# TELLURIUM

(Data in metric tons of contained tellurium unless otherwise noted)

**Domestic Production and Use:** Tellurium is primarily recovered as a byproduct of the electrolytic refining of copper, where it accumulates in the residues of copper anodes. In 2022, two electrolytic copper refineries operated in the United States, one in Texas and one in Utah, and produced copper telluride from tellurium-bearing anode slimes. Copper telluride from the Utah facility was processed by another company in Utah, and copper telluride from the Texas facility was thought to be exported. Downstream companies refined imported commercial-grade tellurium to produce high-purity tellurium, tellurium compounds for specialty applications, and tellurium dioxide. Domestic tellurium production, consumption, and stocks were withheld to avoid disclosing company proprietary data.

Tellurium was predominantly used in the production of cadmium telluride (CdTe) for thin-film solar cells. Another important end use was for the production of bismuth telluride (BiTe), which is used in thermoelectric devices for both cooling and energy generation. Metallurgical uses were as an alloying additive in steel to improve machining characteristics, as a minor additive in copper alloys to improve machinability without reducing conductivity, in lead alloys to improve resistance to vibration and fatigue, in cast iron to help control the depth of chill, and in malleable iron as a carbide stabilizer. It was used in the chemical industry as a vulcanizing agent and accelerator in the processing of rubber and as a component of catalysts for synthetic fiber production. Other uses included those in photoreceptor and thermoelectric devices, blasting caps, and as a pigment to produce various colors in glass and ceramics.

| **Salient Statistics—United States:** | **2018** | **2019** | **2020** | **2021** | **2022[e]** |
|---|---|---|---|---|---|
| Production, refinery[1] | W | W | W | W | W |
| Imports for consumption | 192 | 59 | 12 | 42 | 50 |
| Exports | 4 | 1 | ([2]) | 2 | ([2]) |
| Consumption, apparent[3] | W | W | W | W | W |
| Price, average, dollars per kilogram: | | | | | |
| United States[4] | 79.55 | 68.11 | 59.37 | 69.72 | 70 |
| Europe[5] | 73.67 | 60.45 | 56.05 | 67.26 | 66 |
| Stocks, producer, yearend | W | W | W | W | W |
| Net import reliance[6] as a percentage of apparent consumption | >95 | >95 | >95 | >95 | >75 |

**Recycling:** For traditional metallurgical and chemical uses, there was little or no scrap from which to extract secondary tellurium because these uses of tellurium are highly dispersive or dissipative. A very small amount of tellurium was recovered from scrapped selenium-tellurium photoreceptors employed in older photocopiers in Europe. A plant in the United States recycled tellurium from CdTe solar cells, but the amount recycled was limited because most CdTe solar cells were relatively new and had not reached the end of their useful life.

**Import Sources (2018–21):** Canada, 52%; Germany, 24%; China,[7] 12%; Philippines, 8%; and other, 4%.

| **Tariff: Item** | **Number** | **Normal Trade Relations 12–31–22** |
|---|---|---|
| Tellurium | 2804.50.0020 | Free. |

**Depletion Allowance:** 14% (domestic and foreign).

**Government Stockpile:** None.

**Events, Trends, and Issues:** The estimated tellurium content of copper telluride recovered from domestic copper anode slimes increased in 2022. In May, a company in the United States began operating a new tellurium circuit with an annual production capacity of 20 tons at its electrolytic copper refinery in Utah. The company produced copper telluride that was processed by another company in Utah and primarily supplied to the U.S. solar industry. The leading U.S. manufacturer of solar modules announced plans to expand the capacity of its existing production facilities and to build a fourth facility, contingent upon permitting and regulatory approvals. The company expected to increase its total annual capacity in the United States to approximately 10 gigawatts of solar modules by 2025.

In 2022, the annual average price for tellurium in the United States was an estimated $70 per kilogram, essentially unchanged from $69.72 per kilogram in 2021. Production costs for tellurium increased from those in 2021, but the higher costs were likely partially offset by increased supply in the United States. The supply of tellurium is directly affected by the supply of the materials from which it is a byproduct, primarily copper.

