	91	100	87	83	84	86	84	83	62	62	80	64	63	64	64	64	44	44
Total.	106	104	109	96	105	90	83	84	86	84	83	62	62	80	64	63	64	64	64	44	44
Foundries and Other Industries[(a,c)]																					
Refined.	63	63	67	51	51	55	60	63	62	62	65	65	62	77	67	68	72	72	38	47	47
Scrap.	71	63	65	57	51	52	44	50	51	63	62	50	54	52	52	40	41	41	41	44	44
Total.	134	127	132	109	103	107	104	113	113	125	127	115	116	129	119	109	113	113	79	91	91
Powder Plants[(c)]																					
Refined.	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)
Scrap.	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)
Total.	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)
Miscellaneous[(d)]																					
Refined	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Scrap.	73	77	70	86	89	74	56	57	67	70	72	77	75	75	71	76	80	82	82	74 r	71
Total.	73	77	70	86	89	74	56	57	67	70	72	77	75	75	71	76	80	82	82	74 r	71
All Industries																					
Refined (Table1, Item 16)	**2,524**	**2,662**	**2,506**	**2,327**	**2,356**	**2,228**	**1,817**	**1,947**	**1,936**	**1,940**	**2,013**	**1,933**	**1,982**	**1,996**	**1,985**	**1,996**	**2,026**	**1,883**	**1,917**	**1,888**	**1,733**
Scrap (Table 2, Item 10)	**990**	**1,016**	**1,006**	**1,027**	**978**	**890**	**812**	**823**	**843**	**848**	**841**	**856**	**820**	**893**	**897**	**898**	**905**	**922**	**908**	**878 r**	**896**
TOTAL COPPER CONSUMED (Table 3, Item 3)	**3,514**	**3,678**	**3,512**	**3,354**	**3,334**	**3,118**	**2,628**	**2,771**	**2,780**	**2,788**	**2,854**	**2,789**	**2,802**	**2,889**	**2,882**	**2,894**	**2,932**	**2,806**	**2,826**	**2,766 r**	**2,629**

Source: U.S. Department of the Interior, U.S. Geological Survey, National Minerals Information Center

p - preliminary, r - revised

(a) - Direct consumption only; not including consumption of copper in ingots from ingot makers.

(b) - Ingot makers consume refined copper, scrap copper and alloying metal and ship to foundries, brass mills, powder plants and other industries.

(c) - Starting with 1995 Powder Plants and Other Industries data are included with "Foundries and Other Industries."

(d) - Miscellaneous - reconciles discrepencies between USGS reports.

Numbers may not sum due to rounding.

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Copper Development Association Inc.

Table 3, Item 8.

Consumption of alloying metal by brass mills, ingot makers, foundries and powder plants

	Copper Content, thousands of short tons																				
	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022r**	**2023p**
Consumption of Alloying Metal by:																					
Brass Mills[a]																					
Zinc:Unalloyed & in Secondary Copper Alloys	231	241	236	230	209	179	170	176	173	174	154	150	134	125	125	125	125	136	133	122	118
Lead:Unalloyed & in Secondary Copper Alloys	6	7	4	4	3	3	3	3	4	4	4	6	5	4	2	2	5	4	3	3	3
Tin:Unalloyed & in Secondary Copper Alloys	2	2	3	4	3	2	2	2	5	3	2	2	1	1	1	1	2	1	1	1	1
Nickel:Unalloyed & in Secondary Copper Alloys	6	7	7	6	5	5	5	3	1	1	1	1	1	1	-	-	-	-	1	1	1
Total	245	256	250	243	221	189	180	184	183	182	162	159	141	131	128	128	131	141	138	127	123
Ingot Makers																					
Zinc:Unalloyed & in Secondary Copper Alloys	10	12	10	10	12	10	17	10	10	13	10	10	9	8	8	8	8	7	5	6	6
Lead:Unalloyed & in Secondary Copper Alloys	6	6	6	6	7	9	9	7	8	6	6	6	5	5	4	4	5	3	3	3	3
Tin:Unalloyed & in Secondary Copper Alloys	4	4	4	4	5	5	4	4	5	4	4	4	4	4	3	3	4	3	2	2	2
Nickel:Unalloyed	—	0	0	0	—	0	0	1	0	0	0	0	0	0	0	-	-	-	-	-	-
Total	20	22	20	20	24	24	30	22	23	23	20	20	18	16	15	15	17	13	11	11	11
Foundries and Other Industries(a)																					
Zinc:Unalloyed & in Secondary Copper Alloys	25	32	27	28	32	37	51	50	2	9	2	2	2	2	1	1	1	1	1	1	1
Lead:Unalloyed & in Secondary Copper Alloys	2	1	1	1	0	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0
Tin:Unalloyed & in Secondary Copper Alloys	2	2	2	2	1	1	1	1	2	2	2	1	1	1	0	0	1	0	0	0	0
Nickel:Unalloyed	—	0	0	0	—	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	29	35	30	31	33	39	54	53	5	12	4	4	4	4	2	2	2	1	1	1	1
Powder Plants[a]																					
Zinc-Slab																					
Zinc in Scrap																					
Tin-Refined	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)
Total																					
All Industries																					
Zinc: Unalloyed & in Secondary Copper Alloys	**266**	**284**	**273**	**268**	**253**	**226**	**238**	**236**	**186**	**196**	**166**	**162**	**145**	**134**	**134**	**133.7**	**133.4**	**143.3**	**139**	**129**	**124**
Lead: Unalloyed & in Secondary Copper Alloys	**13**	**14**	**11**	**11**	**11**	**13**	**12**	**11**	**13**	**10**	**10**	**12**	**11**	**10**	**7**	**7**	**10**	**7**	**6**	**6**	**6**
Tin: Unalloyed & in Secondary Copper Alloys	**8**	**8**	**9**	**9**	**9**	**8**	**8**	**7**	**11**	**9**	**8**	**7**	**6**	**6**	**4**	**5**	**6**	**4**	**4**	**4**	**4**
Nickel: Unalloyed & in Secondary Copper Alloys	**6**	**7**	**7**	**6**	**5**	**5**	**5**	**5**	**2**	**1**	**1**	**2**	**1**	**1**	**0**	**0**	**0**	**0**	**1**	**1**	**1**
TOTAL ALLOYING METAL CONSUMED (Table 3, Item 8)	**293**	**314**	**300**	**295**	**278**	**252**	**263**	**259**	**212**	**217**	**186**	**183**	**164**	**151**	**145**	**145**	**150**	**155**	**150**	**140**	**135**

Source: U.S. Department of the Interior, U.S. Geological Survey, National Minerals Information Center

p - preliminary, r - revised

(a) - Direct consumption only; not including consumption of alloying metal in ingots from ingot makers.

(b) - Starting with 1995 Powder Plants data are included with "Foundries and Other Industries."

Numbers may not sum due to rounding.

Copper Development Association Inc.

Table 3, Item 12.

Net consumption of metals by wire rod mills, brass mills, foundries, powder plants and other industries

Copper Content, thousands of short tons																					
	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022r**	**2023p**
Net Metal Consumed by:																					
Wire Rod Mills - Copper (Table 3, Item 13)	1,837	1,991	1,881	1,760	1,802	1,668	1,281	1,403	1,425	1,431	1,464	1,421	1,475	1,477	1,478	1,489	1,522	1,379	1,445	1,401	1,247
Brass Mills																					
Copper	1,364	1,380	1,321	1,303	1,235	1,179	1,105	1,114	1,089	1,078	1,108	1,114	1,073	1,127	1,151	1,158	1,153	1,168	1,156	1,156	1,176
Alloy.	245	256	250	243	221	189	180	184	183	182	162	159	141	131	128	128	131	141	138	127	123
Ingot		2																			
Total (Table 3, Item 20)	1,609	1,637	1,571	1,547	1,455	1,368	1,285	1,298	1,272	1,260	1,270	1,273	1,215	1,258	1,279	1,286	1,284	1,309	1,295	1,284	1,299
Foundries[a]																					
Copper	134	128	132	110	108	107	104	113	113	125	127	115	116	129	119	109	113	113	79	91	91
Alloy.	28	35	30	31	33	39	54	53	5	12	4	4	4	4	2	2	2	1	1	1	1
Ingot	112	109	102	97	90	84	85	83	68	68	65	65	62	65	65	65	65	65	61.18	64	64
Total (Table 3, Item 23)..	274	272	264	238	232	230	242	250	186	204	196	184	183	198	185	175	179	179	141	156	156
Powder Plants[a]																					
Copper	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Alloy.	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Ingot	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Total ..	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Other Industries[a]	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Copper	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Ingot	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Total (Table 3, Item 29)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Misc. and Discrepancies																					
Copper (Table 3, Item 29)	73	77	70	86	84	74	56	57	67	70	72	77	75	75	71	76	80	82	82	74 r	71
Ingot																					
All Industries																					
Copper	**3,408**	**3,575**	**3,403**	**3,258**	**3,229**	**3,029**	**2,545**	**2,687**	**2,694**	**2,703**	**2,771**	**2,727**	**2,740**	**2,808**	**2,819**	**2,832**	**2,868**	**2,742**	**2,762**	**2,722 r**	**2,586**
Alloy..	**273**	**291**	**280**	**274**	**254**	**228**	**233**	**237**	**188**	**193**	**166**	**163**	**146**	**135**	**130**	**130**	**133**	**142**	**140**	**129**	**124**
Ingot (Table 3, Item 10)[b]	**112**	**109**	**102**	**97**	**90**	**84**	**85**	**83**	**68**	**68**	**65**	**65**	**62**	**65**	**65**	**65**	**65**	**65**	**61**	**64**	**64**
NET METAL CONSUMED																					
(Table 3, Item 12)	**3,793**	**3,974**	**3,785**	**3,629**	**3,573**	**3,341**	**2,863**	**3,007**	**2,950**	**2,965**	**3,002**	**2,956**	**2,948**	**3,008**	**3,013**	**3,027**	**3,066**	**2,949**	**2,963**	**2,915 r**	**2,773**

Source: U.S. Department of the Interior, U.S. Geological Survey, National Minerals Information Center

p - preliminary, r - revised

(a) - Starting with 1995 Powder Plants and Other Industries data are included with "Foundries."

(b) - Total consumption of ingot shown here is less than the consumption of metal by ingot makers shown in the details of Table 3, Item 3, and Table 3, Item 8. The difference, shown as Ingot Stocks & Other in Table 3, is partially melting and other losses in the making of ingot.

Numbers may not sum due to rounding.

Copper Development Association Inc.

Table 4.

Supply of wire mill, brass mill, foundry and powder products and their consumption in the end-use markets

Metal Content, millions of pounds

		2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022r	2023p
(1)	Bare Wire..	270	260	255	225	200	175	170	165	160	166	167	150	170	180	184	190	194	189	195	197	189
(2)	Telecommunications Cable..	395	366	375	359	292	225	177	168	160	163	163	155	156	162	171	177	178	165	165	175	167
(3)	Electronic Wire and Cable.	238	255	256	265	290	210	155	150	145	148	151	148	147	149	154	161	170	176	186	188	191
(4)	Building Wire	1,425	1,664	1,700	1,533	1,426	1,259	1,177	1,059	1,005	1,020	1,035	1,031	1,052	1,073	1,100	1,131	1,179	1,262	1,489	1,429	1,286
(5)	Magnet Wire.	561	570	532	536	493	443	400	380	360	367	380	361	370	384	405	420	421	391	391	416	396
(6)	Power Cable	294	300	372	315	249	326	352	335	315	326	335	328	328	307	290	294	302	268	276	285	281
(7)	Apparatus Wire and Cordage..	193	140	140	89	86	124	102	100	95	97	98	95	96	101	106	112	113	105	109	112	109
(8)	Magnet)	411	410	403	400	398	330	283	406	443	518	540	538	554	576	589	615	599	520	556	590	635
(9)	Other Insulated Wire and Cable.	82	85	93	119	90	54	43	40	38	39	40	38	38	38	39	40	41	40	41	42	41
(10)	Total Insulated Wire and Cable..	3,599	3,790	3,871	3,616	3,324	2,972	2,690	2,638	2,561	2,678	2,742	2,694	2,741	2,791	2,852	2,951	3,003	2,926	3,212	3,237	3,106
(11)	**Total Wire Mill Products(a)..**	**3,869**	**4,050**	**4,126**	**3,841**	**3,524**	**3,147**	**2,860**	**2,803**	**2,721**	**2,844**	**2,909**	**2,844**	**2,911**	**2,971**	**3,036**	**3,141**	**3,196**	**3,114**	**3,407**	**3,434**	**3,295**
(12)	Strip, Sheet, Plate and Foil	957	1,068	1,035	1,067	999	928.3	692	794	740	738	816	761	790	788	753	753	676	658	728	722	631
(13)	Mechanical Wire(b)	72	80	75	72	48	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)
(14)	Rod and Bar.	965	1,059	1,032	1,022	879	793	562	672	675	636	641	702	605	625	639	662	600	562	642	585	548
(15)	Tube and Pipe(c)...	1,182	1,233	1,256	1,080	953	812	619	607	608	574	579	567	568	578	568	591	555	545	598	526	416
(16)	**Total Brass Mill Products (page 19).**	**3,177**	**3,439**	**3,397**	**3,241**	**2,879**	**2,533**	**1,873**	**2,073**	**2,023**	**1,948**	**2,035**	**2,030**	**1,963**	**1,991**	**1,961**	**2,005**	**1,831**	**1,765**	**1,968**	**1,832**	**1,595**
(17)	**Total Foundry Products**	**250**	**230**	**225**	**215**	**200**	**180**	**160**	**150**	**145**	**140**	**140**	**138**	**130**	**136**	**138**	**145**	**142**	**128**	**136**	**141**	**147**
(18)	**Total Powder Products**	**45**	**50**	**50**	**45**	**40**	**35**	**27**	**32**	**34**	**34**	**34**	**35**	**36**	**36**	**36**	**37**	**37**	**28**	**30**	**29**	**28**
(19)	**Domestic Products - Total..**	**7,341**	**7,769**	**7,799**	**7,342**	**6,643**	**5,895**	**4,919**	**5,058**	**4,923**	**4,966**	**5,118**	**5,047**	**5,040**	**5,134**	**5,171**	**5,328**	**5,207**	**5,035**	**5,541**	**5,436**	**5,065**
(20)	**Net Imports of Mill Products (page 20).**	**246**	**297**	**224**	**295**	**288**	**261**	**166**	**118**	**173**	**226**	**166**	**280**	**287**	**331**	**391**	**445**	**510**	**602**	**707**	**1,095**	**823**
(21)	**Mill Products to Domestic Market***	**7,587**	**8,066**	**8,022**	**7,637**	**6,931**	**6,156**	**5,085**	**5,176**	**5,096**	**5,191**	**5,284**	**5,326**	**5,327**	**5,465**	**5,562**	**5,773**	**5,717**	**5,636**	**6,249**	**6,531**	**5,888**
(22)	Building Construction	3,620	4,035	4,028	3,697	3,365	3,051	2,478	2,318	2,271	2,299	2,364	2,401	2,406	2,458	2,525	2,487	2,483	2,570	2,907	2,919	2,464
(23)	Electrical and Electronic Products..	1,582	1,569	1,525	1,533	1,400	1,274	1,018	1,059	1,037	1,024	966	976	953	1,033	1,038	1,156	1,179	1,181	1,286	1,436	1,360
(24)	Industrial Machinery and Equipment.	697	682	701	682	575	494	432	430	377	358	378	383	359	351	352	395	397	377	412	451	420
(25)	Transportation Equipment.	915	991	974	947	854	702	621	768	819	915	980	983	987	992	1,068	1,134	1,084	920	1,009	1,065	1,074
(26)	Consumer and General Products..	773	836	794	778	737	634	536	601	592	596	597	584	622	630	580	601	574	589	635	661	570

Sources: Copper Development Association; U.S. Department of Commerce, Bureau of the Census; Metal Powder Industries Federation; and U.S International Trade Adminstration.

Note: Numbers may not sum due to rounding.

p - preliminary, r - revised

(a) - Copper content.

(b) - Rod and bar and mechanical wire data combined starting 2008.

(c) - Comercial tube and plumbing tube data combined.

(d) - Powder product shipments reference only structural metallurgy products and DO NOT include powder used for plating, pigments, chemicals and other miscellaneous uses.

* Markets include:

Building Construction - Building Wire; Plumbing & Heating; Air Conditioning & Commercial Refrigeration; Builders Hardware; Architectural

Electrical and Electronic Products - Power Utilites; Telecommunications; Business Electronics; Lighting & Wiring Devices

Industrial Machinery and Equipmen - In-Plant Equipment; Industrial Valves & Fittings; Non-Electrical Instruments; Off-Highway Vehicles; Heat Exchangers

Transportation Equipment - Automobile; Truck & Bus; Railroad; Marine; Aircraft & Aerospace

Consumer and General Products - Appliances; Cord Sets; Military & Commercial Ordnance; Consumer Electronics; Fasteners & Clsoures; Coinage; Utensils & Cultery; Miscellaneous

Copper Development Association Inc.

Table 4, Item 16.

