

## 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 two electrolytic copper refineries operating in the United States, one reported production of primary selenium, and one exported semirefined selenium for toll refining in Asia.

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; in thin-film photovoltaic copper-indium-gallium-diselenide (CIGS) solar cells; and in copper, lead, and steel alloys to improve machinability.

Selenium is an essential micronutrient and is used as a human dietary supplement, a dietary supplement for livestock, and as a fertilizer additive to enrich selenium-poor soils. Selenium also is used as an active ingredient in antidandruff shampoos.

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

<b>Salient Statistics—United States:</b>	<b>2013</b>	<b>2014</b>	<b>2015</b>	<b>2016</b>	<b>2017<sup>e</sup></b>
Production, refinery	W	W	W	W	W
Imports for consumption, metal and dioxide	435	475	457	433	500
Exports, metal <sup>1</sup>	648	521	468	150	335
Consumption, apparent <sup>2</sup>	W	W	W	W	W
Price, average, dollars per pound <sup>3</sup>	36.08	26.78	22.09	23.69	10.80
Stocks, producer, refined, yearend	W	W	W	W	W
Net import reliance <sup>4</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 was exported for recovery of the contained selenium.

**Import Sources (2013–16):** China, 18%; Japan, 16%; Germany, 13%; Philippines, 11%; and other, 42%.

<b>Tariff: Item</b>	<b>Number</b>	<b>Normal Trade Relations 12–31–17</b>
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—and it is directly affected by the number of facilities that recover selenium. The estimated Platts Metals Week annual average New York dealer price for selenium was \$10.80 per pound in 2017, about 54% less than the annual average price in 2016. During the fourth quarter of 2016, the average price of selenium decreased dramatically from \$34.00 per pound in October to \$8.50 per pound in December. Average monthly prices in 2017 increased steadily from \$8.50 per pound in January to \$11.70 per pound in August.

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The decrease in exports of selenium in 2016 and 2017 is thought to be the result of incomplete data. Common forms of selenium, such as copper selenide or zinc selenide, may be exported under incorrect Schedule B numbers, and thus not reflected properly in export statistics. The United States is still considered to be a net exporter of selenium despite these lower export values.

In China, official investigations into possible fraudulent activities related to the Fanya Metal Exchange Co. Ltd. (FME) continued in 2017. About 338 tons of selenium were reportedly held in FME warehouses prior to the exchange's shutdown in 2015. As of September 2017, no information was available on how or when the material would be released into the market.

Electrolytic manganese production was the main metallurgical end use for selenium in China, where selenium dioxide was used in the electrolytic process to increase current efficiency and the metal deposition rate. Selenium consumption in China was thought to have increased in recent years; 47 electrolytic manganese producers were reported to have been operating in 2016 (latest information available), up from 26 reported in June 2015.

### World Refinery Production and Reserves:

	Refinery production <sup>5</sup>		Reserves <sup>6</sup>
	2016	2017 <sup>e</sup>	
United States	W	W	10,000
Belgium	200	200	—
Canada	176	150	6,000
China	920	930	26,000
Finland	96	95	—
Germany	700	710	—
Japan	752	760	—
Peru	45	50	13,000
Poland	87	90	3,000
Russia	145	150	20,000
Sweden	100	100	—
Other countries	47	50	21,000
World total (rounded)	73,270	73,300	100,000

**World Resources:** Reserves for selenium are based on identified copper deposits and average selenium content. 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 fly ash, although technically feasible, does not appear likely to be economical in the foreseeable future.

**Substitutes:** Silicon is the major substitute for selenium in low- and medium-voltage rectifiers. 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 solar cells.

<sup>e</sup>Estimated. E Net exporter. W Withheld to avoid disclosing company proprietary data. — Zero.

<sup>1</sup>There was no exclusive domestic export classification code for selenium dioxide.

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

<sup>3</sup>U.S. spot market price for selenium metal powder, minimum 99.5% purity, in 5-ton lots. Source: Platts Metals Week.

<sup>4</sup>Defined as imports – exports + adjustments for industry stock changes.

<sup>5</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>6</sup>See [Appendix C](#) for resource and reserve definitions and information concerning data sources.

<sup>7</sup>Excludes U.S. production. Australia, Iran, Kazakhstan, Mexico, the Philippines, and Uzbekistan are known to produce refined selenium, but output was not reported, and information was inadequate to make reliable production estimates.