

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 in Texas 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; 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 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 is also 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%.

Salient Statistics—United States:	2012	2013	2014	2015	2016^e
Production, refinery	W	W	W	W	W
Imports for consumption, metal and dioxide	460	439	475	463	478
Exports, metal and dioxide	952	648	521	468	495
Consumption, apparent	W	W	W	W	W
Price, dealers, average, dollars per pound, 100-pound lots, refined	54.47	36.17	26.78	22.09	26.00
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 (2012–15): Japan, 20%; China, 17%; Belgium, 12%; Germany, 12%; and other, 39%.

Tariff: Item	Number	Normal Trade Relations 12–31–16
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. The estimated Platts Metals Week annual average New York dealer price for selenium was \$26 per pound in 2016, about 18% more than the annual average price in 2015. The average price in January 2016 was \$19.00 per pound and increased to an average of \$34.00 per pound in September.

In China, the Yunnan Provincial government instructed the municipal government of Kunming to launch an official investigation into the trading activities of the Fanya Metal Exchange Co. Ltd. (FME), which began trading selenium in April 2014. The municipal government was instructed to determine if the FME had any physical assets in warehouses, concealed facts, created a capital pool and taken control of the funds within, and illegally possessed and used the funds that it had raised. In February, the owner of the FME was arrested and, in March, the Public Security Bureau announced that it was expanding its investigation into FME activities. The 338 tons of selenium that was reported to be in FME warehouses has not been verified by the Government or a third party.

SELENIUM

The natural gas in the Bowland Shale in northern England was found to contain high levels of selenium. These levels of selenium are of concern because, with planned drilling and fracking operations, selenium may be released into local groundwater supplies. Selenium poisoning has initial symptoms of a garlic odor and a metallic taste in the mouth, and more severe symptoms include gastrointestinal distress, fatigue, irritability, and joint pain. Although selenium is an essential micronutrient, the U.S. Food and Drug Administration recommends an upper adult limit of 400 micrograms per day of selenium.

In China, electrolytic manganese is the main metallurgical end use for selenium, where selenium dioxide is a substitute for sulfur dioxide to reduce the power required to operate the electrolytic cells. Fewer manganese producers have been operating, with 78 operating in 2014, and only 26 reported in June 2015.

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

	Refinery production ²		Reserves ³
	2015	2016 ^e	
United States	W	W	10,000
Belgium	200	200	—
Canada	154	150	6,000
China	NA	NA	26,000
Finland	94	94	—
Germany	660	660	—
Japan	773	750	—
Peru	40	40	13,000
Poland	90	90	3,000
Russia	135	135	20,000
Other countries	⁴ 50	⁴ 50	<u>21,000</u>
World total (rounded)	⁵ 2,200	⁵ 2,200	<u>100,000</u>

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 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 are 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 and reserve definitions and information concerning data sources.

⁴Includes India, Serbia, and Sweden.

⁵Excludes U.S. production. 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 making reliable production estimates.