Supply of brass mill products in the United States

Metal Content, millions of pounds	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022r	2023p
Strip, Sheet, Plate and Foil																					
Copper	341	390	391	394	378	343	224	240	236	234	258	258	287	284	261	255	233	240	245	274	264
Alloy.	616	677	644	673	621	586	468	554	504	504	558	504	504	504	493	498	443	418	483	448	367
Total	957	1,068	1,035	1,067	999	928	692	794	740	738	816	761	790	788	753	753	676	658	728	722	631
Mechanical Wire																					
Copper	16	19	18	14	11	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Alloy.	56	61	57	58	37	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Total	72	80	75	72	48	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Rod and Bar[(a)]																					
Copper	170	205	212	211	184	173	133	158	167	151	163	180	143	159	168	183	171	168	176	170	173
Alloy.	795	854	820	812	695	620	428	515	508	485	478	522	462	466	471	479	430	394	466	415	376
Total	965	1,059	1,032	1,022	879	793	562	672	675	636	641	702	605	625	639	662	600	562	642	585	548
Tube and Pipe[(b)]																					
Copper	1,168	1,218	1,243	1,066	940	800	610	596	597	565	570	559	562	572	562	584	549	539	592	519	411
Alloy.	14	15	13	14	13	12	9	11	11	9	8	8	7	6	6	7	6	6	6	7	5
Total	1,182	1,233	1,256	1,080	953	812	619	607	608	574	579	567	568	578	568	591	555	545	598	526	416
All Mill Products																					
Copper	**1,695**	**1,832**	**1,863**	**1,685**	**1,512**	**1,315**	**968**	**993**	**1,000**	**951**	**991**	**997**	**991**	**1,015**	**991**	**1,021**	**952**	**947**	**1,014**	**962**	**847**
Alloy.	**1,482**	**1,607**	**1,534**	**1,556**	**1,367**	**1,218**	**906**	**1,080**	**1,023**	**997**	**1,044**	**1,033**	**973**	**976**	**970**	**984**	**879**	**817**	**955**	**870**	**748**
TOTAL BRASS MILL PRODUCTS	**3,177**	**3,439**	**3,397**	**3,241**	**2,879**	**2,533**	**1,873**	**2,073**	**2,023**	**1,948**	**2,035**	**2,030**	**1,963**	**1,991**	**1,961**	**2,005**	**1,831**	**1,765**	**1,968**	**1,832**	**1,595**

Sources: Copper Development Association

(a)- Copper and alloy rod and bar and mechanical wire data combined starting 2008.

(b) - Comercial tube and plumbing tube data combined.

Numbers may not sum due to rounding.

Table 4, Item 16a.

Supply of brass mill products in selected countries

Metal Content, millions of pounds	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022r	2023p
Benelux	277	266	266	266	277	278	263	273	276	281	276	274	272	263	290	279	238	214	273	282	285
France	263	227	201	498	421	382	254	274	251	251	261	263	266	270	282	287	291	268	287	294	296
Germany	2,328	2,561	2,510	2,585	4,096	3,909	2,982	3,650	3,597	3,306	3,391	3,526	3,590	3,753	3,765	3,640	2,417	1,526	1,566	1,594	1,591
Italy.	1,957	1,682	1,369	2,020	1,836	1,584	862	1,137	1,106	1,124	1,378	1,368	1,381	1,393	1,478	1,567	1,499	1,451	1,800	1,867	1,884
Japan.	2,175	2,290	2,075	2,296	2,200	1,497	1,436	1,756	1,721	1,686	1,701	1,792	1,681	1,649	1,598	1,728	1,597	1,478	1,637	1,653	1,685
Mexico	311	319	276	229	258	232	302	251	327	277	259	262	266	283	286	280	297	273	253	261	269
Scandinavia.	442	469	464	478	381	437	349	383	393	391	381	408	393	395	418	438	386	439	413	425	426
Spain.	213	166	194	185	194	198	204	225	215	258	178	217	216	216	212	219	195	195	176	158	1
Turkey	88	88	144	160	141	121	46	65	65	66	70	70	70	70	65	65	65	65	65	69	162
United Kingdom..	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	72
United States	3,177	3,439	3,397	3,241	2,896	2,533	1,873	2,073	2,023	1,948	2,035	2,030	1,963	1,991	1,961	2,005	1,831	1,765	1,968	1,832	1,595

Sources: International Copper Study Group

p - preliminary, r - revised, NA - not available

Numbers may not sum due to rounding.

Copper Development Association Inc.

Table 4, Item 20.

Imports and exports of wire mill, brass mill and powder products

Metal Content, millions of pounds

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022r	2023p
Imports of:																					
Bare Wire (including Stranded).	50	42	56	39	38	43	29	36	40	44	55	50	30	31	27	32	47	48	49	61	73
Insulated Wire and Cable	314	334	405	418	417	362	301	334	380	421	432	478	487	487	542	550	540	566	639	874	758
Total Wire Mill Products(1).	**364**	**376**	**461**	**457**	**455**	**405**	**330**	**370**	**420**	**464**	**487**	**529**	**517**	**517**	**569**	**582**	**587**	**614**	**687**	**935**	**832**
Copper-Strip, Sheet, Plate and Foil..	123	145	117	126	89	91	66	88	90	88	70	77	74	72	82	96	101	85	106	140	138
Rod and Bar.	37	54	53	54	69	52	33	46	51	50	51	54	43	35	38	41	37	32	40	53	43
Tube and Pipe	172	202	202	281	256	260	198	167	136	135	143	161	148	150	155	159	161	184	190	246	175
Alloy-Strip, Sheet, Plate and Foil	93	119	95	92	74	61	43	65	61	65	75	81	81	83	88	96	76	74	111	136	85
Mechanical Wire..	37	41	35	36	33	36	22	35	33	41	37	39	43	37	40	41	37	30	39	40	31
Rod and Bar.....	71	85	65	68	57	70	43	70	79	84	86	83	73	56	69	69	63	52	63	66	58
Tube and Pipe...	110	131	120	123	108	104	75	92	101	93	94	103	98	99	98	113	108	98	118	129	99
Total Brass Mill Products..	**645**	**777**	**687**	**779**	**688**	**674**	**480**	**564**	**551**	**556**	**555**	**599**	**560**	**532**	**570**	**616**	**583**	**556**	**666**	**809**	**629**
Total Powder Products..	**8**	**6**	**8**	**10**	**10**	**8**	**7**	**9**	**9**	**8**	**8**	**9**	**9**	**8**	**8**	**8**	**7**	**5**	**6**	**5**	**4**
TOTAL IMPORTS..	**1,016**	**1,160**	**1,156**	**1,246**	**1,153**	**1,086**	**816**	**943**	**980**	**1,028**	**1,050**	**1,136**	**1,085**	**1,058**	**1,148**	**1,206**	**1,177**	**1,175**	**1,359**	**1,749**	**1,465**
Exports of: (1)																					
Bare Wire (including Stranded).	82	99	107	102	103	88	66	88	90	113	157	135	114	97	94	105	89	67	76	73	88
Insulated Wire and Cable	368	386	401	432	382	400	336	458	444	421	434	432	408	355	373	373	331	276	310	319	307
Total Wire Mill Products(1).	**450**	**485**	**508**	**534**	**485**	**488**	**402**	**546**	**534**	**534**	**591**	**567**	**523**	**452**	**466**	**477**	**420**	**344**	**386**	**393**	**394**
Copper-Strip, Sheet, Plate and Foil..	33	38	34	36	32	32	25	37	37	37	36	38	36	38	41	41	36	35	45	45	45
Rod and Bar	9	21	33	37	40	44	26	23	31	32	29	26	26	28	27	22	19	21	22	21	21
Tube and Pipe	73	74	75	76	77	48	51	40	48	41	41	35	32	31	32	41	35	34	44	50	44
Alloy-Strip, Sheet, Plate and Foil	63	72	96	81	72	71	58	65	56	62	75	75	59	60	68	59	40	31	36	44	37
Mechanical Wire.	16	20	21	29	34	33	23	27	25	24	24	21	25	23	21	16	13	9	14	12	13
Rod and Bar	77	88	95	95	64	50	22	27	25	23	39	41	43	44	50	52	51	49	60	51	40
Tube and Pipe	37	43	44	39	35	40	29	36	33	31	32	35	37	36	35	37	40	39	29	23	27
Total Brass Mill Products..	**307**	**356**	**397**	**391**	**355**	**318**	**233**	**255**	**255**	**249**	**275**	**272**	**258**	**259**	**274**	**267**	**234**	**218**	**251**	**246**	**225**
Total Powder Products..	**13**	**21**	**27**	**26**	**25**	**19**	**15**	**24**	**18**	**18**	**18**	**18**	**18**	**16**	**17**	**16**	**13**	**12**	**14**	**15**	**22**
TOTAL EXPORTS.	**770**	**862**	**932**	**951**	**865**	**825**	**650**	**825**	**807**	**802**	**884**	**857**	**798**	**727**	**757**	**761**	**667**	**574**	**651**	**654**	**642**
NET IMPORTS (Table 4, Item 20)	**246**	**297**	**224**	**295**	**288**	**261**	**166**	**118**	**173**	**226**	**166**	**280**	**287**	**331**	**391**	**445**	**510**	**602**	**707**	**1,095**	**823**

Sources: U.S. Internaional Trade Administration

p - preliminary, r - revised

(1) - In previous additions, wire rod exports were included in the table. Starting with 1999, net wire rod imports are shown as line 16 on table 3, page 14. Appropriate adjustments have been made for all years.

Note: Changes to the trade dataset are made from time to time as the USITC adds, collapses, or sometimes stops collecting data for certain Harmonized Tariff codes.

Numbers may not sum due to rounding.

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U.S. Geological Survey

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Copper

By Daniel M. Flanagan

Domestic survey data and tables were prepared by Hodan A. Fatah, statistical assistant.

In 2020, mine production of recoverable copper in the United States decreased by 4% to 1.20 million metric tons (Mt) from 1.26 Mt in 2019 (tables 1, 3). Production decreased primarily because of lower ore grades at a leading mine in Utah and the temporary closure of a mine in New Mexico after workers tested positive for coronavirus disease 2019 (COVID-19). Globally, the United States remained the fifth-ranked mine producer of copper behind Chile, Peru, China, and Congo (Kinshasa), in descending order of output, and accounted for 6% of global production. World mine production of copper increased to 20.6 Mt in 2020 from 20.4 Mt in 2019, mostly owing to increases in production in Congo (Kinshasa), Indonesia, Panama, and Zambia. These increases were partially offset by lower output in Chile, Laos, Peru, and the United States (table 20).

Smelter production of copper in the United States decreased by 32% in 2020 to an estimated 315,000 metric tons (t) from 464,000 t (reported) in 2019, and domestic output of refined copper was 918,000 t, 11% less than 1.03 Mt in 2019 (table 1). One smelter in Arizona and the refinery in Texas temporarily shut down in October 2019 as the result of a worker strike and remained closed for all of 2020. Smelter and refinery production also were affected by multiple disruptions of the smelting facility in Utah, where the flash converting furnace required a rebuild after an earthquake in March and the startup of the smelter was delayed following planned major maintenance in May and June. The United States remained the sixth-ranked producer of refined copper, following China, Chile, Japan, Congo (Kinshasa), and Russia, in descending order of production, and accounted for 4% of global output. World refinery production of copper increased to 25.0 Mt from 24.4 Mt (revised) in 2019. Large production increases in China, Chile, Congo (Kinshasa), Indonesia, Japan, and Zambia were partially offset by significant decreases in output in Brazil, India, and the United States (table 22).

Reported U.S. consumption of refined copper was 1.77 Mt in 2020, slightly lower than 1.81 Mt in 2019 because of reduced economic activity resulting from the global COVID-19 pandemic (tables 1, 4, 5). Domestic consumption of refined copper decreased from a record high of 3.02 Mt in 2000 to 1.65 Mt in 2009 and remained at approximately 1.8 Mt every year since 2010. In 2020, China (including Hong Kong) accounted for 58% of world apparent consumption, which increased slightly to 25.0 Mt from 24.4 Mt (revised) in 2019, according to data compiled by the International Copper Study Group (ICSG). Consumption in China increased by 1.68 Mt from that in 2019, whereas consumption in all other countries and localities collectively decreased by 1.08 Mt. The ICSG calculation of China's apparent consumption was based on reported production, trade, and Shanghai Futures Exchange (SHFE) stock data and did not include unreported Government or industry stocks, which can fluctuate significantly on an annual basis. The United States remained the second-ranked consumer of refined copper and accounted for 7% of global apparent consumption, followed by Germany, Japan, and the Republic of Korea, in descending order of consumption (International Copper Study Group, 2021a, p. 9, 19–20).

In 2020, the average annual Commodity Exchange Inc. (COMEX) spot copper price increased by 3% to $2.80 per pound from $2.72 per pound in 2019 (table 1). Factors that contributed to the increased price included strong demand for copper in China during the second half of the year; supply disruptions resulting from COVID-19 containment measures, particularly in Peru; and expectations of additional global investments in copper-intensive technologies in the near future (Freeport-McMoRan Inc., 2021, p. 70; Glencore plc, 2021, p. 56; PJSC MMC Norilsk Nickel, 2021a, p. 60).

Production

Domestic production data were compiled from U.S. Geological Survey (USGS) monthly canvasses of the mines, smelters, and refineries operating in the United States. In 2020, responses to the surveys and data from public company documents represented more than 99% of the total mine production and 61% of the total refinery production reported in table 1. To avoid disclosing company proprietary data, smelter and electrolytic refinery production in 2020 were estimated based on information in public company reports and do not reflect actual output reported to the USGS.

Mine.—Recoverable copper production in the United States decreased by 4% to 1.20 Mt in 2020 from 1.26 Mt in 2019, and the value of production decreased slightly to $7.60 billion from $7.75 billion. Copper recoverable in concentrates and precipitates accounted for 53% of mine output and decreased by 12% to 643,000 t in 2020 from 730,000 t in 2019, and copper produced by solvent extraction (leaching) and electrowinning (SX–EW) represented 47% of mine production and increased by 6% to 559,000 t from 527,000 t (tables 1, 3). Arizona was the leading copper-producing State and accounted for 73% of U.S. output (880,000 t of recoverable copper) in 2020. Copper also was produced in Michigan, Missouri, Montana, Nevada, New Mexico, and Utah. Although 25 mines in the United States (including 14 SX–EW facilities) recovered copper in 2020, 17 mines accounted for more than 99% of production (table 2). Most of the remaining mines were small leach operations or byproduct producers of copper.

Domestic mine output of copper decreased in 2020 primarily owing to lower production at Rio Tinto Kennecott's Bingham Canyon Mine and Freeport-McMoRan Inc.'s Chino Mine. At Bingham Canyon, copper production decreased by 46,800 t from that in 2019 because ore grades decreased by 25% and Rio Tinto prioritized molybdenum production during a lengthy shutdown of the smelter. At Freeport's Chino Mine, operations were suspended in April 2020 following a limited outbreak of COVID-19; copper output consequently decreased by 37,600 t. These decreases were partially offset by higher production from Freeport's Safford Mine, where copper output increased by 23,100 t owing to the start of production from a new open pit in the third quarter of 2020 (Freeport-McMoRan Inc., 2020, p. 1; 2021, p. 9, 28; Rio Tinto Group, 2021, p. 52, 339).

Smelter and Refinery.—In 2020, smelter production in the United States, which consisted of primary (from ore) output only, decreased by 32% to an estimated 315,000 t from 464,000 t (reported) in 2019. Production of primary electrolytically refined copper consequently decreased by 31% to an estimated 315,000 t from 457,000 t (reported) (table 1). To avoid disclosing company proprietary data, smelter and electrolytic refinery output were estimated in 2020 based on information in public company reports and do not reflect actual production reported to the USGS. Smelter and electrolytic refinery production were affected by multiple disruptions in 2020. ASARCO LLC's smelter and electrolytic refinery temporarily shut down in October 2019 as the result of a worker strike and remained closed for all of 2020 (Grupo México, S.A.B. de C.V., 2021, p. 83). In March 2020, the flash converting furnace at the Rio Tinto smelter was damaged by an earthquake and needed to be entirely rebuilt. The restart of the Rio Tinto smelter also was delayed by unexpected issues after planned major maintenance in May and June (Rio Tinto Group, 2021, p. 52).

In total, U.S. refinery production in 2020 was 918,000 t, 11% less than 1.03 Mt in 2019. Primary refined copper produced by electrowinning was 559,000 t in 2020, an increase of 6% from that in 2019, primarily owing to the start of copper production at the Lone Star expansion of Freeport's Safford Mine (Freeport-McMoRan Inc., 2021, p. 9, 28). Secondary (from scrap) electrolytic and fire-refined copper decreased by 3% to 43,200 t. Primary copper accounted for 95% of total domestic refined output (34% electrolytic and 61% electrowon), and secondary copper accounted for 5% (table 1). Three smelters, three electrolytic refineries, 14 electrowon refineries, and four fire refineries operated in the United States in 2020.

Operating Property Reviews.—In 2020, ASARCO LLC (a subsidiary of Grupo México, S.A.B. de C.V.) produced a total of 128,000 t of copper at its three mines in Arizona, a slight increase from 125,000 t in 2019. At the Mission Mine, the company produced 57,800 t of copper in concentrates in 2020 (54,800 t in 2019). Output from the Ray Mine was 37,900 t of copper in concentrates (33,900 t in 2019) and 11,400 t of copper by SX–EW (16,300 t in 2019). The Silver Bell Mine produced 20,400 t of electrowon copper (unchanged from that in 2019). ASARCO's smelter in Hayden, AZ, and electrolytic refinery in Amarillo, TX, remained idled for all of 2020 following what the company described as temporary shutdowns in October 2019 because of a worker strike. Although the strike ended in July 2020, ASARCO had not publicly announced as of yearend 2020 when operations were expected to resume nor a reason for the continued closures (Grupo México, S.A.B. de C.V., 2021, p. 83, 108–110, 113–114).

Primarily owing to mill optimization measures that offset planned lower ore grades, copper production at the Pinto Valley Mine in Arizona, owned by Capstone Mining Corp., increased to 54,000 t in 2020 (51,700 t in concentrates and 2,270 t of electrowon cathode) from 53,400 t in 2019 (51,600 t in concentrates and 1,710 t of cathode). In December 2020, Capstone tested a flotation technology that increased copper recovered in concentrates by 6%. The combination of higher mill throughput and improved copper recovery rates had the potential to increase annual output of copper in concentrates by up to 5,400 t. The company announced in July 2020 that production of electrowon cathode per area leached had doubled during the prior twelve months because of the implementation of a new technology developed by Jetti Resources, LLC for leaching low-grade sulfide ores. Capstone planned to expand SX–EW operations at Pinto Valley and to produce about 135,000 to 160,000 t of cathodes over the next 20 years, significantly greater than the roughly 2,000 t that were produced on an annual basis as of 2020 (Capstone Mining Corp., 2020; 2021, p. 5–6, 17).

In December 2020, Excelsior Mining Corp. produced the first copper cathode at the Gunnison Mine in Arizona, with the first sales expected in January 2021. Copper production had been anticipated to begin in the second quarter of 2020 but was delayed by the COVID-19 pandemic; the company placed the project on care-and-maintenance status from late March 2020 until early November 2020. Excelsior planned to develop Gunnison in three stages, with a maximum annual copper output of approximately 57,000 metric tons per year (t/yr) and total production of approximately 980,000 t over a mine life of 24 years. The company projected that the mine would ramp up to the first stage design capacity of 11,300 t/yr of copper by yearend 2021. Gunnison used in situ recovery, which involves injecting sulfuric acid directly into a deposit, leaching copper in the ground without mining any ore, and pumping the copper-bearing solution to an electrowon plant through a series of recovery wells (Excelsior Mining Corp., 2021, p. 17–18, 21, 23, 32).

