

SELENIUM

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

Domestic Production and Use: Primary selenium was refined from anode slimes recovered from the electrolytic refining of copper. Of the three electrolytic copper 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; in gun bluing to improve cosmetic appearance and provide corrosion resistance; in rubber compounding chemicals to act as a vulcanizing agent; in the electrolytic production of manganese to increase yields; and in copper, lead, and steel alloys to improve machinability. It is used 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.

Estimates for world consumption are as follows: metallurgy, 40%; glass manufacturing, 25%; agriculture, 10%; chemicals and pigments, 10%; electronics, 10%; and other uses, 5%.

Salient Statistics—United States:	2011	2012	2013	2014	2015^e
Production, refinery	W	W	W	W	W
Imports for consumption, metal and dioxide	601	460	439	441	480
Exports, metal, waste and scrap	1,350	952	648	521	735
Consumption, apparent	W	W	W	W	W
Price, dealers, average, dollars per pound, 100-pound lots, refined	66.35	54.47	36.17	26.78	22.80
Stocks, producer, refined, yearend	W	W	W	W	W
Net import reliance ¹ 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 was exported for recovery of the contained selenium.

Import Sources (2011–14): Japan, 21%; China, 16%; Belgium, 14%; Germany, 12%; and other, 37%.

Tariff: Item	Number	Normal Trade Relations 12–31–15
Selenium metal	2804.90.0000	Free.
Selenium dioxide	2811.29.2000	Free.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

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 the first 3 months of 2015, the price of selenium remained relatively stagnant, ranging from \$22.00 per pound to \$25.00 per pound. During the second and third quarters of the year, the price of selenium decreased to \$8.00 per pound, a 90% decrease from its alltime high value of \$80.00 per pound in 2011. The average price of selenium has decreased by a factor of 3 over the past 5 years.

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In China, the Fanya Metal Exchange Co. Ltd., which began trading minor metals in 2011, froze accounts in June, halting selenium deliveries in or out of the exchange. Additionally, the Ri Jin Bao, an investment product that guaranteed annual returns of at least 13%, had its payments suspended in July. Investors were unable to buy or sell contracts, and the price of selenium fell dramatically. In August, Fanya entered into a debt-restructuring plan, and Fanya's investors reportedly met with the China Securities Regulatory Commission (China's stock market regulator) and Provincial-level authorities to protest Fanya's actions. At the time deliveries were frozen, Fanya warehouses reportedly held 338 tons of selenium as compared with 205 tons in October 2014, although the reliability of this data was uncertain.

The global use of selenium in glass remained unchanged owing to stable manganese and glass production. The use of selenium in fertilizers as a supplement in the plant-animal food chain and as a human vitamin supplement also was unchanged. Selenium consumption in CIGS solar cells also remained unchanged in 2015, despite technological advances which increased the efficiency of CIGS solar cells to above that for silicon-based solar cells.

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

	Refinery production ²		Reserves ³
	2014	2015 ^e	
United States	W	W	10,000
Belgium	200	200	—
Canada	159	160	6,000
Chile	41	50	25,000
China	NA	NA	26,000
Finland	94	100	—
Germany	700	700	—
Japan	782	790	—
Peru	49	50	13,000
Poland	90	90	3,000
Russia	145	150	20,000
Other countries	⁴ 50	⁴ 50	<u>21,000</u>
World total (rounded)	⁵ NA	⁵ NA	120,000

World Resources: Reserves for selenium are based on identified copper deposits and average selenium contents. Coal generally contains between 0.5 and 12 parts per million of selenium, or about 80 to 90 times the average for porphyry copper deposits. The recovery of selenium from coal fly ash, although technically feasible, appears unlikely to be economical in the foreseeable future.

Substitutes: Silicon is 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 but it is not as energy efficient.

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 with CIGS in thin-film photovoltaic power cells.

^eEstimated. E Net exporter. NA Not available. W Withheld to avoid disclosing company proprietary data. — Zero.

¹Defined as imports – exports + adjustments for industry stock changes.

²Insofar 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.

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

⁴Includes India, Serbia, and Sweden.

⁵Australia, 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.