TELLURIUM

(Data in metric tons unless otherwise noted)

<u>Domestic Production and Use</u>: In 2021, tellurium was recovered in copper slimes in the United States. One company in Texas was thought to export copper anode slimes to Mexico for recovery of commercial-grade tellurium. One company in Utah announced the development of a tellurium plant with a capacity of 20 tons per year which was expected to begin production in the fourth quarter of 2021. Downstream companies further refined imported commercial-grade metal to produce tellurium dioxide, high-purity tellurium, and tellurium compounds for specialty applications.

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. Other 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.

Global consumption estimates of tellurium by end use are solar, 40%; thermoelectric production, 30%; metallurgy, 15%; rubber applications, 5%; and other, 10%.

<u>Salient Statistics—United States</u>:	**2017**	**2018**	**2019**	**2020**	**2021[e]**
Production, refinery	W	W	W	W	W
Imports for consumption	163	192	59	12	22
Exports	2	4	1	([1])	2
Consumption, apparent[2]	W	W	W	W	W
Price,[3] dollars per kilogram	38	74	60	56	68
Stocks, producer, refined, yearend	W	W	W	W	W
Net import reliance[4] as a percentage of apparent consumption	>95	>95	>95	>95	>95

<u>Recycling</u>: For traditional metallurgical and chemical uses, there was little or no old 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 plain-paper copiers in Europe. A plant in the United States recycled tellurium from CdTe solar cells; however, the amount recycled was limited because most CdTe solar cells were relatively new and had not reached the end of their useful life.

<u>Import Sources (2017–20)</u>: Canada, 57%; Germany, 19%; China,[5] 17%; the Philippines, 4%; and other, 3%.

<u>Tariff</u>: Item	**Number**	**Normal Trade Relations <u>12–31–21</u>**
Tellurium	2804.50.0020	Free.

<u>Depletion Allowance</u>: 14% (domestic and foreign).

<u>Government Stockpile</u>: None.

<u>Events, Trends, and Issues</u>: In 2021, domestic tellurium content in anode slimes was estimated to have remained essentially unchanged from that in 2020. One domestic producer of anode slimes shipped at least a portion of its anode slimes to Mexico for treatment and refining. In 2021, the domestic average monthly price of tellurium generally increased throughout the year, continuing a trend from December 2020. The price increased from around $60 per kilogram in January to $71 per kilogram in October.

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Domestic imports of tellurium were estimated to have increased by about 83% in 2021 from those of 2020, mostly as a result of a significant increase in imports from the Philippines. During the first 8 months of 2021, the United States imported 9.5 tons of tellurium from the Philippines, an increase of 82% with respect to the total imports from the Philippines in 2020, and an increase of 325% with respect to the same time period in 2020. Imports from Japan also increased in the first 8 months of 2021, by 161% compared with the same time period in 2020.

World production of tellurium was estimated to be about 580 tons in 2021. China was the leading producer of refined tellurium, recovering tellurium from copper anode slimes and from residues generated during the lead, nickel, precious metals, and zinc smelting processes. In early 2021, a Chinese producer of tellurium metal announced an increase of tellurium production following the Lunar New Year holiday, rising from 3 to 4 tons per month to 6 tons per month, or 72 tons per year. In Canada, one producer announced further investment in their new ultrahigh-purity tellurium line. The line is expected to produce up to 7N purity (99.99999%) tellurium for digital and solid-state radiation detectors, as well as other applications. Solid-state radiation detectors produce highly accurate images, and are used in healthcare, security, and military systems.

World Refinery Production and Reserves: The values shown for reserves include only tellurium contained in copper reserves. These estimates assume that more than one-half of the tellurium contained in unrefined copper anodes is recoverable.

	Refinery production		Reserves[6]
	2020	2021[e]	
United States	W	W	3,500
Bulgaria	[e]3	5	NA
Canada	[e]44	45	800
China	[e]330	340	6,600
Japan	[e]70	75	—
Russia	71	70	NA
South Africa	[e]2	3	—
Sweden	42	40	670
Other countries[7]	NA	NA	19,000
World total (rounded)	[8]562	[8]580	31,000

World Resources:[6] Data on tellurium resources were not available. More than 90% of tellurium has been produced from anode slimes collected from 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. 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. 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.

The selenium-tellurium photoreceptors used in some plain paper photocopiers and laser printers have been replaced by organic photoreceptors in newer devices. Amorphous silicon and copper-indium-gallium selenide were 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.

[e]Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data. — Zero.
[1]Less than ½ unit. U.S. Census Bureau export data were adjusted by U.S. Geological Survey.
[2]Defined as production + imports – exports + adjustments for industry stock changes.
[3]Average annual price for 99.95% tellurium, in warehouse, Rotterdam. Source: Argus Media group—Argus Metals International.
[4]Defined as imports – exports + adjustments for industry stock changes. For 2020, exports were not included in the calculation.
[5]Includes Hong Kong.
[6]See Appendix C for resource and reserve definitions and information concerning data sources.
[7]In addition to the countries listed, Australia, Belgium, Chile, Colombia, Germany, Kazakhstan, Mexico, the Philippines, and Poland produced refined tellurium, but output was not reported and available information was inadequate to make reliable production estimates.
[8]Excludes U.S. production.