Total output of recoverable copper at Freeport-McMoRan Inc.'s U.S. operations in 2020 was approximately 768,000 t, a decrease of 3% from about 790,000 t during the prior year. The lower production was primarily a result of the suspension of operations at the Chino Mine in April 2020 following a limited outbreak of COVID-19; the mine was expected to restart at a reduced operating rate of 50% of full capacity in January 2021. Decreased production from Chino was partially offset by the completion of development activities at the Lone Star expansion of the Safford Mine in the third quarter of 2020, where Freeport anticipated that copper output would ramp up to more than 90,000 t in 2021. Combined copper in concentrates and (or) electrowon production at each of the company's mines in Arizona was as follows: Bagdad—98,000 t (98,900 t in 2019), Miami—7,710 t (6,800 t in 2019), Morenci (the third-ranked global copper mine by production quantity in 2020, 72%-owned by Freeport)—445,000 t (460,000 t in 2019), Safford—73,000 t (49,900 t in 2019), and Sierrita—80,700 t (72,600 t in 2019). In New Mexico, copper output at the Chino Mine totaled 41,700 t (79,400 t in 2019), and SX–EW production at the Tyrone Mine was 20,400 t (21,800 t in 2019). Freeport also produced refined copper cathodes at its electrolytic facility in El Paso, TX, but did not publicly report cathode output (Freeport-McMoRan Inc., 2020, p. 1; 2021, p. 7, 9, 28).

KGHM International Ltd. (a subsidiary of KGHM Polska Miedź S.A.) produced 47,400 t of recoverable copper in concentrates at the Robinson Mine in Nevada. Output decreased by 3% compared with 48,800 t in 2019 because of lower ore grades and decreased copper recovery rates. At the Carlota Mine in Arizona, electrowon production was 5,000 t in 2020 and 4,400 t in 2019 (KGHM Polska Miedź S.A., 2020, p. 12–13; 2021, p. 12–13, 76).

In 2020, Lundin Mining Corp. produced 18,700 t of copper in concentrates at the Eagle nickel-copper mine in Michigan, 31% more than 14,300 t in 2019 owing to a full year of mining from the Eagle East expansion. The company processed the first ore from Eagle East in the fourth quarter of 2019. As of yearend 2016, Eagle and Eagle East contained 117,000 t of probable copper reserves, enough to extend the mine life to 2023. In addition to the higher copper grades, Lundin processed a record quantity of ore through the Eagle mill in 2020 (Roscoe Postle Associates Inc., 2017, p. 1-6, 15-2; Lundin Mining Corp., 2020, p. 17; 2021, p. 1, 17).

Nevada Copper Corp. began producing copper at the underground Pumpkin Hollow Mine in Nevada on December 16, 2019. In 2020, the company suspended operations at Pumpkin Hollow from April 6 through August 19 because of COVID-19 restrictions implemented by the State of Nevada, and the mine was affected by a series of additional unplanned stoppages owing to geotechnical and mechanical issues. The rampup to steady-state production consequently was expected to be delayed until the third quarter of 2021. At full capacity, Nevada Copper projected the underground portion of Pumpkin Hollow to generate approximately 23,000 t/yr of copper in concentrates over a mine life of nearly 14 years. Copper output from the underground mine in 2020 was 1,200 t of copper contained in concentrates. An additional open pit project at the site, which was still in the feasibility stage, would potentially yield about 77,000 t/yr of copper in concentrates over a mine life of 19 years (French and others, 2019, p. 1-23, 20-14; Nevada Copper Corp., 2019a; 2019b, p. 9, 11; 2021, p. 3–4, 11).

At the Bingham Canyon Mine in Utah, owned by Rio Tinto Kennecott (a subsidiary of Rio Tinto Group), production of copper in concentrates was 140,000 t in 2020, 25% lower than 187,000 t in 2019 as a result of lower copper ore grades and the prioritization of molybdenum production during disruptions of the company's smelter in Magna, UT. The flash converting furnace at the smelter required a rebuild after an earthquake in March, and the restart of the smelter was delayed following planned major maintenance in May and June. Publicly reported production of copper cathodes at the company's electrolytic refinery in Magna, UT, consequently decreased by 54% to 84,800 t in 2020 from 185,000 t in 2019. Total refinery output reported to the USGS was higher than that stated in company reports because smelter and refinery production from purchased and toll third-party concentrates were not included in the company's public figures. Rio Tinto continued a project to push back the south wall of the Bingham Canyon open pit, which was anticipated to result in higher copper ore grades beginning in 2021 (Rio Tinto Group, 2021, p. 33, 52, 339).

Consumption

Domestic consumption data were compiled from USGS annual and monthly canvasses of U.S. manufacturers. In 2020, copper was consumed (used) as refined copper and scrap at about 30 brass mills; 14 wire-rod mills; and 500 chemical plants, foundries, and miscellaneous manufacturers in the United States. Reported U.S. consumption of refined copper was 1.77 Mt, slightly lower than 1.81 Mt in 2019; consumption by wire-rod mills was 1.30 Mt (73% of total refined use), and consumption by brass mills was 414,000 t (23%). Domestic consumption of copper-base scrap in 2020 was 926,000 t (gross weight), essentially unchanged from 931,000 t in 2019. Brass mills consumed 649,000 t of copper-base scrap (equivalent to 70% of total use), and wire-rod mills consumed 120,000 t (13%) (tables 1, 4, 5, 10, 11). The overall decreases in consumption of refined copper and copper scrap in 2020 were likely a consequence of reduced U.S. copper demand resulting from the COVID-19 pandemic.

Copper recovered from refined or remelted scrap (of copper-base and non-copper-base) in the United States decreased to 858,000 t in 2020 (81% from new scrap and 19% from old scrap) from 866,000 t (revised) in 2019 and accounted for 35% of the total U.S. copper supply of 2.47 Mt (defined as primary refined production plus copper recovered from new and old scrap plus refined imports for consumption minus refined exports, including adjustments for changes in refined copper stocks). The conversion of old (post-consumer) scrap to alloys and refined copper decreased by 3% to 160,000 t in 2020 from 166,000 t (revised) in 2019, and recovery of copper from new (manufacturing) scrap decreased to 697,000 t from 700,000 t (tables 1, 6). Brass and wire-rod mills accounted for 83% of copper recovered from scrap in 2020 (table 7).

In June 2020, Freeport announced that it would close its wire-rod manufacturing operation in Norwich, CT, with most employees halting work by the end of August. The company attributed the closure to a decrease in economic activity associated with the COVID-19 pandemic. In September 2020, SDI LaFarga LLC, a joint venture of Steel Dynamics, Inc. and the LaFarga Group, commissioned a new furnace at its wire-rod facility in New Haven, IN. The furnace was expected to more than double the plant capacity and increase the company's domestic wire-rod production to about 17,500 metric tons per month (Bera, 2020; Grahn, 2020).

According to preliminary data from the Copper Development Association Inc. (2021, p. 18), copper and copper-alloy product supply to the U.S. market by fabricators (brass mills, foundries, powder producers, and wire mills), consisting of shipments from domestic plants and net imports, decreased slightly to 2.55 Mt of copper content in 2020 from 2.59 Mt in 2019. Since 2000, when the copper supply reached a record high of 4.33 Mt, deliveries to the domestic market trended downward, and those in 2020 were 41% less than those in 2000. In 2020, wire-mill products accounted for 55% of the total U.S. copper supply; brass mill products, 31%; net imports, 11%; and foundry and powder products, 3% combined. The building construction sector remained the leading end-use market and accounted for 46% of total shipments, followed by electrical and electronic products, 21%; transportation equipment, 16%; consumer and general products, 10%; and industrial machinery and equipment, 7%. Examples of product categories included in each sector are as follows: building construction—air conditioning, building wire, commercial refrigeration, and heating and plumbing; consumer and general products—appliances, consumer electronics, and cords; electrical and electronic products—lighting and wiring devices, power utilities, and telecommunications; industrial machinery and equipment—industrial valves and fittings and plant equipment; and transportation equipment—aircraft, automobiles, railroad, and ships.

The decreased quantity of copper and copper-alloy product shipments to the domestic market in 2020 compared with those in 2019 corresponded with mostly negative economic trends in major industries that used copper. In 2020, housing starts in the United States increased by 7% to 1.38 million units from 1.29 million units, and manufacture of telecommunications equipment increased by 4%. In contrast, fabrication of equipment for heating, ventilation, and air-conditioning (HVAC) decreased by 3%; production of appliances and electrical equipment (such as batteries, generators, lighting components, and wiring devices) decreased by 4%; output of aircraft, automobiles, and ships decreased by 14%; and manufacture of power transmission products was 21% lower than output in 2019 (U.S. Census Bureau, 2021; Board of Governors of the Federal Reserve System, 2022).

Stocks

In 2020, total refined copper stocks in the United States increased by 8,020 t (7%) to 118,000 t at the end of December from 110,000 t at the beginning of January. Inventories of domestic refined copper at yearend were located primarily in COMEX warehouses (60% of total stocks), London Metal Exchange Ltd. (LME) warehouses (16%), and wire-rod mills (9%). LME and wire-rod stocks decreased by 16,700 t (48%) and 9,270 t (46%), respectively, and COMEX stocks increased by 36,200 t (more than twofold). Combined stockpiles at brass mills, refineries, and other manufacturers decreased by 2,180 t (11%) from those at yearend 2019 (table 1).

Prices

The average annual COMEX spot copper price increased by 3% to $2.80 per pound in 2020 from $2.72 per pound in 2019 (table 1). The monthly average COMEX price decreased in each of the first 4 months of the year, to a low of $2.31 per pound in April, because of economic uncertainty related to the COVID-19 pandemic, then increased in each of the last 8 months of the year to a high of $3.53 per pound in December. Factors that contributed to the increased annual price included strong demand for copper in China during the second half of the year, supply disruptions resulting from COVID-19 containment measures (particularly in Peru), and expectations of additional global investments in copper-intensive technologies in the near future (Freeport-McMoRan Inc., 2021, p. 70; Glencore plc, 2021, p. 56; PJSC MMC Norilsk Nickel, 2021a, p. 60).

Copper scrap prices generally followed the trend in refined copper prices, and trends for prices of various types of scrap in 2020 ranged from a decrease of 4% to an increase of 9%. The refiners no. 2 scrap price averaged $2.43 per pound, 4% greater than $2.33 per pound in 2019. The average annual discount for refiners no. 2 scrap from the COMEX spot price decreased to 36.5 cents per pound from 39.1 cents per pound (tables 1, 13).

Foreign Trade

Imports of refined copper into the United States increased slightly and exports of refined copper from the United States decreased by 67% in 2020. Overall, net imports (imports minus exports) were 635,000 t (676,000 t of imports and 41,200 t of exports), 18% higher than 537,000 t (663,000 t of imports and 125,000 t of exports) in 2019 (tables 1, 14, 16). Imports likely increased in 2020 because the decrease in domestic refined production (112,000 t) was greater than the decrease in domestic refined copper consumption (32,300 t) (table 1). Shipments to Canada and Mexico accounted for nearly all U.S. refined copper exports in 2020 and decreased by a combined 84,900 t from those in 2019. Canada and Mexico likely imported less refined copper from the United States because of oversupplied markets. In Canada, output of refined copper increased by an estimated 8,800 t in 2020, whereas refined consumption decreased by 15,400 t. In Mexico, refined production increased by 5,000 t in 2020, whereas consumption of refined copper decreased by 34,500 t (table 22; International Copper Study Group, 2021a, p. 19).

In 2020, refined copper accounted for 88% of all U.S. unmanufactured copper imports (consisting of refined copper, unalloyed copper scrap, and the copper content of alloyed copper scrap; blister and anodes; matte, ash, and precipitates; and ore and concentrates), and the copper content of scrap accounted for 12% (8% copper-alloy scrap and 4% unalloyed scrap). The copper content of scrap was the primary source of copper shipped to international markets and represented 59% of total unmanufactured copper exports (23% alloyed and 36% unalloyed), followed by the copper content of ore and concentrates (35%), and refined copper (4%). Chile was the leading foreign source of refined copper for the United States and accounted for 61% of the total refined import quantity, followed by Canada (22%) and Mexico (14%). The leading destinations for refined copper exports from the United States were Mexico (65%) and Canada (31%). Imports of copper ore and concentrates originated entirely from Canada in 2020 and predominantly (greater than 99%) from Mexico in 2019 and decreased by 92% to 2,170 t of copper content in 2020. Exports of copper ore and concentrates increased by 8% and were primarily shipped to Mexico (65%), China (13%), Canada (9%), and Japan (4%). Ore and concentrate exports to China increased to 49,300 t in 2020 from 7 t in 2019 (tables 14, 16, 18, 19). The Government of China enacted a tariff on copper ore and concentrate shipments from the United States in September 2018, but companies in China were allowed to apply for tariff waivers beginning in March 2020 (Daly, 2020).

The United States imported an estimated 89,900 t of copper contained in scrap in 2020, a decrease of 17% from 108,000 t in 2019. Imports of copper in scrap originated primarily from

Canada (49%) and Mexico (40%) (table 19). Shipments of copper in scrap from the United States to international markets decreased by 10% in 2020, to an estimated copper content of 643,000 t from 714,000 t. Total global imports of copper scrap (in gross weight) decreased by 17% to 4.69 Mt in 2020 from 5.65 Mt in 2019. COVID-19 lockdowns in many countries restricted global flows of scrap because the scrap industry was typically not classified as an essential economic activity (International Copper Study Group, 2020, p. 13; 2021a, p. 40–41). Malaysia was the leading destination for domestic copper scrap in 2020 and accounted for 21% of total copper exported in scrap, followed by China (16%), Canada (11%), the Republic of Korea (9%), Germany (5%), and India (5%), in descending order of quantity (table 18).

World Industry Structure

Mine Production.—According to S&P Global Market Intelligence, the COVID-19 pandemic caused at least 275 mines, including 51 copper mines, in 36 countries to suspend production from March to June 2020. Nearly 90% of the affected operations restarted by late June (MacDonald, 2020). Despite the high level of disruption, world mine production of copper increased to 20.6 Mt in 2020 from 20.4 Mt in 2019. Copper in concentrates accounted for 80% of global mine output and increased to 16.4 Mt from 16.3 Mt in 2019. Copper produced by SX–EW represented 20% of world mine production and increased slightly to 4.19 Mt from 4.11 Mt (revised). Fifty-three countries and localities were known to have mined copper in 2020. Chile was the leading producer of mined copper in 2020 and accounted for 28% of total global production, followed by Peru (10%), China (8%), Congo (Kinshasa) (8%), and the United States (6%). The remaining countries among the 10 leading producers, in descending order of output, were Australia, Zambia, Russia, Mexico, and Canada. The 10 leading producers accounted for 79% of production, and the 20 leading producers accounted for 94%. The largest increases in production took place in Congo (Kinshasa), where output increased by 231,000 t (17% higher than country production in 2019); Indonesia, by 155,000 t (44%); Panama, by 58,100 t (39%); and Zambia, by 52,800 t (7%). These increases were partially offset by significant decreases in Peru, where output was lower by 301,000 t (12%); the United States, by 55,400 t (4%); Chile, by 54,300 t (essentially unchanged); and Laos, by 53,100 t (38%) (table 20). According to data compiled by the International Copper Study Group (2021a, p. 9), global annual mine capacity increased slightly to 24.8 Mt in 2020 from 24.2 Mt in 2019.

Refined Production.—Global output of refined copper in 2020 increased by 3% to 25.0 Mt from 24.4 Mt (revised) in 2019. Primary copper represented 84% of world refined production and totaled 21.1 Mt, an increase of 4% from 20.3 Mt in 2019; electrowon copper output (17% of worldwide refined production) increased slightly, and primary copper produced by electrolytic and fire refining (other primary, 67%) was 4% greater than that in 2019. Secondary copper accounted for 16% of global refined output in 2020 and decreased by 4% to 3.97 Mt from 4.13 Mt (revised), primarily owing to reduced production in China. In 2020, 44 countries and localities were known to have produced refined copper. China was the leading producer of refined copper and accounted for 40% of world refinery production, followed by Chile (9%), Japan (6%), Congo (Kinshasa) (5%), Russia (4%), and the United States (4%). The remaining countries among the 10 leading producers, in descending order of output, were the Republic of Korea, Germany, Poland, and Kazakhstan. The 10 leading producers represented 78% of worldwide output, and the 20 leading producers represented 93%. Most of the growth in refined copper production was in China, where output increased by 243,000 t (slightly greater than country production in 2019). Large increases also took place in Congo (Kinshasa), by 206,000 t (18%); Zambia, by 114,000 t (43%); Indonesia, by 88,400 t (49%); Japan, by 87,700 t (6%); and Chile, by 60,200 t (3%). The most significant decreases were in the United States, where production decreased by 112,000 t (11%); India, by 92,700 t (22%); and Brazil, by 65,300 t (37%) (table 22). Global refinery capacity increased by 3% to 29.9 Mt in 2020 from 29.0 Mt (revised) in 2019 (International Copper Study Group, 2021a, p. 9).

Apparent Consumption.—In 2020, global apparent consumption of refined copper increased slightly to 25.0 Mt from 24.4 Mt (revised) in 2019, according to the ICSG. China (including Hong Kong) was the leading user of refined copper and accounted for 58% of worldwide consumption, followed by the United States (7%), Germany (4%), Japan (3%), and the Republic of Korea (3%). The remaining countries among the 10 leading consumers, in descending order of quantity, were Turkey, Italy, India, the United Arab Emirates, and Taiwan. The 10 leading consumers accounted for 83% of global apparent consumption, and the 20 leading consumers accounted for 94%. Consumption of copper in China increased by 1.68 Mt to 14.4 Mt in 2020 from 12.8 Mt (revised) in 2019, and consumption collectively decreased by 1.08 Mt in all countries and localities except China. The ICSG calculation of China’s apparent consumption was based on reported production, trade, and SHFE stock data and did not include unreported Government or industry stocks, which can fluctuate significantly on an annual basis. By region, use of refined copper in Asia accounted for 77% of the global total in 2020 (20% excluding China), followed by Europe (11%); North America (9%); and South America, Africa, and Oceania (3% combined). Consumption increased by 6% in Asia (but decreased by 11% outside of China) and decreased by 10% and 5% in Europe and North America, respectively, compared with that in 2019 (International Copper Study Group, 2021a, p. 9, 19–20).