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In June 2022, the Government of China released a development plan for renewable energy and set goals of generating 25% of energy consumption and installing 1.2 billion kilowatts of capacity for wind and solar power by 2030. If realized, the proposals would likely increase the demand for tellurium from the solar industry for thin-film CdTe solar panels. China was the leading producer of refined tellurium in 2022 and accounted for 53% of estimated global output. Estimated end uses for tellurium in global consumption were solar power cells, 40%; thermoelectric production, 30%; metallurgy, 15%; rubber applications, 5%; and other, 10%.

**World Refinery Production and Reserves:** The values shown for reserves reflect the estimated tellurium content of copper reserves, with the exception of China and Sweden. Reserves for Sweden were reported by the only tellurium producer in the country. Reserves for China were revised based on Government reports, and reserves for Russia and South Africa were revised based on company reports. These estimates assume that more than one-half of the tellurium contained in unrefined copper anodes is recoverable.

| | Refinery production[e, 8] | | Reserves[9] |
|---|---|---|---|
| | 2021 | 2022 | |
| United States | W | W | 3,500 |
| Bulgaria | 4 | 4 | NA |
| Canada | 44 | 50 | 800 |
| China | 330 | 340 | 3,000 |
| Japan | 68 | 70 | — |
| Russia | 70 | 80 | 4,500 |
| South Africa | 4 | 4 | 800 |
| Sweden | [10]41 | 40 | 670 |
| Uzbekistan | 48 | 50 | NA |
| Other countries[11] | NA | NA | 19,000 |
| World total (rounded)[12] | 610 | 640 | 32,000 |

**World Resources:**[9] Reserves for tellurium are based on identified copper deposits and average tellurium content. More than 90% of tellurium has been produced from anode slimes as a byproduct of electrolytic copper refining, and the remainder was derived from skimmings at lead refineries and from flue dusts and gases generated during the smelting of bismuth, copper, and lead-zinc ores. Other potential sources of tellurium include bismuth telluride and gold telluride ores.

**Substitutes:** Several materials can replace tellurium in most of its uses, but usually with losses in efficiency or product characteristics. Amorphous silicon and copper-indium-gallium selenide are the two principal competitors of CdTe in thin-film photovoltaic solar cells. Bismuth selenide and organic polymers can be used to substitute for some BiTe thermal devices. Bismuth, calcium, lead, phosphorus, selenium, and sulfur can be used in place of tellurium in many free-machining steels. Several of the chemical process reactions catalyzed by tellurium can be carried out with other catalysts or by means of noncatalyzed processes. In rubber compounding, sulfur and (or) selenium can act as vulcanization agents in place of tellurium. The selenides and sulfides of niobium and tantalum can serve as electrical-conducting solid lubricants in place of tellurides of those metals.

[e]Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data. — Zero.

[1]Refined tellurium production and estimated tellurium content of copper telluride recovered from copper anode slimes.

[2]Less than ½ unit. Export data reported by the U.S. Census Bureau in 2020 were adjusted by the U.S. Geological Survey.

[3]Production + imports – exports ± adjustments for industry stock changes.

[4]Average annual price for 99.95%-minimum-purity tellurium, free on board, U.S. warehouse. Source: Argus Media group, Argus Metals International.

[5]Average annual price for 99.99%-maximum-purity tellurium, in warehouse, Rotterdam. Source: Argus Media group, Argus Metals International.

[6]Defined as imports – exports ± adjustments for industry stock changes.

[7]Includes Hong Kong.

[8]Insofar as possible, data relate to refinery output only; countries that produced tellurium contained in blister copper, copper concentrates, copper ores, and (or) refinery residues but did not recover refined tellurium from these materials were excluded to avoid double counting.

[9]See Appendix C for resource and reserve definitions and information concerning data sources.

[10]Reported.

[11]In addition to the countries listed, Australia, Belgium, Chile, Colombia, Germany, Kazakhstan, Mexico, the Philippines, and Poland may have produced refined tellurium, but output was not reported, and available information was inadequate to make reliable production estimates.

[12]Excludes U.S. production.