

## TELLURIUM

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

**Domestic Production and Use:** In the United States, one firm produced commercial-grade tellurium at its refinery complex in Texas, mainly from copper anode slimes but also from lead refinery skimmings, each of domestic origin. Primary and intermediate producers further refined domestic and imported commercial-grade metal and tellurium dioxide, producing tellurium and tellurium compounds in high-purity form for specialty applications.

Tellurium was used in the production of cadmium-tellurium-based solar cells, which was the major end use for tellurium. Although not a major use domestically, in China, tellurium is used with bismuth in thermoelectric devices, such as refrigerators and water dispensers because of increased energy efficiency. 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 thermal cooling devices, as an ingredient in blasting caps, and as a pigment to produce various colors in glass and ceramics.

<b>Salient Statistics—United States:</b>	<b><u>2009</u></b>	<b><u>2010</u></b>	<b><u>2011</u></b>	<b><u>2012</u></b>	<b><u>2013<sup>e</sup></u></b>
Production, refinery	W	W	W	W	W
Imports for consumption, unwrought, waste and scrap	84	42	71	36	40
Exports	9	59	39	47	8
Consumption, apparent	W	W	W	W	W
Price, dollars per kilogram, 99.95% minimum <sup>1</sup>	158	221	349	150	112
Stocks, producer, refined, yearend	W	W	W	W	W
Net import reliance <sup>2</sup> as a percentage of apparent consumption	W	W	W	W	W

**Recycling:** For traditional metallurgical and chemical uses, there was little or no old scrap from which to extract secondary tellurium because these uses of tellurium were 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 cadmium-tellurium-based solar cells; however, most of this was new scrap because cadmium-tellurium-based solar cells were relatively new and had not reached the end of their useful life.

**Import Sources (2009–12):** Canada, 43%, China, 23%; Philippines, 12%; Belgium, 4%; and other, 18%.

<b>Tariff: Item</b>	<b>Number</b>	<b>Normal Trade Relations</b>
Tellurium	2804.50.0020	<b><u>12–31–13</u></b> Free.

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

**Government Stockpile:** None.

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**Events, Trends, and Issues:** In 2013, estimated domestic tellurium production was slightly less than production in 2012. Although detailed information on the world tellurium market was not available, world tellurium consumption was estimated to have decreased in 2013. The price of tellurium continued to decline in 2013 because of the continued decrease in use of tellurium in solar cells owing to the surplus of all types of solar cells. In addition, Chinese consumption was estimated to have decreased because of lower sales of refrigerators and water dispensers, which accounted for about 75% of Chinese consumption of tellurium.

Although Canada remained the leading source of U.S. imports of tellurium, having displaced China in 2010, imports from Belgium rose substantially during the first 8 months of 2013 compared with those in the same period of 2012, and accounted for 37% of imports. Belgium had been the leading source of imported tellurium in 2005 and 2006.

**World Refinery Production and Reserves:** The figures 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 <sup>3</sup>
	<u>2012</u>	<u>2013<sup>e</sup></u>	
United States	W	W	3,500
Canada	11	10	800
Japan	45	45	—
Peru	—	—	3,600
Russia	35	40	NA
Other countries <sup>4</sup>	<u>NA</u>	<u>NA</u>	<u>16,000</u>
World total (rounded)	NA	NA	24,000

**World Resources:** 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. In copper production, tellurium was recovered only during electrolytic refining of smelted copper. Increased use of leaching solvent extraction-electrowinning processes for copper extraction, which does not capture tellurium, has limited the future supply of tellurium from certain copper deposit types. Other potential sources of tellurium include bismuth telluride, gold telluride, and lead-zinc ores.

**Substitutes:** Several materials can replace tellurium in most of its uses, but usually with losses in production 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 of the refractory metals can function as high-temperature, high-vacuum lubricants in place of tellurides. The selenides and sulfides of niobium and tantalum can serve as electrically 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 diselenide were the two principal competitors to cadmium telluride in thin-film photovoltaic power cells.

<sup>e</sup>Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data. — Zero.

<sup>1</sup>For 2009, the price listed was the average price published by Mining Journal for United Kingdom lump and powder, 99.95% tellurium. In 2010 through 2013, the price listed was the average price published by Metal-Pages for 99.95% tellurium.

<sup>2</sup>Defined as imports – exports + adjustments for Government and industry stock changes.

<sup>3</sup>Estimates include tellurium contained in copper resources only. [See Appendix C for resource/reserve definitions and information concerning data sources.](#)

<sup>4</sup>In addition to the countries listed, Australia, Belgium, Chile, China, Colombia, Germany, India, Kazakhstan, Mexico, the Philippines, Poland, and Sweden produce refined tellurium, but output was not reported, and available information was inadequate for formulation of reliable production and detailed reserve estimates.