World Review

Chile.—In 2020, 9 of the leading 25 copper mines in the world were located in Chile, the first-ranked global producer of mined copper every year since 1982. The COVID-19 pandemic caused limited disruption to the Chilean mining industry; workforces at many companies were reduced to prevent outbreaks, but the Government considered mining to be an essential economic activity and did not require mines to suspend production (International Copper Study Group, 2020, p. 7; MacDonald, 2020). Mined copper output in Chile was 5.73 Mt in 2020, essentially unchanged from 5.79 Mt in 2019 (table 20).

Production at the Escondida Mine [the first-ranked global mine by copper output in 2020, majority-owned by BHP Group (57.5%)] was unchanged at 1.16 Mt in 2020, as increased concentrator throughput mostly offset lower quantities of ore stacked onto the leaching pads as a preventive measure in response to COVID-19 (BHP Group, 2020, p. 14; 2021, p. 11; Rio Tinto Group, 2021, p. 52). At the Collahuasi Mine [second-ranked, Anglo American plc and Glencore plc (44% each)], copper production increased by 11% to 629,000 t in 2020 because of processing improvements implemented in 2019 and higher ore grades (Anglo American plc, 2021, p. 73, 251). Copper output at the Los Pelambres Mine [10th-ranked, Antofagasta plc (60%)] was 360,000 t in 2020, essentially unchanged from 363,000 t in 2019 (Antofagasta plc, 2021, p. 2, 66). Owing to planned mining of lower ore grades and drought conditions that restricted water availability, copper production decreased by 3% at the Los Bronces Mine [12th-ranked, Anglo American (50.1%)], to 325,000 t from 335,000 t (Anglo American plc, 2021, p. 73, 251). The Centinela Mine [18th-ranked, Antofagasta (70%)] produced 247,000 t of copper in 2020, 11% less than 277,000 t in 2019 as a result of expected lower ore grades in the concentrates circuit (Antofagasta plc, 2021, p. 2, 68–69). In 2020, the Corporación Nacional del Cobre de Chile (Codelco) owned 7 mines in the country, 4 of which were ranked among the 25 leading global copper mines. Total production of mined copper from Codelco's operations increased slightly to 1.62 Mt from 1.59 Mt in 2019. The company attributed the higher output to improved processing plant performance and increased copper ore grades (Corporación Nacional del Cobre de Chile, 2021, p. 38). These 12 operations accounted for 76% of mined copper production in Chile in 2020.

Codelco, the leading copper-producing company in the world, initiated production from an expansion of the El Teniente Mine (fourth-ranked) on January 23, 2020. The project contained enough copper resources to extend the mine life into the 2070s and was one in a series of expansions planned at multiple mines to prevent a decrease in Codelco's copper output in the coming years amid declining grades and ore depletion (Rostás, 2020). Additional projects were in progress at Codelco's Andina (24th-ranked) and Salvador Mines in 2020, and the company began extracting ore from an underground expansion of the Chuquicamata Mine (sixth-ranked in 2020) in 2019. Open pit mining at Chuquicamata, ongoing since 1915, had been anticipated to cease in 2020, but Codelco announced in November 2020 that operations would be extended for an additional year (Rostás, 2019; Corporación Nacional del Cobre de Chile, 2020a, p. 90; 2020b; 2021, p. 161, 163).

In 2020, refined copper output in Chile was 2.33 Mt, 3% higher than 2.27 Mt in 2019 (table 22). Codelco's three electrolytic refineries and five wholly owned electrowon refineries accounted for 55% of the refined copper capacity in Chile, and other SX–EW operations accounted for the remainder (International Copper Study Group, 2021b, p. 194–201). Codelco did not report its total refined copper production in 2020, but the company's refined sales increased by 125,000 t (11%) to 1.23 Mt from 1.11 Mt in 2019 (Corporación Nacional del Cobre de Chile, 2020a, p. 40; 2021, p. 57). Owing to a greater volume of ore leached and higher oxide ore grades, output of refined copper in the form of SX–EW cathodes increased at Centinela in 2020 by 12,200 t (15%) (Antofagasta plc, 2020, p. 2, 58; 2021, p. 2, 69). These increases were partially offset by lower production of electrowon copper at BHP's Spence Mine, by 47,400 t (25%); at the Zaldivar Mine [Antofagasta and Barrick Gold Corp. (50% each)], by 19,800 t (17%); at Escondida, by 16,300 t (7%); and at Freeport's 51%-owned El Abra complex, by approximately 9,500 t (12%). Mining rates and (or) leach pad throughput in 2020 were lower at Escondida, El Abra, and Zaldivar than those in 2019. Copper ore grades and recovery rates decreased at Zaldivar, and copper output at Spence was impacted by unplanned maintenance (BHP Group, 2020, p. 14, 18; 2021, p. 5, 11, 15; Antofagasta plc, 2021, p. 2, 71; Freeport-McMoRan Inc., 2021, p. 15–16, 28; Rio Tinto Group, 2021, p. 52). Using sales from the Codelco facilities as a proxy for production, these 13 operations accounted for approximately 80% of refined copper output in Chile in 2020.

China.—Widespread COVID-19-related business closures in early 2020 significantly affected copper smelters and refineries in China (CRU International Ltd., 2020c, p. 15–16; Luk and Hunter, 2020). In February, CRU International Ltd. (2020a) reported that daily blister output in the country was 15% lower than average production levels and estimated that cathode supply to manufacturing plants would decrease by 9% in the first quarter compared with the first 3 months of 2019. Copper demand in China recovered significantly during the second half of 2020, and total production of refined copper increased slightly to 10.0 Mt at yearend from 9.78 Mt (revised) in 2019 (table 22). Secondary refined copper output in China decreased by 195,000 t (9%) in 2020, owing to lockdowns in Malaysia that restricted the flow of copper scrap. In contrast to the smelting and refining industry, COVID-19 lockdowns had a minimal impact on copper mining in China (International Copper Study Group, 2020, p. 8, 13). Production of mined copper in 2020 increased slightly to 1.72 Mt from 1.68 Mt in 2019 (table 20).

On November 1, 2020, updated standards for imports of high-grade copper scrap into China took effect, with minimum copper contents ranging from 94% to 99.9%, depending on the scrap type. The Government of China planned to ban imports of material that it classified as solid waste, including some types of copper scrap, beginning on January 1, 2021. Imports of scrap that contained no less than the minimum copper quantities would no longer be considered solid waste under the new regulations (CRU International Ltd., 2020b; Mir, 2020; Staub, 2020).

Congo (Kinshasa).—Copper operations in Congo (Kinshasa) produced at normal capacity in 2020 and were not affected by COVID-19 (International Copper Study Group, 2020, p. 6). Mined copper production increased by 231,000 t (17%) to 1.60 Mt in 2020 from 1.37 Mt (revised) in 2019, and refined copper output was 1.35 Mt, higher by 206,000 t (18%) compared with 1.14 Mt (revised) in 2019 (tables 20, 22). The Katanga Mine [14th-ranked; Katanga Mining Ltd. (75%), a subsidiary of Glencore], also known as the Kamoto Mine, continued to ramp up following the completion of expansion projects in late 2018. Production of SX–EW cathode increased by 36,200 t (15%) in 2020 to 271,000 t (90% of capacity) from 235,000 t in 2019 (Katanga Mining Ltd., 2019; Glencore plc, 2021, p. 66, 228). Output also increased significantly, by 30,000 t (36%), at the Kolwezi Mine [Zijin Mining Group Co., Ltd. (72%)]; the mine produced 114,000 t of copper in 2020, consisting of 57,400 t of electrowon cathodes and 56,900 t of copper in concentrates, compared with 84,300 t of copper in 2019, consisting of 58,100 t of copper in concentrates and 26,200 t of electrowon cathodes (Zijin Mining Group Co., Ltd., 2020, p. 24; 2021, p. 40). At the Tenke Fungurume Mine and electrowon refinery [China Molybdenum Co., Ltd. (80%)], copper metal output was 183,000 t, 4,640 t (3%) more than 178,000 t in 2019 (China Molybdenum Co., Ltd., 2020, p. 18; 2021, p. 17). MMG Ltd. increased production of SX–EW cathodes at its Kinsevere Mine by 4,070 t (6%), to 72,000 t in 2020, despite suspending mining activity in the third quarter. Higher ore grades, increased leach pad throughput, and improved copper recovery rates offset a significant decrease in the volume of mined ore. MMG expected to process ore stockpiles until the projected restart of mining in the second quarter of 2021 (MMG Ltd., 2021, p. 26–27). In contrast, Glencore's copper-cobalt Mutanda Mine did not have any production in 2020. Glencore reduced operations at Mutanda and placed the mine on temporary care-and-maintenance status in 2019 owing to low cobalt prices and global cobalt oversupply. The company planned to reopen the mine when it determined that the cobalt market had sufficiently recovered. Mutanda produced 103,000 t of refined copper in 2019 (Glencore plc, 2020, p. 8, 49, 70; 2021, p. 161, 228). In 2020, these five operations accounted for 40% of copper mine production and 47% of copper refinery production in Congo (Kinshasa). Copper output and other operational information were not publicly available for most of the other mines in the country.

India.—In 2020, refined copper production in India was 334,000 t, a decrease of 22% from 426,000 t in 2019 (table 22). The Tuticorin smelter and refinery, owned by Vedanta Resources Ltd., were shut down in March 2018, and production at the Gujarat refinery, owned by Hindustan Copper Ltd., was suspended in August 2019 (Vedanta Resources Ltd., 2019, p. 5; Hindustan Copper Ltd., 2021, p. 128). With the closures of these facilities, Hindalco Industries Ltd.'s Dahej complex accounted for nearly all of the refined copper capacity in India in 2020. Hindalco shut down the plant at the beginning of the global COVID-19 pandemic in March 2020 and did not resume operations until June (Hindalco Industries Ltd., 2020, p. 6; 2021, p. 43, 54; International Copper Study Group, 2021b, p. 208–209).

Indonesia.—Mine production of copper in Indonesia increased by 44%, to 505,000 t in 2020 from 351,000 t (revised) in 2019, owing to significantly higher output from PT Freeport Indonesia's (PT-FI) Grasberg Mine (ninth-ranked) and PT Medco Energi Internasional Tbk's Batu Hijau Mine (table 20). PT-FI mined the final ore from the Grasberg open pit in 2019; in 2020, the rampup of production from four underground ore deposits advanced on schedule, and output of copper in concentrates increased by 33% to 367,000 t from 275,000 t in 2019 (Freeport-McMoRan Inc., 2021, p. 17, 19, 28). At Batu Hijau, PT Medco began producing from a new ore zone in April 2020 and increased production of copper in concentrates by more than twofold to 133,000 t compared with 59,100 t in 2019 (PT Medco Energi Internasional Tbk, 2020, p. 40; 2021, p. 42). These two mines accounted for 99% of mined copper output in Indonesia in 2020.

Laos.—In 2020, mined copper production in Laos was 88,200 t, a decrease of 38% from 141,000 t (revised) in 2019 (table 20). Two copper mines operated in the country, the Phu Kham Mine [PanAust Ltd. (90%)] and the Sepon Mine [Chifeng Jilong Gold Mining Co., Ltd. (90%)]. At Phu Kham, operations were halted for most of April after two employees tested positive for COVID-19, and the processing plant was shut down from May 10 to May 27 because of a worker shortage. Phu Kham produced 48,400 t of copper in concentrates in 2020, 30% less than 69,300 t in 2019 (PanAust Ltd., 2021, p. 18, 25). The Sepon Mine was not disrupted by the COVID-19 pandemic, but leaching operations ramped down in anticipation of the projected cessation of copper production in 2021. Output of electrowon copper from the mine decreased by 45% to 39,700 t from 72,000 t in 2019 (Chifeng Lane Xang Minerals Ltd., 2020a, b, 2021).

Panama.—First Quantum Minerals Ltd. commenced production at its 90%-owned Cobre Panama Mine (20th-ranked in 2020) in 2019 and expected that the rampup to a full capacity of 285,000 to 310,000 t/yr of copper would be completed in 2020. Output of copper in concentrates at Cobre Panama in 2020 was significantly less than anticipated but increased by 39% to 206,000 t from 147,000 t in 2019. Owing to restrictions enacted by the Government of Panama related to the COVID-19 pandemic, First Quantum placed the mine on care-and-maintenance status on April 7, 2020. Normal activities resumed on July 7, and all mills were fully operational by August 8. Production also was affected by unplanned maintenance of the crusher in the first quarter of 2020 and planned maintenance of the milling circuit in October 2020 (First Quantum Minerals Ltd., 2020, p. 27; 2021, p. 12, 20–21). Cobre Panama was the only copper mine in Panama and represented the largest addition to global copper mine capacity from a new mine or expansion since the Las Bambas Mine in Peru began operating in late 2015.

Peru.—Six of the leading twenty-five copper mines in the world were located in Peru in 2020, and mine production of copper in the country decreased by 12% to 2.15 Mt from 2.46 Mt in 2019 (table 20). To limit the spread of COVID-19, the Government of Peru declared a national emergency on March 15, 2020, that required the mining industry to adopt strict health protocols and reduce workforce sizes (International Copper Study Group, 2020, p. 7). Many leading mines in Peru consequently operated at reduced capacity in 2020. Output by mine was as follows: Antamina [seventh-ranked, BHP and Glencore (33.75% each)]—381,000 t (67,800 t lower than that in 2019); Cerro Verde [eighth-ranked, Freeport (53.56%)]—372,000 t (83,000 t); Las Bambas [13th-ranked, MMG (62.5%)]—311,000 t (71,500 t); Toquepala (16th-ranked; Southern Copper Corp., a subsidiary of Grupo México)—255,000 t (2,900 t); and Antapaccay (22d-ranked, Glencore)—186,000 t (12,000 t). The Antamina and Cerro Verde Mines shut down for some of the first and (or) second quarters to comply with Government requirements, whereas all other leading mines remained open throughout the COVID-19 pandemic. In addition to COVID-19, production at Las Bambas was affected by protests that blocked access roads and restricted the transport of copper concentrates for 64 days in 2020 (International Copper Study Group, 2020, p. 20–22;

Freeport-McMoRan Inc., 2021, p. 15, 28; Glencore plc, 2021, p. 66, 228; Grupo México, S.A.B. de C.V., 2021, p. 104–105; MMG Ltd., 2021, p. 23–24; Teck Resources Ltd., 2021, p. 12). These five operations accounted for 70% of mined Peruvian copper production in 2020. The Toromocho Mine, owned by Aluminum Corp. of China Ltd., also ranked among the leading 25 copper mines in the world according to a production estimate by S&P Global Market Intelligence, but copper output was not publicly available (S&P Capital IQ, undated).

Russia.—In 2020, refined copper production in Russia was 1.04 Mt, essentially unchanged compared with that in 2019 (table 22). PJSC MMC Norilsk Nickel (Nornickel), which owned multiple refineries that accounted for approximately 40% of the refined copper capacity in Russia, reported refined output of 416,000 t from its Russian facilities in 2020, a decrease of 3% from 431,000 t in 2019. Nornickel stated that the COVID-19 pandemic did not disrupt any of its operations and attributed the reduced production to decreased output of its own copper-bearing ores and lower than expected copper content of the concentrate feedstock supplied by another company (International Copper Study Group, 2021b, p. 218–220; PJSC MMC Norilsk Nickel, 2021a, p. 88, 90–94; 2021b). None of the other major copper refining companies in Russia reported publicly available information on the refined copper output of their facilities in 2020.

Zambia.—As in neighboring Congo (Kinshasa), the COVID-19 pandemic did not significantly affect the copper industry in Zambia (International Copper Study Group, 2020, p. 6). Output of mined copper increased by 7% in 2020 to 853,000 t from 800,000 t (revised) in 2019 (table 20). Production at some of the leading copper mines in Zambia was as follows: the Sentinel Mine (17th-ranked, First Quantum)—251,000 t in 2020 (220,000 t in 2019); the Kansanshi Mine [19th-ranked, First Quantum (80%)]—221,000 t (232,000 t in 2019); the Lumwana Mine (Barrick)—125,000 t (108,000 t in 2019); and the Chambishi Mine [China Nonferrous Mining Corp. Ltd. (85%)]—40,200 t (14,200 t in 2019). First Quantum attributed the decreased production at Kansanshi to lower copper ore grades and the higher output at Sentinel to a significant increase in mill throughput. The increased production at Lumwana reflected higher ore grades and improved mill performance. At Chambishi, China Nonferrous Mining brought an additional ore zone into commercial production in July 2020 (China Nonferrous Mining Corp. Ltd., 2020, p. 27; 2021, p. 29; Barrick Gold Corp., 2021, p. 72, 105; First Quantum Minerals Ltd., 2021, p. 22–25). The combined output of these four operations was equivalent to 75% of the country's total mined copper in 2020.

Refined copper production in Zambia was 378,000 t in 2020, 43% greater than 265,000 t (revised) in 2019 (table 22). At Glencore's Mopani operations, output of refined copper in 2020 increased by 61% to 82,500 t from 51,300 t in 2019, when the smelter was shut down for extensive planned maintenance in the second half of the year (Glencore plc, 2020, p. 70; 2021, p. 228). Copper production by SX–EW at the Kansanshi Mine was 52,000 t, 15% greater than 45,000 t in 2019 (First Quantum Minerals Ltd., 2021, p. 61). Public information was not available for any of the other major copper refineries that operated in Zambia.

