

## SELENIUM

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

**Domestic Production and Use:** Primary selenium was recovered from anode slimes generated in the electrolytic refining of copper. Of the three electrolytic refineries operating in the United States, one in Texas reported production of primary selenium, one exported semirefined selenium for toll refining in Asia, and one generated selenium-containing slimes that were exported for processing.

In glass manufacturing, selenium is used to decolorize the green tint caused by iron impurities in container glass and other soda-lime silica glass and is used in architectural plate glass to reduce solar heat transmission. Cadmium sulfoselenide pigments are used in plastics, ceramics, and glass to produce a ruby-red color. Selenium is used in catalysts to enhance selective oxidation; in plating solutions, where it improves appearance and durability; in blasting caps and gun bluing; in rubber compounding chemicals; in the electrolytic production of manganese to increase yields; and in brass alloys to improve machinability. It is used as a metallurgical additive to improve machinability of copper, lead, and steel alloys, and in thin-film photovoltaic copper indium gallium diselenide (CIGS) solar cells.

Selenium is used as a human dietary supplement and in antidandruff shampoos. The leading agricultural uses are as a dietary supplement for livestock and as a fertilizer additive to enrich selenium-poor soils.

<b>Salient Statistics—United States:</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>2013<sup>e</sup></b>
Production, refinery	W	W	W	W	W
Imports for consumption, metal and dioxide	263	480	601	454	475
Exports, metal, waste and scrap	613	857	1,350	952	680
Consumption, apparent	W	W	W	W	W
Price, dealers, average, dollars per pound, 100-pound lots, refined	23.07	37.83	66.35	54.47	35.00
Stocks, producer, refined, yearend	W	W	W	W	W
Net import reliance <sup>1</sup> as a percentage of apparent consumption	E	E	E	E	E

**Recycling:** Domestic production of secondary selenium was estimated to be very small because most scrap from older plain paper photocopiers and electronic materials were exported for recovery of the contained selenium.

**Import Sources (2009–12):** Belgium, 17%; China, 17%; Japan, 16%; Philippines, 12%; and other, 38%.

<b>Tariff: Item</b>	<b>Number</b>	<b>Normal Trade Relations 12–31–13</b>
Selenium metal	2804.90.0000	Free.
Selenium dioxide	2811.29.2000	Free.

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

**Government Stockpile:** None.

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**Events, Trends, and Issues:** The supply of selenium is directly affected by the supply of the materials from which it is a byproduct—copper, and to a lesser extent, nickel. In 2013, estimated domestic selenium recoverable from domestic electrolytic copper refining increased slightly owing to an increase in electrolytic copper production. Domestic production of refined selenium, however, was estimated to have declined owing to lower refined copper production by the only domestic selenium refiner.

In 2013, the price of selenium decreased significantly owing to decreased consumption in China. In China, the world's leading consumer of selenium, selenium dioxide was mainly used in the refining of manganese. In 2013, Chinese manganese producers were operating at about 40% of capacity because of higher energy costs, export tariffs, and declining demand for manganese. Domestic and global use of selenium in glass remained unchanged because of stagnate glass production. The use of selenium in fertilizers and supplements in the plant-animal-human food chain and as human vitamin supplements also was unchanged. Selenium consumption in solar cells decreased because oversupply in the solar cell market in 2012 led solar manufacturers to curtail some of their production in 2013.

**World Refinery Production and Reserves:** Selenium reserves in China were estimated based on selenium content of Chinese copper reserves, but production estimates for China were not available.

	Refinery production <sup>2</sup>		Reserves <sup>3</sup>
	2012	2013 <sup>e</sup>	
United States	W	W	10,000
Belgium	200	200	—
Canada	144	150	6,000
Chile	70	70	25,000
China	NA	NA	26,000
Finland	93	100	—
Germany	650	700	—
Japan	755	780	—
Peru	50	54	13,000
Poland	80	80	3,000
Russia	145	150	20,000
Other countries	<sup>4</sup> 50	<sup>4</sup> 50	<u>21,000</u>
World total (rounded)	<sup>5</sup> NA	<sup>5</sup> NA	120,000

**World Resources:** Reserves for selenium are based on only identified copper deposits. Coal generally contains between 0.5 and 12 parts per million of selenium, or about 80 to 90 times the average for copper deposits. The recovery of selenium from coal, although technically feasible, does not appear likely to be economical in the foreseeable future.

**Substitutes:** High-purity silicon has replaced selenium in high-voltage rectifiers. Silicon is also the major substitute for selenium in low- and medium-voltage rectifiers and solar photovoltaic cells. Organic pigments have been developed as substitutes for cadmium sulfoselenide pigments. Other substitutes include cerium oxide as either a colorant or decolorant in glass; tellurium in pigments and rubber; bismuth, lead, and tellurium in free-machining alloys; and bismuth and tellurium in lead-free brasses. Sulfur dioxide can be used as a replacement for selenium dioxide in the production of electrolytic manganese metal.

The selenium-tellurium photoreceptors used in some plain paper copiers and laser printers have been replaced by organic photoreceptors in newer machines. Amorphous silicon and cadmium telluride are the two principal competitors to CIGS in thin-film photovoltaic power cells.

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

<sup>1</sup>Defined as imports – exports + adjustments for Government and industry stock changes.

<sup>2</sup>Insofar as possible, data relate to refinery output only; thus, countries that produced selenium contained in copper ores, copper concentrates, blister copper, and (or) refinery residues but did not recover refined selenium from these materials indigenously were excluded to avoid double counting.

<sup>3</sup>[Appendix C for resource/reserve definitions and information concerning data sources.](#)

<sup>4</sup>Includes India, Serbia, and Sweden.

<sup>5</sup>Australia, China, Iran, Kazakhstan, Mexico, the Philippines, and Uzbekistan are known to produce refined selenium, but output is not reported, and information is inadequate for formulation of reliable production estimates. Total world production is not shown because of the lack of data from China and other major world producers.