Outlook

Based on production guidance published by companies that operate in the United States, domestic mine and refined output of copper will likely increase in 2021. The Chino Mine (which produces copper in concentrates and refined SX–EW cathode) will restart at a reduced operating rate in January 2021, and the Gunnison (cathode) and Pumpkin Hollow (concentrates) Mines are projected to complete rampups to full capacity by yearend 2021. At the Bingham Canyon Mine (concentrates), a project to push back the south wall of the open pit will yield higher copper ore grades in 2021. Production of refined copper at Rio Tinto's electrolytic refinery will likely recover from multiple disruptions in 2020, whereas output from Freeport's electrolytic refinery might decrease because of planned major maintenance of the company's smelter. Globally, two major mines are anticipated to begin producing copper in 2021, the Qulong Mine in China and the Kamoa-Kakula Mine in Congo (Kinshasa). The ICSG projects that world mine production capacity will increase by 4% and world refinery production capacity will be essentially unchanged in 2021. As economies recover from the global COVID-19 pandemic, worldwide copper production and consumption are expected to increase. Copper consumption will continue to depend on economic trends in sectors such as automobiles, housing and building construction, HVAC, power utilities, and telecommunications.

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TABLE 1
SALIENT COPPER STATISTICS[1]

(Metric tons, copper content, unless otherwise specified)

		2016	2017	2018	2019	2020
United States:						
Mine production:						
Copper ore concentrated, gross weight		226,000,000 r	229,000,000 r	228,000,000 r	235,000,000 r	221,000,000
Average yield of concentrated copper ore	percent	0.34 r	0.29 r	0.29 r	0.30 r	0.28
Recoverable copper:[2]						
Arizona		969,000	868,000	801,000	859,000	880,000
Other States		461,000	391,000	421,000	398,000	322,000
Total		1,430,000	1,260,000	1,220,000	1,260,000	1,200,000
Total value[3]	millions	$7,090	$7,920	$8,050	$7,750	$7,600
Smelter production:						
Primary (from ore)[4]		563,000	470,000	536,000	464,000	315,000 e, 5
Byproduct sulfuric acid, sulfur content		590,000	489,000	586,000	522,000	508,000
Refinery production:						
Primary (from ore):						
Electrolytic		561,000	482,000	538,000	457,000	315,000 e, 5
Electrowon		615,000	557,000	532,000	527,000	559,000
Total		1,180,000	1,040,000	1,070,000	985,000	874,000
Secondary (from scrap), electrolytic and fire-refined		46,300	40,100	41,200	44,400	43,200
Grand total, primary and secondary		1,220,000	1,080,000	1,110,000	1,030,000	918,000
Secondary production, refineries and manufacturers:[6]						
Recovered from new (manufacturing) scrap		690,000	702,000	712,000	700,000	697,000
Recovered from old (post-consumer) scrap		149,000	146,000	141,000	166,000 r	160,000
Total		838,000	847,000	853,000	866,000 r	858,000
Copper sulfate production, gross weight		18,400	18,400	18,200	17,500	17,500
Exports, refined[7]		134,000	94,200	190,000	125,000	41,200
Imports for consumption, refined[7]		708,000	813,000	778,000	663,000	676,000
Closing stocks, December 31:						
Blister and anodes		14,400	12,600	9,230	16,400	9,380
Refined copper:						
Refineries		4,190	5,840	3,850	7,010	3,850
Wire-rod mills		26,700	27,800	21,800	20,000	10,700
Brass mills		7,380	7,870	8,210	7,520	7,850
Other industry		5,430	5,360	7,070	6,200	6,850
Commodity Exchange Inc. (COMEX)[8]		80,700	191,000	99,600	34,100	70,200
London Metal Exchange Ltd. (LME), U.S. warehouses[8]		98,900	27,100	104,000	35,000	18,300
Total		223,000	265,000	244,000	110,000	118,000
Consumption:						
Reported, refined copper		1,800,000	1,800,000	1,820,000	1,810,000	1,770,000
Apparent, primary refined and copper from old scrap[9]		1,880,000	1,860,000	1,820,000	1,820,000	1,660,000
Price, annual average:[8]						
U.S. producers cathode[10]	cents per pound	224.873	285.393	298.738	279.596	286.745
COMEX, high grade first position	do.	219.727	280.425	292.568	272.267	279.948
LME, grade A cash	do.	220.571	279.518	295.960	272.364	279.797
World, production:[11]						
Mine		20,500,000	20,100,000 r	20,600,000 r	20,400,000	20,600,000
Smelter		19,100,000	19,500,000	20,100,000	19,900,000 r	21,200,000
Refinery		23,700,000 r	23,900,000	24,400,000	24,400,000 r	25,000,000

See footnotes at end of table.

TABLE 1—Continued
SALIENT COPPER STATISTICS[1]

[e]Estimated. [r]Revised. do. Ditto.
[1]Table includes data available through January 31, 2022. Data are rounded to no more than three significant digits, except prices; may not add to totals shown.
[2]Includes the recoverable copper content of concentrates (of copper and other metals), copper produced by solvent extraction and electrowinning (SX–EW), and copper recovered as precipitates.
[3]Calculated with the U.S. producers cathode price.
[4]May contain small quantities of copper from scrap.
[5]To avoid disclosing company proprietary data, production is an estimate based on information in public company reports and does not reflect actual output reported to the U.S. Geological Survey.
[6]Copper converted to refined metal, alloys, and other forms by refineries and manufacturers (brass mills, chemical plants, foundries, wire-rod mills, and other).
[7]Source: U.S. Census Bureau.
[8]Source: S&P Global Platts Metals Week.
[9]Primary refined copper production plus copper recovered from old (post-consumer) scrap plus refined imports for consumption minus refined exports, including adjustments for changes in refined stocks.
[10]Sum of the annual average COMEX price and annual average New York dealer cathode premium; reflects the delivered spot price of copper to U.S. consumers by U.S. producers.
[11]May include estimated data.

TABLE 2
LEADING COPPER-PRODUCING MINES IN THE UNITED STATES IN 2020, IN ORDER OF PUBLICLY AVAILABLE OUTPUT[1, 2]

Rank	Mine	County and State	Operator	Source of copper	Capacity[3] (thousand metric tons)
1	Morenci	Greenlee, AZ	Freeport-McMoRan Inc.	Copper-molybdenum ore, concentrated and leached	595
2	Bingham Canyon	Salt Lake, UT	Rio Tinto Kennecott[4]	Copper-molybdenum ore, concentrated	220
3	Bagdad	Yavapai, AZ	Freeport-McMoRan Inc.	Copper-molybdenum ore, concentrated and leached	115
4	Sierrita	Pima, AZ	do.	do.	110
5	Safford	Graham, AZ	do.	Copper ore, leached	130
6	Mission	Pima, AZ	ASARCO LLC[5]	Copper ore, concentrated	65
7	Pinto Valley	Gila, AZ	Capstone Mining Corp.	Copper-molybdenum ore, concentrated and leached	75
8	Ray	Pinal, AZ	ASARCO LLC[5]	Copper ore, concentrated and leached	135
9	Robinson	White Pine, NV	Robinson Nevada Mining Co.[6]	Copper-molybdenum ore, concentrated	65
10	Chino	Grant, NM	Freeport-McMoRan Inc.	Copper ore, concentrated and leached	140
11	Silver Bell	Pima, AZ	ASARCO LLC[5]	Copper ore, leached	25
12	Tyrone	Grant, NM	Freeport-McMoRan Inc.	do.	45
13	Phoenix	Lander, NV	Nevada Gold Mines LLC[7]	Gold-copper ore, concentrated and leached	20 [e]
14	Eagle	Marquette, MI	Lundin Mining Corp.	Nickel-copper ore, concentrated	20
15	Miami	Gila, AZ	Freeport-McMoRan Inc.	Copper ore, leached	90
16	Carlota	do.	Carlota Copper Co.[6]	do.	35 [e]
(8)	Continental	Silver Bow, MT	Montana Resources LLP	Copper-molybdenum ore, concentrated	(8)

[e]Estimated. do. Ditto.
[1]Table includes data available through January 31, 2022.
[2]The mines listed accounted for more than 99% of U.S. mine production of copper in 2020.
[3]For copper produced from concentrates, capacity is calculated based on the material handling capacity of the mill and the copper content of ore reserves. For copper produced by solvent extraction and electrowinning (SX–EW), capacity is the reported design capacity of the tankhouse.
[4]Wholly owned subsidiary of Rio Tinto Group.
[5]Wholly owned subsidiary of Grupo México, S.A.B. de C.V.
[6]Wholly owned subsidiary of KGHM International Ltd., which is a wholly owned subsidiary of KGHM Polska Miedź S.A.
[7]A joint venture of Barrick Gold Corp. and Newmont Corp. The mine was operated by Barrick.
[8]The rank order and capacity are not shown because public data are not available.

TABLE 3
MINE PRODUCTION OF COPPER-BEARING ORES AND RECOVERABLE COPPER CONTENT OF ORES PRODUCED IN THE UNITED STATES[1]

(Metric tons)

Source and treatment process	2019		2020	
	Gross weight	Recoverable copper	Gross weight	Recoverable copper
Copper ore:				
Concentrated	235,000,000 r	706,000	221,000,000	609,000
Leached	NA	527,000	NA	559,000
Total	NA	1,230,000	NA	1,170,000
Copper precipitates, leached from tailings, dumps, and in-place material	NA	W	NA	W
Other copper-bearing ores, concentrated[2]	7,290,000 r	24,100	9,910,000	33,500
Grand total	XX	1,260,000	XX	1,200,000

[r]Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; included with “Other copper-bearing ores, concentrated.” XX Not applicable.
[1]Table includes data available through January 31, 2022. Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Includes gold ore, lead ore, and nickel ore.

TABLE 4
CONSUMPTION OF COPPER AND BRASS MATERIALS IN THE UNITED STATES[1]

(Metric tons, gross weight)

Item	Brass mills	Wire-rod mills	Foundries, chemical plants, miscellaneous users	Smelters, refiners, ingot makers	Total
2019:					
Copper scrap	646,000	107,000	48,700	130,000	931,000
Refined copper	413,000	1,330,000	54,900	8,740	1,810,000
Hardeners and master alloys	W	--	3,550 e	--	3,550 e
Brass ingots	--	--	56,700 r	--	56,700 r
Slab zinc	W	--	413	W	42,400
2020:					
Copper scrap	649,000	120,000	45,500	112,000	926,000
Refined copper	414,000	1,300,000	53,300	8,880	1,770,000
Hardeners and master alloys	W	--	3,550 e	--	3,550 e
Brass ingots	--	--	51,100	--	51,100
Slab zinc	W	--	410 e	W	42,800

[e]Estimated. [r]Revised. W Withheld to avoid disclosing company proprietary data; included with “Slab zinc” under “Total.” -- Zero.
[1]Table includes data available through January 31, 2022. Data are rounded to no more than three significant digits; may not add to totals shown.

TABLE 5
CONSUMPTION OF REFINED COPPER SHAPES IN THE UNITED STATES[1]

(Metric tons)

Class of consumer	Cathodes	Ingots and ingot bars	Cakes and slabs	Wirebar, billets, other	Total
2019:					
Wire-rod mills	1,330,000	--	--	(2)	1,330,000
Brass mills	317,000	W	43,900	51,600	413,000
Chemical plants[e]	W	--	--	236	236
Ingot makers	W	W	--	8,740	8,740
Foundries	W	3,860	--	26,800	30,700
Miscellaneous[3]	W	W	--	23,900	23,900
Total	1,650,000	3,860	43,900	111,000	1,810,000
2020:					
Wire-rod mills	1,300,000	--	--	(2)	1,300,000
Brass mills	317,000	W	43,700	52,600	414,000
Chemical plants[e]	W	--	--	240	240
Ingot makers	W	W	--	8,880	8,880
Foundries	W	3,740	--	26,000	29,700
Miscellaneous[3]	W	W	--	23,300	23,300
Total	1,620,000	3,740	43,700	111,000	1,770,000

[e]Estimated. Withheld to avoid disclosing company proprietary data; included with “Wirebar, billets, other.” -- Zero.
[1]Table includes data available through January 31, 2022. Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Withheld to avoid disclosing company proprietary data; included with “Cathodes.”
[3]Includes consumers of copper powder and copper shot, iron and steel plants, and other manufacturers.

TABLE 6
COPPER RECOVERED FROM SCRAP PROCESSED IN THE UNITED STATES[1]

(Metric tons)

	2019	2020
Kind of scrap:		
New:		
Copper-base	662,000	665,000
Aluminum-base	38,300	32,000
Nickel-base[e]	20	20
Total	700,000	697,000
Old:		
Copper-base	141,000	138,000
Aluminum-base	24,700 r	22,400
Nickel- and zinc-base	286	70
Total	166,000 r	160,000
Grand total, new and old scrap	866,000 r	858,000
Form of recovery:		
As unalloyed copper	44,400	43,200
In brass and bronze	757,000 r	758,000
In aluminum alloys	63,000 r	54,300
In alloy iron and steel and other alloys	304	88
In chemical compounds[e]	1,800	1,800
Total	866,000 r	858,000

[e]Estimated. [r]Revised.
[1]Table includes data available through January 31, 2022. Data are rounded to no more than three significant digits; may not add to totals shown.

TABLE 7
COPPER RECOVERED AS REFINED COPPER AND IN ALLOYS AND OTHER FORMS
FROM PURCHASED COPPER-BASE SCRAP IN THE UNITED STATES[1]

(Metric tons)

Type of operation	From new scrap[2]		From old scrap[2]		Total	
	2019	2020	2019	2020	2019	2020
Ingot makers	5,840	4,730	58,000	46,900	63,900	51,600
Refineries[3]	20,100 e	20,100 e	24,200	23,100	44,400	43,200
Brass and wire-rod mills	617,000	631,000	36,500	38,100	653,000	670,000
Foundries and miscellaneous manufacturers	19,300	9,150	22,100	29,600	41,400	38,800
Total	662,000	665,000	141,000	138,000	803,000	803,000

[e]Estimated.
[1]Table includes data available through January 31, 2022. Data are rounded to no more than three significant digits; may not add to totals shown.
[2]New scrap refers to material generated during the manufacturing process. Old scrap consists of copper items used by consumers.
[3]Electrolytically refined and fire refined from scrap based on source of material at smelter or refinery level.

TABLE 8
PRODUCTION OF SECONDARY COPPER AND COPPER-ALLOY PRODUCTS
IN THE UNITED STATES[1]

(Metric tons, gross weight)

Item produced from scrap	2019	2020
Unalloyed copper products[2]	44,400	43,200
Alloyed copper products:		
Brass and bronze ingots:		
Tin bronzes	6,830	3,750
Leaded red brass and semi-red brass	39,600	36,200
High leaded tin bronze	8,830	9,310
Yellow brass	1,710	1,210
Manganese bronze	7,260	7,010
Aluminum bronze	5,360	3,870
Nickel silver	1,320	918
Silicon bronze and brass	4,930	3,090
Copper-base hardeners and master alloys	4,480 e	4,500
Miscellaneous	7,500	7,050
Total	87,800	76,900
Brass mill and wire-rod mill products	739,000	755,000
Brass and bronze castings	33,900	33,700
Copper in chemical products[e]	1,800	1,800
Grand total	907,000	910,000

[e]Estimated.
[1]Table includes data available through January 31, 2022. Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Includes electrolytically refined copper, fire-refined copper, and copper castings.

TABLE 9
ESTIMATED COMPOSITION OF SECONDARY COPPER-ALLOY PRODUCTION IN THE UNITED STATES[1]

(Metric tons)

	Copper	Tin	Lead	Zinc	Nickel	Aluminum	Total
Brass and bronze ingots:							
2019	77,800	1,960	2,860	5,120	135	9	87,800
2020	65,100	2,320	3,170	6,150	150	13	76,900
Brass mill and wire-rod mill products:							
2019	655,000	414	1,680	80,200	1,150	16	739,000
2020	670,000	462	1,670	81,700	1,140	15	755,000
Brass and bronze castings:							
2019	32,900	137	145	642	47	27	33,900
2020	32,700	137	145	642	47	27	33,700

[1]Table includes data available through January 31, 2022. Data are rounded to no more than three significant digits; may not add to totals shown.

TABLE 10

CONSUMPTION AND YEAREND STOCKS OF COPPER-BASE SCRAP IN THE UNITED STATES[1]

(Metric tons, gross weight)

	2019		2020	
Scrap type and processor	Consumption	Stocks	Consumption	Stocks
Unalloyed scrap:				
No. 1 wire and heavy:				
Smelters, refiners, and ingot makers	14,300	W	12,400	W
Brass and wire-rod mills	387,000	(2)	400,000	(2)
Foundries and miscellaneous manufacturers	21,900	(2)	20,500	(2)
No. 2 mixed heavy and light:				
Smelters, refiners, and ingot makers	57,000	W	49,400	W
Brass and wire-rod mills	95,000	(2)	99,900	(2)
Foundries and miscellaneous manufacturers	14,600	(2)	13,700	(2)
Total unalloyed scrap:				
Smelters, refiners, and ingot makers	71,300	68,000	61,800	49,300
Brass and wire-rod mills	482,000	700	500,000	986
Foundries and miscellaneous manufacturers	36,600	3,040	34,200	2,260
Alloyed scrap:				
Red brass:[3]				
Smelters, refiners, and ingot makers	13,000	1,610	11,300	2,750
Brass mills	W	(2)	W	(2)
Foundries and miscellaneous manufacturers	W	(2)	W	(2)
Leaded yellow brass:				
Smelters, refiners, and ingot makers	9,070	628	4,700	596
Brass mills	W	(2)	W	(2)
Foundries and miscellaneous manufacturers	739	(2)	607	(2)
Yellow and low brass, all plants	72,800	885	71,400	725
Cartridge cases and brass, all plants	W	(2)	W	(2)
Auto radiators:				
Smelters, refiners, and ingot makers	16,600	621	13,200	600
Foundries and miscellaneous manufacturers	W	(2)	W	(2)
Bronzes:				
Smelters, refiners, and ingot makers	10,100	1,220	8,530	1,230
Brass mills and miscellaneous manufacturers	198	(2)	1,000	(2)
Nickel-copper alloys, all plants	10,900	171	10,300	296
Low grade and residues; smelters, refiners, miscellaneous manufacturers	3,460	477	2,280	470
Other alloy scrap:[4]				
Smelters, refiners, and ingot makers	1,520	233	1,350	410
Brass mills and miscellaneous manufacturers	W	(2)	W	(2)
Total alloyed scrap:				
Smelters, refiners, and ingot makers	58,300	6,520	50,600	3,710
Brass mills	270,000	385	269,000	564
Foundries and miscellaneous manufacturers	12,200	1,110	11,400	1,010
Grand total, scrap:				
Smelters, refiners, and ingot makers	130,000	74,500	112,000	53,000
Brass and wire-rod mills	752,000	1,090	768,000	1,550
Foundries and miscellaneous manufacturers	48,700	4,150	45,600	3,280

W Withheld to avoid disclosing company proprietary data; included in “Total unalloyed scrap,” “Total alloyed scrap,” and grand totals.

[1]Table includes data available through January 31, 2022. Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Individual breakdown is not available; included in “Total unalloyed scrap,” “Total alloyed scrap,” and grand totals.

[3]Includes cocks and faucets, commercial bronze, composition turnings, gilding metal, railroad car boxes, and silicon bronze.

[4]Includes aluminum bronze, beryllium copper, and refinery brass.

TABLE 11
CONSUMPTION OF PURCHASED COPPER-BASE SCRAP IN THE UNITED STATES[1]

(Metric tons, gross weight)

	New scrap[2]		Old scrap[2]		Total	
Type of operation	2019	2020	2019	2020	2019	2020
Ingot makers	15,500	12,600	68,200	55,200	83,700	67,800
Smelters and refineries	20,800 e	20,800 e	25,100	23,800	45,900	44,600
Brass and wire-rod mills[3]	714,000	729,000	38,800	39,900	752,000	768,000
Foundries and miscellaneous manufacturers	22,700	10,800	26,000	34,800	48,700	45,500
Total	773,000	773,000	158,000	154,000	931,000	926,000

[e]Estimated.
[1]Table includes data available through January 31, 2022. Data are rounded to no more than three significant digits; may not add to totals shown.
[2]New scrap refers to material generated during the manufacturing process. Old scrap consists of copper items used by consumers.
[3]Consumption at brass and wire-rod mills assumed equal to receipts.

TABLE 12
CONSUMPTION OF BRASS INGOT, REFINED COPPER, AND COPPER SCRAP AT
FOUNDRIES AND MISCELLANEOUS MANUFACTURERS IN THE UNITED STATES[1]

(Metric tons, gross weight)

Ingot type or material consumed	2019	2020
Brass ingot:		
Tin bronzes	3,510 r	3,680
Leaded red brass and semi-red brass	20,900	19,100
Yellow, leaded, low brass[2]	15,500	9,090
Manganese bronze	2,830	2,620
Nickel silver[3]	5,560	8,800
Aluminum bronze	4,600	3,900
Hardeners and master alloys[e, 4]	3,550	3,550
Lead free alloys[e, 5]	3,880	3,880
Total	60,300 r	54,700
Refined copper	54,900	53,300
Copper scrap	48,700	45,500

[e]Estimated. [r]Revised.
[1]Table includes data available through January 31, 2022. Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Includes brass and silicon bronze.
[3]Includes brass, copper nickel, and nickel bronze.
[4]Includes special alloys.
[5]Includes copper-bismuth and copper-bismuth-selenium alloys.

TABLE 13
AVERAGE BUYING PRICES FOR COPPER SCRAP
IN THE UNITED STATES[1]

(Cents per pound)

			Dealers[2]	
Year	Brass mills no. 1 scrap	Refiners no. 2 scrap	No. 2 scrap	Red brass turnings and borings
2019	262.76	233.19	185.19	136.53
2020	268.76	243.47	201.72	130.67

[1]Table includes data available through January 31, 2022.
[2]As of January 2020, domestic dealer prices were available only for the entire United States, whereas dealer prices were available only for individual domestic markets prior to January 2020. Dealer prices in 2019 are for New York.

Source: Fastmarkets-AMM.

TABLE 14

U.S. EXPORTS OF UNMANUFACTURED COPPER (COPPER CONTENT), BY COUNTRY OR LOCALITY[1]

Country or locality	Ore and concentrates[2] Quantity (metric tons)	Ore and concentrates[2] Value[7] (thousands)	Matte, ash, and precipitates[3] Quantity (metric tons)	Matte, ash, and precipitates[3] Value[7] (thousands)	Blister and anodes[4] Quantity (metric tons)	Blister and anodes[4] Value[7] (thousands)	Refined[5] Quantity (metric tons)	Refined[5] Value[7] (thousands)	Unalloyed copper scrap[6] Quantity (metric tons)	Unalloyed copper scrap[6] Value[7] (thousands)	Total Quantity (metric tons)	Total Value[7] (thousands)
2019	353,000	$2,150,000	21,800	$45,600	7,270	$39,200	125,000	$795,000	422,000	$1,960,000	929,000	$5,000,000
2020:												
Belgium	230	920	6,110	7,950	190	731	64	155	20,900	105,000	27,500	115,000
Canada	36,100	199,000	13,100	29,600	1,690	10,100	12,600	79,500	51,800	285,000	115,000	603,000
China	49,300	279,000	62	219	148	931	233	814	81,200	423,000	131,000	704,000
Germany	--	--	288	673	128	823	22	163	22,400	104,000	22,800	106,000
Greece	--	--	--	--	43	60	--	--	13,000	75,000	13,000	75,000
Hong Kong	9	40	--	--	86	543	18	20	7,810	37,800	7,930	38,400
India	20	91	37	127	247	1,220	--	--	9,570	38,400	9,880	39,800
Italy	--	--	--	--	197	1,300	86	297	220	1,010	503	2,600
Japan	14,600	84,100	251	79	24	146	4	107	16,400	91,300	31,300	176,000
Korea, Republic of	8,140	46,300	1	5	1,390	9,170	1,160	6,740	45,700	238,000	56,400	301,000
Malaysia	--	--	3	4	218	1,160	--	--	54,400	182,000	54,600	184,000
Mexico	250,000	1,300,000	2,720	5,150	848	2,930	26,800	173,000	2,650	14,500	283,000	1,500,000
Netherlands	4	17	59	181	--	--	--	--	5,480	23,900	5,550	24,100
Philippines	6,250	32,300	--	--	10	68	--	--	340	1,370	6,600	33,700
Poland	--	--	--	--	--	--	--	--	5,000	26,400	5,000	26,400
Russia	--	--	--	--	--	--	--	--	7,310	38,300	7,310	38,300
Slovakia	--	--	1,050	4,390	--	--	--	--	56	245	1,110	4,640
Spain	8,990	48,400	1,820	1,370	35	210	--	--	4,070	21,100	14,900	71,100
Sweden	--	--	--	--	135	309	--	--	1,800	7,850	1,940	8,160
Taiwan	1,510	8,860	2	45	60	392	25	162	17,000	88,400	18,600	97,900
Thailand	--	--	2	3	256	1,030	(8)	3	4,800	17,400	5,050	18,400
Vietnam	--	--	--	--	--	--	--	--	7,480	40,200	7,480	40,200
Other	7,460	34,200	366	479	498	2,510	151	1,680	17,000	85,300	25,500	124,000
Total	383,000	2,040,000	25,900	50,300	6,210	33,600	41,200	262,000	396,000	1,950,000	852,000	4,330,000

-- Zero.

[1]Table includes data available through June 16, 2021. Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Schedule B of the United States code 2603.00.0010. Includes copper ore and concentrates only; excludes copper contained in ore and concentrates of other metals.

[3]Schedule B codes 2620.30.0000, 7401.00.0010, and 7401.00.0050. Includes copper matte, ash, and precipitates only; excludes the copper content of mattes and ashes of other metals.

[4]Schedule B code 7402.00.0000.

[5]Schedule B codes 7403.11.0000, 7403.12.0000, 7403.13.0000, and 7403.19.0000.

[6]Schedule B codes 7404.00.0010, 7404.00.0015, 7404.00.0025, and 7404.00.0030.

[7]Free alongside ship value.

[8]Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 15

U.S. EXPORTS OF REFINED COPPER SEMIMANUFACTURES AND COPPER SULFATE, BY COUNTRY OR LOCALITY[1, 2]

Country or locality	Pipes and tubing[3]		Plates, sheets, foil, bars[4]		Bare wire, including wire rod[5]		Wire and cable, stranded[6]		Copper sulfate (gross weight)[7]	
	Quantity (metric tons)	Value[8] (thousands)	Quantity (metric tons)	Value[8] (thousands)	Quantity (metric tons)	Value[8] (thousands)	Quantity (metric tons)	Value[8] (thousands)	Quantity (metric tons)	Value[8] (thousands)
2019	13,000	$111,000	24,100	$263,000	159,000	$1,030,000	34,500	$295,000	8,380	$47,000
2020:										
Canada	2,100	18,700	6,010	50,200	30,700	206,000	11,300	85,100	2,230	4,770
China	583	2,850	888	14,900	451	3,460	199	4,040	641	8,620
Dominican Republic	21	244	9	40	62	216	108	789	182	406
Germany	117	889	634	5,250	7	192	35	968	36	59
Hong Kong	1	35	777	19,800	345	1,050	22	668	5	66
Ireland	(9)	4	27	120	1	19	1	10	1,480	10,300
Israel	1	8	12	293	7	36	40	1,020	972	3,380
Italy	8	51	101	622	16	121	14	142	--	--
Japan	18	172	389	14,000	42	466	30	650	92	420
Jordan	247	2,220	(9)	9	1	7	--	--	--	--
Korea, Republic of	25	426	256	4,040	342	2,260	69	1,040	1,120	9,760
Malaysia	21	145	237	3,220	61	207	417	834	149	253
Mexico	5,330	45,900	13,000	107,000	92,600	617,000	13,100	112,000	6	27
Qatar	125	1,100	--	--	6	28	(9)	3	--	--
Saudi Arabia	1,810	15,400	108	921	(9)	9	162	1,020	--	--
Singapore	109	554	227	2,040	251	3,010	19	694	134	1,510
Taiwan	3	22	382	7,980	39	144	60	355	944	15,300
Thailand	2	43	105	1,020	17	54	5	93	--	--
United Arab Emirates	1,190	10,800	5	35	10	28	2	59	--	--
United Kingdom	38	542	161	875	120	529	123	1,230	--	--
Vietnam	384	2320	17	427	1	58	2	61	--	--
Other	697	6,890	605	5,930	362	3,220	512	11,400	167	1,180
Total	12,800	109,000	23,900	239,000	125,000	838,000	26,200	222,000	8,160	56,100

-- Zero.

[1]Table includes data available through June 16, 2021. Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Copper-alloy products are excluded.

[3]Includes all products listed under the Schedule B of the United States heading 7411.10 (tubes and pipes of refined copper), whether or not seamless.

[4]Includes all products listed under the Schedule B headings 7407.10 (bars, rods, and profiles of refined copper); 7409.11 and 7409.19 (plates, sheets, and strip of refined copper), whether or not coiled; and 7410.11 (foil of refined copper, not backed).

[5]Includes all products listed under the Schedule B headings 7408.11 and 7408.19 (wire of refined copper), regardless of the maximum cross-sectional dimension. Exports of wire rod (wire with a maximum cross-sectional dimension of more than 6 millimeters) were 149,000 metric tons (t) valued at $951 million in 2019 and 118,000 t valued at $783 million in 2020.

[6]Includes all products listed under the Schedule B heading 7413 (stranded wire and cables of refined copper, not electrically insulated), excluding those with fittings or made into articles.

[7]Schedule B code 2833.25.0000.

[8]Free alongside ship value.

[9]Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 16

U.S. IMPORTS FOR CONSUMPTION OF UNMANUFACTURED COPPER (COPPER CONTENT), BY COUNTRY OR LOCALITY[1]

	Ore and concentrates[2]		Matte, ash, and precipitates[3]		Blister and anodes[4]		Refined[5]		Unalloyed scrap[6]		Total	
Country or locality	Quantity (metric tons)	Value[7] (thousands)	Quantity (metric tons)	Value[7] (thousands)	Quantity (metric tons)	Value[7] (thousands)	Quantity (metric tons)	Value[7] (thousands)	Quantity (metric tons)	Value[7] (thousands)	Quantity (metric tons)	Value[7] (thousands)
2019	27,000	$149,000	1,960	$5,390	236	$1,850	663,000	$4,010,000	32,500	$145,000	724,000	$4,310,000
2020:												
Bahrain	--	--	--	--	--	--	76	388	--	--	76	388
Belgium	--	--	354	1,430	--	--	--	--	(8)	3	354	1,440
Bolivia	--	--	--	--	--	--	1,030	6,780	40	130	1,070	6,910
Canada	2,170	8,140	459	1,900	(8)	6	149,000	900,000	14,500	67,600	166,000	978,000
Chile	--	--	--	--	--	--	410,000	2,510,000	76	489	411,000	2,510,000
China	--	--	--	--	--	--	426	2,620	(8)	2	426	2,620
Colombia	--	--	--	--	--	--	--	--	60	340	60	340
Congo (Kinshasa)	--	--	--	--	--	--	148	792	--	--	148	792
Costa Rica	--	--	--	--	--	--	--	--	619	1,980	619	1,980
Dominican Republic	--	--	--	--	--	--	--	--	876	4,200	876	4,200
Finland	--	--	--	--	275	1,650	--	--	--	--	275	1,650
Germany	--	--	--	--	(8)	20	1,910	13,000	179	79	2,090	13,100
Honduras	--	--	--	--	--	--	--	--	54	226	54	226
Japan	--	--	176	821	(8)	38	2,060	14,000	--	--	2,240	14,800
Korea, Republic of	--	--	--	--	(8)	2	72	4,930	--	--	72	4,930
Mexico	--	--	(8)	46	(8)	6	95,200	554,000	9,450	39,200	105,000	593,000
Netherlands	--	--	11	56	(8)	8	(8)	4	78	176	89	244
Nicaragua	--	--	--	--	--	--	--	--	114	596	114	596
Panama	--	--	--	--	--	--	--	--	714	2,770	714	2,770
Peru	--	--	--	--	--	--	14,500	86,900	495	2,760	15,000	89,700
Spain	--	--	49	294	--	--	654	3,830	--	--	703	4,130
Vietnam	--	--	--	--	--	--	--	--	121	540	121	540
Other	--	--	11	105	5	315	50	494	174	797	240	1,710
Total	2,170	8,140	1,060	4,650	280	2,040	676,000	4,100,000	27,600	122,000	707,000	4,230,000

-- Zero.

[1]Table includes data available through June 16, 2021. Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Harmonized Tariff Schedule of the United States (HTS) code 2603.00.0010. Includes copper ore and concentrates only; excludes copper contained in ore and concentrates of other metals.

[3]HTS codes 2620.30.0010 and 7401.00.0000. Includes copper matte, ash, and precipitates only; excludes the copper content of mattes and ashes of other metals.

[4]HTS code 7402.00.0000.

[5]HTS codes 7403.11.0000, 7403.12.0000, 7403.13.0000, and 7403.19.0000.

[6]HTS codes 7404.00.3020 and 7404.00.6020.

[7]U.S. Customs value.

[8]Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 17

U.S. IMPORTS FOR CONSUMPTION OF REFINED COPPER SEMIMANUFACTURES AND COPPER SULFATE, BY COUNTRY OR LOCALITY[1,2]

	Pipes and tubing[3]		Plates, sheets, foil, bars[4]		Bare wire, including wire rod[5]		Wire and cable, stranded[6]		Copper sulfate (gross weight)[7]	
Country or locality	Quantity (metric tons)	Value[8] (thousands)	Quantity (metric tons)	Value[8] (thousands)	Quantity (metric tons)	Value[8] (thousands)	Quantity (metric tons)	Value[8] (thousands)	Quantity (metric tons)	Value[8] (thousands)
2019	63,300	$502,000	62,900	$603,000	197,000	$1,280,000	3,760	$32,400	43,600 r	$94,100
2020:										
Bahrain	2,240	16,700	--	--	--	--	--	--	--	--
Brazil	1,560	10,800	2,280	16,100	20	211	--	--	220	437
Bulgaria	--	--	1,620	11,100	--	--	--	--	--	--
Canada	13,300	134,000	274	3,440	149,000	965,000	1,170	7,650	1,970	3,920
Chile	--	--	72	345	--	--	--	--	589	1,060
China	430	3,860	878	8,830	411	3,750	33	495	54	118
Finland	369	4,570	4,490	34,800	521	4,250	--	--	--	--
France	22	352	1,660	14,300	150	5,580	55	1,220	--	--
Germany	1,420	13,000	17,800	143,000	865	9,080	43	1,090	1	34
Greece	2,980	21,000	78	387	--	--	--	--	--	--
India	839	6,390	155	1,160	46	372	50	845	299	556
Italy	1,410	12,900	930	6,900	5	90	3	48	--	--
Japan	30	383	5,780	103,000	521	5,910	5	127	413	510
Korea, Republic of	10,400	75,500	2,020	22,100	4,350	36,200	1	48	1	3
Malaysia	2,110	15,300	12	107	1	9	(9)	5	--	--
Mexico	4,630	37,100	2,500	17,800	10,900	67,200	592	4,200	32,800	68,600
Netherlands	1	55	874	7,100	1	10	--	--	--	--
Peru	--	--	8,480	62,600	1,970	12,200	--	--	1,800	3,350
Russia	--	--	4	40	(9)	3	--	--	10,600	13,800
Taiwan	92	1,010	2,220	25,900	116	1,300	7	129	957	1,850
Thailand	4,520	30,200	68	672	158	1,030	42	470	--	--
Turkey	--	--	266	1,780	59	474	1,510	10,800	--	--
Vietnam	29,100	202,000	--	--	11	60	--	--	--	--
Other	587	4,690	915	10,600	144	2,340	48	1,060	212	1,060
Total	76,000	590,000	53,300	491,000	169,000	1,110,000	3,560	28,100	49,800	95,300

[r]Revised. -- Zero.

[1]Table includes data available through June 16, 2021. Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Copper-alloy products are excluded.

[3]Includes all products listed under the Harmonized Tariff Schedule of the United States (HTS) heading 7411.10 (tubes and pipes of refined copper), whether or not seamless and (or) coiled.

[4]Includes all products listed under the HTS headings 7407.10 (bars, rods, and profiles of refined copper), whether or not hollow; 7409.11 and 7409.19 (plates, sheets, and strip of refined copper), whether or not coiled; and 7410.11 (foil of refined copper, not backed).

[5]Includes all products listed under the HTS headings 7408.11 and 7408.19 (wire of refined copper), regardless of the maximum cross-sectional dimension. Imports of wire rod (wire with a maximum cross-sectional dimension of more than 6 millimeters) were 178,000 metric tons (t) valued at $1.15 billion in 2019 and 149,000 t valued at $973 million in 2020.

[6]Includes all products listed under the HTS heading 7413 (stranded wire and cables of refined copper, not electrically insulated), excluding those with fittings or made into articles.

[7]HTS code 2833.25.0000.

[8]U.S. Customs value.

[9]Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 18
U.S. EXPORTS OF COPPER SCRAP, BY COUNTRY OR LOCALITY[1]

Country or locality	Unalloyed copper scrap[2] Quantity (metric tons)	Unalloyed copper scrap[2] Value[4] (thousands)	Copper-alloy scrap[3] Gross weight (metric tons)	Copper-alloy scrap[3] Copper content[e, 5] (metric tons)	Copper-alloy scrap[3] Value[4] (thousands)
2019	422,000	$1,960,000	449,000	292,000	$853,000
2020:					
Austria	3,970	20,200	1,010	658	2,800
Belgium	20,900	105,000	11,100	7,240	28,900
Cambodia	49	218	2,650	1,720	15,500
Canada	51,800	285,000	32,200	21,000	34,600
Chile	1,860	10,700	325	211	190
China	81,200	423,000	35,400	23,000	78,300
Germany	22,400	104,000	16,000	10,400	56,000
Greece	13,000	75,000	1,450	941	5,410
Hong Kong	7,810	37,800	7,750	5,040	15,000
India	9,570	38,400	34,800	22,600	77,000
Indonesia	277	1,150	1,090	711	1,240
Japan	16,400	91,300	13,800	8,960	59,800
Korea, Republic of	45,700	238,000	18,500	12,000	60,100
Malaysia	54,400	182,000	122,000	79,100	157,000
Mexico	2,650	14,500	2,210	1,440	10,400
Netherlands	5,480	23,900	645	419	2,150
Pakistan	697	3,290	14,500	9,400	8,940
Poland	5,000	26,400	6,560	4,270	5,030
Russia	7,310	38,300	830	539	610
Singapore	362	1,460	1,540	1,000	2,040
Slovakia	56	245	2,170	1,410	6,950
Spain	4,070	21,100	7,610	4,950	22,800
Sweden	1,800	7,850	2,510	1,630	10,200
Taiwan	17,000	88,400	16,400	10,700	21,600
Thailand	4,800	17,400	20,900	13,600	29,600
Turkey	1,820	7,950	293	191	259
United Arab Emirates	3,450	16,200	747	485	591
Vietnam	7,480	40,200	2,340	1,520	5,640
Other	5,120	26,600	2,390	1,550	5,860
Total	396,000	1,950,000	380,000	247,000	725,000

[e]Estimated.

[1]Table includes data available through June 16, 2021. Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Schedule B of the United States codes 7404.00.0010, 7404.00.0015, 7404.00.0025, and 7404.00.0030.

[3]Schedule B codes 7404.00.0041, 7404.00.0046, 7404.00.0051, 7404.00.0056, 7404.00.0061, 7404.00.0066, 7404.00.0075, 7404.00.0085, and 7404.00.0095.

[4]Free alongside ship value.

[5]Content is estimated by the U.S. Geological Survey to be 65% of gross weight.

Source: U.S. Census Bureau.

TABLE 19

U.S. IMPORTS FOR CONSUMPTION OF COPPER SCRAP, BY COUNTRY OR LOCALITY[1]

Country or locality	Unalloyed copper scrap[2] Quantity (metric tons)	Unalloyed copper scrap[2] Value[4] (thousands)	Copper-alloy scrap[3] Gross weight (metric tons)	Copper-alloy scrap[3] Copper content[e, 5] (metric tons)	Copper-alloy scrap[3] Value[4] (thousands)
2019	32,500	$145,000	105,000	75,800	$461,000
2020:					
Antigua and Barbuda	--	--	151	109	370
Bahamas, The	--	--	681	490	1,810
Brazil	--	--	164	118	492
Canada	14,500	67,600	41,300	29,700	204,000
Cayman Islands	4	20	262	189	464
Colombia	60	340	808	582	3,400
Costa Rica	619	1,980	934	672	3,960
Dominican Republic	876	4,200	1,150	829	3,160
Ecuador	--	--	154	111	497
El Salvador	--	--	294	212	1,290
Germany	179	79	108	78	337
Guatemala	--	--	289	208	906
Haiti	--	--	145	104	504
Honduras	54	226	844	608	3,050
Jamaica	--	--	258	186	531
Mexico	9,450	39,200	37,100	26,700	139,000
Nicaragua	114	596	--	--	--
Panama	714	2,770	335	241	1,150
Peru	495	2,760	251	181	846
Philippines	31	118	133	96	605
St. Lucia	--	--	118	85	406
Venezuela	--	--	147	106	674
Vietnam	121	540	22	16	98
Other	331	1,460	859	618	2,650
Total	27,600	122,000	86,500	62,300	371,000

[e]Estimated. -- Zero.

[1]Table includes data available through June 16, 2021. Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Harmonized Tariff Schedule of the United States (HTS) codes 7404.00.3020 and 7404.00.6020.

[3]HTS codes 7404.00.3045, 7404.00.3055, 7404.00.3065, 7404.00.3090, 7404.00.6045, 7404.00.6055, 7404.00.6065, and 7404.00.6090.

[4]U.S. Customs value.

[5]Content is estimated by the U.S. Geological Survey to be 72% of gross weight.

Source: U.S. Census Bureau.

TABLE 20
COPPER: WORLD MINE PRODUCTION, BY COUNTRY OR LOCALITY[1, 2]

(Metric tons, copper content)

Country or locality	2016	2017	2018	2019	2020[p]
Albania, concentrates	200 [e, 3]	--	2,600	3,600	3,600 [e]
Argentina, concentrates	81,902	33,303	17,435	--	--
Armenia, concentrates	95,079	95,793	68,928	89,700 [r]	82,600
Australia:					
Concentrates	918,000	823,000	888,000	897,000 [r, 4]	860,000
Leaching, electrowon	30,000	26,000	23,000	28,000 [r, 4]	25,000
Total	948,000	849,000	911,000	925,000 [r, 4]	885,000
Azerbaijan, concentrates	1,947	2,063	1,650	2,213	2,642
Bolivia:					
Concentrates	6,519	4,450	2,102	1,381 [r]	1,068
Leaching, electrowon	2,199	2,269	3,114	3,097 [r]	1,754
Total	8,718	6,719	5,216	4,478 [r]	2,822
Botswana, concentrates	12,415	1,239	1,462	--	--
Brazil, concentrates	338,921	384,542	385,762	363,268 [r]	352,635
Bulgaria, concentrates[5]	70,573	73,003	69,841	70,927	75,000 [e]
Burma, leaching, electrowon	75,000	115,100	153,000	153,100	185,000
Canada, concentrates	695,508 [r]	597,194 [r]	542,932	572,705	584,609
Chile:					
Concentrates	3,892,300	3,917,300	4,256,300	4,207,200	4,265,600
Leaching, electrowon	1,660,300	1,586,200	1,575,300	1,580,200	1,467,500
Total	5,552,600	5,503,500	5,831,600	5,787,400	5,733,100
China:					
Concentrates	1,850,700	1,656,400	1,569,900	1,628,000	1,673,000
Leaching, electrowon	49,500	50,000	55,000	55,700	50,100
Total	1,900,200	1,706,400	1,624,900	1,683,700	1,723,100
Colombia, concentrates	8,493	9,355	9,920	7,644	9,371
Congo (Brazzaville), leaching, electrowon	--	15,400	15,875 [r]	15,000 [e]	10,000 [e]
Congo (Kinshasa):					
Concentrates[e, 6]	212,000	276,000	280,000	244,000 [r]	276,000
Leaching, electrowon	811,274	818,730	945,607	1,126,500 [r]	1,325,600
Total	1,023,274	1,094,730	1,225,607	1,370,500 [r]	1,601,600
Cyprus, leaching, electrowon	1,754	1,293	908	703	--
Dominican Republic, concentrates	9,725	9,618	8,588	6,047 [r]	6,000 [e]
Ecuador, concentrates[e, 3]	40,000	8,200	42,000	9,900 [r]	43,000
Eritrea, concentrates	25,300	7,900	17,000	16,008	21,725
Finland, concentrates	47,488	53,144	46,674	32,861	36,278
Georgia, concentrates	7,700 [e]	9,500 [e]	9,200 [e]	9,547 [r]	10,036
India, concentrates	30,500 [r]	31,800 [r]	34,100 [r]	28,000 [r]	22,800
Indonesia:					
Concentrates	699,000 [r]	577,000 [r]	591,000 [r]	334,000 [r]	500,000
Leaching, electrowon	11,760	23,160	17,071	16,777	5,377
Total	710,760 [r]	600,160 [r]	608,071 [r]	350,777 [r]	505,377
Iran:					
Concentrates	275,900	288,900	300,800	295,800	297,100
Leaching, electrowon	13,400	13,200	15,700	16,400	16,400
Total	289,300	302,100	316,500	312,200	313,500
Kazakhstan:					
Concentrates	432,400	515,600	592,800	522,600	513,600
Leaching, electrowon	35,100	42,200	42,700	39,500	38,200
Total	467,500	557,800	635,500	562,100	551,800
Korea, North, concentrates[e]	25,000	10,000	10,000	10,000	10,000
Korea, Republic of, concentrates	108	7	--	--	--
Kyrgyzstan, concentrates	8,300	8,000	7,600	7,400	5,400
Laos:					
Concentrates	89,187	90,363	83,680	69,284	48,433
Leaching, electrowon	78,492	62,941	68,200	72,006 [r]	39,730
Total	167,679	153,304	151,880	141,290 [r]	88,163

See footnotes at end of table.

TABLE 20—Continued
COPPER: WORLD MINE PRODUCTION, BY COUNTRY OR LOCALITY[1, 2]

(Metric tons, copper content)

Country or locality	2016	2017	2018	2019	2020[p]
Macedonia:					
Concentrates	9,032	8,008	6,950	6,512	5,903
Leaching, electrowon	1,396	958	768	719	722
Total	10,428	8,966	7,718	7,231	6,625
Mauritania, concentrates	32,818	28,791	28,137	29,620	28,491
Mexico:					
Concentrates	571,900 [r]	540,200 [r]	517,300 [r]	526,100 [r]	566,100
Leaching, electrowon	222,100 [r]	202,000 [r]	179,300 [r]	187,600 [r]	166,800
Total	794,000	742,200	696,600	713,700 [r]	732,900
Mongolia:					
Concentrates[e, 3]	332,000	303,000	301,000	290,000	294,000
Leaching, electrowon	15,010	14,689	14,175	11,758	9,488
Total[e]	347,000	318,000	315,000	302,000	303,000
Morocco, concentrates[e, 3]	28,000	30,000	29,000	25,000	26,900
Namibia:					
Concentrates	262	68	--	180 [r, e, 3]	110 [e, 3]
Leaching, electrowon	16,391	15,466	15,177	14,940	15,741
Total	16,653	15,534	15,177	15,120 [r]	15,851
Pakistan, concentrates	14,136	10,052	12,538	13,049	13,200
Panama, concentrates	--	--	--	147,480	205,548
Papua New Guinea, concentrates	80,022	105,000	97,300	99,400	82,800
Peru:					
Concentrates	2,280,005	2,383,163	2,370,778	2,389,145	2,086,694
Leaching, electrowon	73,854	62,421	66,257	66,295	67,258
Total	2,353,859	2,445,584	2,437,035	2,455,440	2,153,952
Philippines, concentrates	83,649	68,156	69,933	71,892	60,856
Poland, concentrates	424,300	419,300	401,300	398,900	392,700
Portugal, concentrates	74,352	63,812	49,064	41,553	32,230
Romania, concentrates	8,600	8,700	8,700	9,200	8,300
Russia:					
Concentrates	701,000	759,800 [r]	869,300 [r]	811,200 [r]	810,000 [e]
Leaching, electrowon	1,300	1,300	1,200 [r]	1,200 [r]	1,200 [e]
Total	702,300	761,100 [r]	870,500 [r]	812,400 [r]	811,000 [e]
Saudi Arabia, concentrates	27,500 [e, 3]	67,097 [r]	60,340 [r]	88,491 [r]	92,915
Serbia, concentrates	41,312	44,750	42,500	43,550	52,207
South Africa, concentrates	65,300	65,500	46,900	52,500	29,100
Spain:					
Concentrates	94,093	124,689	116,976	122,466 [r]	136,000
Leaching, electrowon	73,643	73,664	70,738	48,090	54,352
Total	167,736	198,353	187,714	170,556 [r]	190,352
Sweden, concentrates	79,247	104,594	106,140	99,332 [r]	100,065
Tanzania, concentrates	17,400	15,800	10,000	10,000 [e]	10,000 [e]
Turkey, concentrates	100,000	83,000	79,600	73,500	107,000
Uganda, concentrates	550 [e]	-- [e]	--	--	--
United States:					
Concentrates[7]	815,000	702,000	690,000	730,000	643,000
Leaching, electrowon	615,000	557,000	532,000	527,000	559,000
Total	1,430,000	1,260,000	1,220,000	1,260,000	1,200,000
Uzbekistan, concentrates	140,000 [r, e]	140,100 [r]	141,200 [r]	137,300 [r]	140,000 [e]
Vietnam, concentrates[e]	22,300 [6]	21,000 [6]	26,200 [3]	29,200 [r, 6]	38,000 [6]
Zambia:					
Concentrates	595,500	628,400	677,300	655,500	706,700
Leaching, electrowon	195,800 [r]	201,300 [r]	210,000 [r]	144,400 [r]	146,000
Total	791,300 [r]	829,700 [r]	887,300 [r]	799,900 [r]	852,700
Zimbabwe, concentrates	9,101	8,839	9,077	8,452 [r]	7,933
Grand total	20,500,000	20,100,000 [r]	20,600,000 [r]	20,400,000	20,600,000
Of which:					
Concentrates	16,500,000	16,200,000 [r]	16,600,000 [r]	16,300,000	16,400,000
Leaching, electrowon	3,980,000 [r]	3,890,000 [r]	4,010,000 [r]	4,110,000 [r]	4,190,000

See footnotes at end of table.

TABLE 20—Continued

COPPER: WORLD MINE PRODUCTION, BY COUNTRY OR LOCALITY[1, 2]

[e]Estimated. [p]Preliminary. [r]Revised. -- Zero.

[1]Table includes data available through September 27, 2021. All data are reported unless otherwise noted; totals may include estimated data. Grand totals, U.S. data, and estimated data are rounded to no more than three significant digits; may not add to totals shown.

[2]For some countries and (or) localities, the copper content of concentrates may include copper precipitates.

[3]Estimate based on reported production of ore and (or) concentrates.

[4]Total mine production is reported, but the distribution between concentrates and electrowon output is estimated.

[5]Copper content of concentrates produced in Bulgaria and then processed to produce anodes and cathodes within Bulgaria. Total output is higher, as the copper content of concentrates produced in and then exported from Bulgaria is not reported.

[6]Estimate based on a combination of reported copper production for some companies and reported production of concentrates for other companies.

[7]Recoverable copper content.

TABLE 21
COPPER: WORLD SMELTER PRODUCTION, BY COUNTRY OR LOCALITY[1, 2]

(Metric tons, copper content)

Country or locality	2016	2017	2018	2019	2020[p]
Armenia, primary	12,920	12,051	8,831	--	--
Australia, primary	445,000	360,000	361,000	401,000	402,000
Austria, secondary	58,558 [r]	65,939 [r]	66,689 [r]	68,595 [r]	75,412
Belgium, secondary	143,800	126,900	140,500	139,900	152,000
Botswana, primary[3]	11,348	--	--	--	--
Brazil:					
Primary	188,500	118,800	125,500 [r]	115,400 [r]	85,400
Secondary	27,000	24,800	15,300	41,700 [r]	24,000
Total	215,500	143,600	140,800 [r]	157,100 [r]	109,400
Bulgaria:					
Primary	245,000	322,700	316,800	260,600 [4]	310,000
Secondary	51,800	52,500	41,800	49,600 [4]	55,000
Total	296,800	375,200	358,600	310,200 [4]	365,000
Canada:					
Primary	304,349	289,400	290,100	290,000 [e]	290,000 [e]
Secondary	29,165	31,000	30,000	30,000 [e]	30,000 [e]
Total	333,514	320,400	320,100	320,000 [e]	320,000 [e]
Chile, primary	1,365,300	1,264,600	1,246,100	1,011,200	1,206,300
China:					
Primary	6,215,000	6,600,000	7,035,600	7,400,000 [r]	7,907,000
Secondary	1,325,400	1,380,500	1,561,800	1,688,400	1,749,800
Total	7,540,400	7,980,500	8,597,400	9,088,400 [r]	9,656,800
Finland:					
Primary	120,600 [r, 4]	112,400 [r, 4]	123,500 [r, 4]	109,700 [r, 4]	130,000 [e]
Secondary	6,300 [r, 4]	5,900 [r, 4]	6,500 [r, 4]	5,800 [r, 4]	7,000 [e]
Total	126,900 [r, 4]	118,300 [r, 4]	130,000 [r, 4]	115,500 [r, 4]	137,000 [e]
Germany:					
Primary	342,800	332,600	311,200	288,600	312,600
Secondary	159,100	198,300	157,400	169,300	204,000
Total	501,900	530,900	468,600	457,900	516,600
India:					
Primary	769,800	813,100	481,500	342,300	243,200
Secondary	3,500	10,000	10,000	2,000	--
Total	773,300	823,100	491,500	344,300	243,200
Indonesia, primary	258,800	245,800 [r]	213,767 [r]	163,429 [r]	279,598
Iran:					
Primary	153,400	114,200	204,100	201,100	223,300
Secondary	72,200	70,900	100,300	109,100	127,500
Total	225,600	185,100	304,400	310,200	350,800
Japan:					
Primary	1,137,864	1,118,626	1,169,500	1,112,276	1,259,400
Secondary	358,810	369,525	421,736 [r]	394,401	332,100
Total	1,496,674	1,488,151	1,591,236 [r]	1,506,677	1,591,500
Kazakhstan, primary	310,001	334,844	327,314	371,359	375,000 [e]
Korea, North:[e]					
Primary	10,000	10,000	10,000	10,000	10,000
Secondary	5,000	5,000	5,000	5,000	5,000
Total	15,000	15,000	15,000	15,000	15,000
Korea, Republic of:					
Primary	510,000	510,000	530,000	520,000	513,900
Secondary	125,000	125,000	140,000	160,000	166,000
Total	635,000	635,000	670,000	680,000	679,900
Mexico:					
Primary	267,800	270,200	286,200	277,700 [r]	283,600
Secondary[e]	5,000	5,000	5,000	5,000	5,000
Total	272,800	275,200	291,200	282,700 [r]	288,600
Namibia, primary	40,869	45,523	48,970	45,953	46,792

See footnotes at end of table.

TABLE 21—Continued
COPPER: WORLD SMELTER PRODUCTION, BY COUNTRY OR LOCALITY[1, 2]

(Metric tons, copper content)

Country or locality	2016	2017	2018	2019	2020[p]
Oman, primary	11,300	5,100	6,000	--	--
Pakistan, primary	14,000 [e]	10,000 [e]	12,500 [e]	13,000 [e]	5,700
Peru, primary	309,469	316,882	327,821	294,315	342,738
Philippines, primary	215,000	240,000	170,900	217,800	247,000
Poland:					
Primary	446,902	457,549	461,865	489,242	462,868
Secondary	60,369	53,024	50,001	51,904	69,696
Total	507,271	510,573	511,866	541,146	532,564
Russia:					
Primary	665,000	730,000	789,000	801,000 [r]	815,200
Secondary	202,000	216,000	230,000	240,000 [r]	235,000
Total	867,000	946,000	1,019,000	1,041,000 [r]	1,050,200
Serbia:					
Primary	61,000	68,200	75,000	73,000	285,000 [e]
Secondary[e]	1,000	1,000	1,000	1,000	5,000
Total	62,000	69,200	76,000	74,000	290,000 [e]
Slovakia, secondary	42,691	48,152	38,379	51,796	55,316
South Africa, primary	51,000 [r]	52,600 [r]	33,300 [r]	26,000 [r]	13,000
Spain:					
Primary	292,300	272,000	284,800	255,700 [4]	257,700
Secondary	4,600	11,100	10,600	16,300 [4]	18,200
Total	296,900	283,100	295,400	272,000 [4]	275,900
Sweden:					
Primary	131,500	150,000	152,100 [4]	135,900	157,200 [4]
Secondary	62,200	60,000	65,200 [4]	60,000	67,400 [4]
Total	193,700	210,000	217,300 [4]	195,900	224,600 [4]
Turkey:					
Primary	46,200	53,400	85,400	83,700	78,900
Secondary[e]	5,000	5,000	5,000	5,000	5,000
Total	51,200	58,400	90,400	88,700	83,900
United States, primary	563,000	470,000	536,000	464,000	315,000 [e, 5]
Uzbekistan, primary[e]	140,000 [r]	140,000 [r]	140,000 [r]	145,000	145,000
Vietnam, primary	11,600 [r]	15,800	15,100	19,200	19,200
Zambia, primary	698,100	787,900	828,700	638,500	750,600
Grand total	19,100,000	19,500,000	20,100,000	19,900,000 [r]	21,200,000
Of which:					
Primary	16,400,000	16,600,000	17,000,000 [r]	16,600,000 [r]	17,800,000
Secondary	2,750,000	2,870,000 [r]	3,100,000	3,290,000 [r]	3,390,000

[e]Estimated. [p]Preliminary. [r]Revised. -- Zero.

[1]Table includes data available through September 27, 2021. All data are reported unless otherwise noted; totals may include estimated data. Grand totals, U.S. data, and estimated data are rounded to no more than three significant digits; may not add to totals shown.

[2]To the extent possible, primary and secondary output of each country and (or) locality is shown separately.

[3]Copper content of nickel-copper-cobalt matte.

[4]Total smelter production is reported, but the distribution between primary and secondary output is estimated.

[5]To avoid disclosing company proprietary data, production is an estimate based on information in public company reports and does not reflect actual output reported to the U.S. Geological Survey.

TABLE 22

COPPER: WORLD REFINERY PRODUCTION, BY COUNTRY OR LOCALITY[1, 2]

(Metric tons)

Country or locality	2016	2017	2018	2019	2020[p]
Argentina, secondary[e]	16,000	16,000	16,000	16,000	16,000
Australia, primary:					
Leaching, electrowon	30,000	26,000	23,000	28,000 [r, 3]	25,000
Other	445,000	360,000	354,000	398,000 [r, 3]	402,000
Total	475,000	386,000	377,000	426,000 [3]	427,000
Austria, secondary	103,215	109,823 [r]	107,210 [r]	128,207 [r]	132,019
Belgium:					
Primary	217,900	235,500	230,800	209,600	188,000
Secondary	148,800	163,400	159,400	147,000	133,500
Total	366,700	398,900	390,200	356,600	321,500
Bolivia, leaching, electrowon	2,199	2,269	3,114	3,097 [r]	1,754
Brazil:					
Primary	225,558	118,100 [r]	131,800 [r]	133,500 [r]	85,900
Secondary	38,500	24,800	15,300	41,700 [r]	24,000
Total	264,058	142,900 [r]	147,100 [r]	175,200 [r]	109,900
Bulgaria:					
Primary	197,300	203,500	199,000	182,000	200,000
Secondary	19,200	25,000	25,000 [e]	25,000 [e]	25,000 [e]
Total	216,500	228,500	224,000	207,000	225,000
Burma, leaching, electrowon	75,000	115,100	153,000	153,100	185,000
Canada:					
Primary	284,400	300,700 [3]	259,300 [3]	253,100 [3]	260,000 [e]
Secondary	30,000	29,700 [3]	32,000 [3]	28,100 [3]	30,000 [e]
Total	314,400	330,400 [3]	291,300 [3]	281,200 [3]	290,000 [e]
Chile, primary:					
Leaching, electrowon	1,660,300	1,586,200	1,575,300	1,580,200	1,467,500
Other	952,200	843,300	885,900	688,900	861,800
Total	2,612,500	2,429,500	2,461,200	2,269,100	2,329,300
China:					
Primary:					
Leaching, electrowon	49,500	50,000	55,000	55,700	50,100
Other	6,195,700	6,564,300	7,001,800	7,556,400 [r]	7,999,800
Total, primary	6,245,200	6,614,300	7,056,800	7,612,100 [r]	8,049,900
Secondary	2,209,000	2,300,800	2,234,600	2,170,800	1,975,500
Total, primary and secondary	8,454,200	8,915,100	9,291,400	9,782,900 [r]	10,025,400
Congo (Brazzaville), leaching, electrowon	--	15,400	15,875 [r]	15,000 [e]	10,000 [e]
Congo (Kinshasa), primary:					
Leaching, electrowon	811,274	818,730	945,607	1,126,500 [r]	1,325,600
Other	10,039	11,757	7,631	14,838	21,663
Total	821,313	830,487	953,238	1,141,338 [r]	1,347,263
Cyprus, leaching, electrowon	1,754	1,293	908	703	--
Egypt, secondary	95,795	100,000 [e]	100,000 [e]	100,000 [e]	100,000 [e]
Finland:					
Primary	122,600 [r, 3]	126,500 [r, 3]	132,100 [r, 3]	114,727 [r]	139,903
Secondary	6,500 [r, 3]	6,700 [r, 3]	7,000 [r, 3]	5,642 [r]	5,944
Total	129,100 [3]	133,200 [3]	139,100 [3]	120,369 [r]	145,847
Germany:					
Primary	396,100	413,200	396,700	351,400 [r]	358,000
Secondary	275,300	281,200	275,700	278,300	285,000
Total	671,400	694,400	672,400	629,700 [r]	643,000
India:					
Primary	769,300	819,000	541,000	424,200	333,500
Secondary	3,500	10,000	10,000	2,000	--
Total	772,800	829,000	551,000	426,200	333,500

See footnotes at end of table.

TABLE 22—Continued

COPPER: WORLD REFINERY PRODUCTION, BY COUNTRY OR LOCALITY[1, 2]

(Metric tons)

Country or locality	2016	2017	2018	2019	2020[p]
Indonesia, primary:					
Leaching, electrowon	11,760	23,160	17,071	16,777	5,377
Other	234,395 [r]	224,015 [r]	213,853 [r]	163,427 [r]	263,208
Total	246,155 [r]	247,175 [r]	230,924 [r]	180,204 [r]	268,585
Iran:					
Primary:					
Leaching, electrowon	13,400	13,200	15,700	16,400	16,400
Other	125,700	90,000	149,600	160,400	167,500
Total, primary	139,100	103,200	165,300	176,800	183,900
Secondary	61,700	57,000	73,300	84,700	95,500
Total, primary and secondary	200,800	160,200	238,600	261,500	279,400
Italy, secondary	6,600	8,700	7,200	9,800	15,000
Japan:					
Primary	1,259,426	1,166,194	1,241,100	1,152,847	1,242,743
Secondary	293,707	321,886	353,417	342,512	340,348
Total	1,553,133	1,488,080	1,594,517	1,495,359	1,583,091
Kazakhstan, primary:					
Leaching, electrowon	35,100	42,200	42,700	39,500	38,200
Other	408,435	426,191	438,115	472,327	477,016
Total	443,535	468,391	480,815	511,827	515,216
Korea, North:[e]					
Primary	10,000	10,000	10,000	10,000	10,000
Secondary	5,000	5,000	5,000	5,000	5,000
Total	15,000	15,000	15,000	15,000	15,000
Korea, Republic of:					
Primary	522,400	501,300	500,500	473,600 [r]	489,500
Secondary	124,800	163,000	174,000	189,400	181,800
Total	647,200	664,300	674,500	663,000 [r]	671,300
Laos, leaching, electrowon	78,492	62,941	68,200	72,006 [r]	39,730
Macedonia, leaching, electrowon	1,396	958	768	719	722
Mexico:					
Primary:					
Leaching, electrowon	222,100 [r]	202,000 [r]	179,300 [r]	187,600 [r]	166,800
Other	263,900 [r]	256,300 [r]	289,300 [r]	294,300 [r]	320,100
Total, primary	486,000	458,300	468,600	481,900 [r]	486,900
Secondary[e]	5,000	5,000	5,000	5,000	5,000
Total, primary and secondary	491,000	463,300	473,600	486,900 [r]	491,900
Mongolia, leaching, electrowon	15,010	14,689	14,175	11,758	9,488
Namibia, leaching, electrowon	16,391	15,466	15,177	14,940	15,741
Norway, primary	28,100	22,700	20,600	22,000	20,500
Oman, primary	11,300	5,100	6,000	--	--
Peru, primary:					
Leaching, electrowon	73,854	62,421	66,257	66,295	67,258
Other	257,470	272,996	270,541	241,567	256,322
Total	331,324	335,417	336,798	307,862	323,580
Philippines, primary	185,100	205,000	170,800	217,300	220,900
Poland:					
Primary	429,000	429,600	423,600	463,600	428,500
Secondary	106,600	92,400	78,200	102,000	131,800
Total	535,600	522,000	501,800	565,600	560,300
Russia:					
Primary:					
Leaching, electrowon	1,300 [4]	1,300 [4]	1,200 [r, 4]	1,200 [r, 4]	1,200 [e]
Other	662,300 [4]	729,700 [r, 4]	781,400 [r, 4]	790,600 [r, 4]	800,500
Total, primary	663,600 [4]	731,000 [r, 4]	782,600 [r, 4]	791,800 [r, 4]	801,700
Secondary	197,800 [4]	218,000 [r, 4]	233,400 [r, 4]	236,200 [r, 4]	239,700
Total, primary and secondary	861,400 [4]	949,000 [r, 4]	1,016,000 [r, 4]	1,028,000 [r, 4]	1,041,400

See footnotes at end of table.

TABLE 22—Continued

COPPER: WORLD REFINERY PRODUCTION, BY COUNTRY OR LOCALITY[1, 2]

(Metric tons)

Country or locality	2016	2017	2018	2019	2020[p]
Serbia:					
Primary	59,078 r	67,752	66,200 r	73,000	45,100
Secondary	2,231 r	1,469	1,000	1,000	1,900
Total	61,309 r	69,221	67,200 r	74,000	47,000
South Africa, primary	53,900 r	66,200 r	43,900 r	35,600 r	21,800
Spain:					
Primary:					
Leaching, electrowon	73,643	73,664	70,738	48,090	54,352
Other	281,600	260,700	273,200	252,900	256,600
Total, primary	355,243	334,364	343,938	300,990	310,952
Secondary	74,200	80,800	79,900	85,300	88,700
Total, primary and secondary	429,443	415,164	423,838	386,290	399,652
Sweden:					
Primary	148,600 r	157,500 r	167,900 r	146,600 r	167,200
Secondary	58,400 r	61,500 r	56,100 r	54,400 r	58,800
Total	207,000 r	219,000 r	224,000 r	201,000 r	226,000
Turkey:					
Primary	47,400	88,000	116,300	106,000	116,100
Secondary	5,000	7,000	10,000	10,000 e	10,000 e
Total	52,400	95,000	126,300	116,000	126,100
Ukraine, secondary	21,973	25,186	24,901	20,409	24,335
United States:					
Primary:					
Leaching, electrowon	615,000	557,000	532,000	527,000	559,000
Other	561,000	482,000	538,000	457,000	315,000 e, 5
Total, primary	1,180,000	1,040,000	1,070,000	985,000	874,000
Secondary	46,300	40,100	41,200	44,400	43,200
Total, primary and secondary	1,220,000	1,080,000	1,110,000	1,030,000	918,000
Uzbekistan, primary	140,000 r, e	140,100 r	141,200 r	147,250	145,000 e
Vietnam, primary	11,600 r	15,800	15,100	19,200	19,200
Zambia, primary:					
Leaching, electrowon	195,800 r	201,300 r	210,000 r	144,400 r	146,000
Other	230,600	264,800	248,200	120,100	232,400
Total	426,400 r	466,100 r	458,200 r	264,500 r	378,400
Grand total	23,700,000 r	23,900,000	24,400,000	24,400,000 r	25,000,000
Of which:					
Primary:					
Leaching, electrowon	3,980,000 r	3,890,000 r	4,010,000 r	4,110,000 r	4,190,000
Other	15,700,000	15,900,000	16,300,000	16,100,000 r	16,900,000
Total	19,700,000	19,800,000 r	20,300,000	20,300,000	21,100,000
Secondary	3,960,000	4,150,000 r	4,120,000 r	4,130,000 r	3,970,000

[e]Estimated. [p]Preliminary. [r]Revised. -- Zero.

[1]Table includes data available through September 27, 2021. All data are reported unless otherwise noted; totals may include estimated data. Grand totals, U.S. data, and estimated data are rounded to no more than three significant digits; may not add to totals shown.

[2]To the extent possible, primary and secondary output of each country and (or) locality is shown separately. The “primary,” “primary, other,” and “secondary” categories consist of electrolytic and fire-refined copper, and the “leaching, electrowon” category consists of refined copper produced by solvent extraction and electrowinning.

[3]Total refined production is reported, but the distribution between primary (electrowon), primary (other), and (or) secondary output is estimated.

[4]Total refined production and electrowon production are reported, but the distribution between primary (other) and secondary output is estimated.

[5]To avoid disclosing company proprietary data, production is an estimate based on information in public company reports and does not reflect actual output reported to the U.S. Geological Survey.

ATTACHMENT 6

DEPARTMENT of COMMERCE

WEDNESDAY, DECEMBER 4, 2024

Copper Manufacturer Invests $27 Million to Expand in Stokes County

RALEIGH, N.C.

Today, Governor Roy Cooper announced that Wieland, a global copper manufacturer, will add 50 new jobs and invest more than $27 million in expanding its production facility in Pine Hall.

“North Carolina is a proud leader in manufacturing, and Wieland's announcement to expand in Stokes County continues that tradition,” Governor Cooper said. “Our excellent workforce paired with a commitment to innovation make new jobs like these a reality.”

Wieland is one of the world's leading suppliers of semi-finished copper and copper alloy products. With a global network of production sites, Wieland offers a range of solutions for customers in the air conditioning, refrigeration, electronics, and automotive industries. The company will expand its current facility in Pine Hall to meet rising market demand for tubing and energy-efficient cooling systems within the HVAC, defense, and aerospace industries. With the addition of new manufacturing lines, Wieland Copper Products will begin production of *Tech Tubes* — high-performance tubes designed to optimize heat transfer in air conditioning and refrigeration technology, and *Cold Plates* — energy-efficient cooling devices designed enhance the performance and lifespan of electronics.

“Today’s announcement demonstrates Wieland’s proud impact in Pine Hall as we grow and strengthen our influence on the community and the industry with high quality products made in America," said Ivan Di Stefano, President, Wieland Thermal Solutions and SVP Wieland Group. "I appreciate the commitment of the North Carolina Department of Commerce and Stokes County whose efforts were instrumental in advancing this project.”

“Wieland Copper Products’ expansion is a tremendous win, not only for the Pine Hall community, but for North Carolina’s prominent aerospace, defense, information technology, and manufacturing industries,” said N.C. Commerce Secretary Machelle Baker Sanders. “I look forward to seeing this company expand in our great state, and the innovative, green technology they will produce.”

While wages vary by position, annual wages for new positions will average $56,900, exceeding the Stokes County average of $36,481. These new jobs could potentially create an annual payroll impact of more than $2.8 million for the region.

A performance-based grant of $100,000 from the One North Carolina Fund awarded to Wieland Copper Products will help facilitate the company’s expansion in Stokes County. The OneNC Fund provides financial assistance to local governments to help attract economic investment and to create jobs. Companies receive no money upfront and must meet job creation and capital investment targets to qualify for payment. All OneNC grants require a matching grant from local governments and any award is contingent upon that condition being met.

“Wieland Copper Products has been a foundational member of our Pine Hall community for over a decade,” said N.C. Senator Dana Jones. “I congratulate them wholeheartedly on their expansion and look forward to another decade of partnership.”

“I am elated to see Wieland Copper Products expand in Stokes County,” said N.C. Representative Kyle Hall. “Thank you, Wieland, for your continued commitment to our state, and congratulations on this exciting milestone.”

In addition to the North Carolina Department of Commerce and the Economic Development Partnership of North Carolina, other key partners in this project include the North Carolina General Assembly, North Carolina Community College System, Forsyth Tech Community College, County of Stokes, and Stokes County Economic Development.

Related Topics:

- Business (/press-release-terms/business)

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