

INDIUM

(Data in metric tons unless otherwise noted)

Domestic Production and Use: Indium was not recovered from ores in the United States in 2011. Two companies, one in New York and the other in Rhode Island, produced indium metal and indium products by upgrading lower grade imported indium metal. High-purity indium shapes, alloys, and compounds were also produced from imported indium by several additional firms. Production of indium tin oxide (ITO) continued to be the leading end use of indium and accounted for most global indium consumption. ITO thin-film coatings were primarily used for electrically conductive purposes in a variety of flat-panel devices—most commonly liquid crystal displays (LCDs). Other end uses included solders and alloys, compounds, electrical components and semiconductors, and research. The estimated value of primary indium metal consumed in 2011, based upon the annual average New York dealer price, was about \$82 million.

Salient Statistics—United States:	2007	2008	2009	2010	2011^e
Production, refinery	—	—	—	—	—
Imports for consumption ¹	147	144	105	117	150
Exports	NA	NA	NA	NA	NA
Consumption, estimated	125	130	110	120	120
Price, annual average, dollars per kilogram					
U.S. producer ²	795	685	500	565	720
New York dealer ³	637	519	382	552	685
99.99% c.i.f. Japan ⁴	NA	479	348	546	680
Stocks, producer, yearend	NA	NA	NA	NA	NA
Net import reliance ⁵ as a percentage of estimated consumption	100	100	100	100	100

Recycling: Data on the quantity of secondary indium recovered from scrap were not available. Indium is most commonly recovered from ITO. Sputtering, the process in which ITO is deposited as a thin-film coating onto a substrate, is highly inefficient; approximately 30% of an ITO target material is deposited onto the substrate. The remaining 70% consists of the spent ITO target material, the grinding sludge, and the after-processing residue left on the walls of the sputtering chamber. ITO recycling is concentrated in China, Japan, and the Republic of Korea—the countries where ITO production and sputtering take place.

An LCD manufacturer has developed a process to reclaim indium directly from scrap LCD panels. Indium recovery from tailings was thought to have been insignificant, as these wastes contain low amounts of the metal and can be difficult to process. However, recent improvements to the process technology have made indium recovery from tailings viable when the price of indium is high.

Import Sources (2007–10):¹ China, 31%; Canada, 25%; Japan, 16%; Belgium, 9%; and other, 19%.

Tariff:	Item	Number	Normal Trade Relations
	Unwrought indium, including powders	8112.92.3000	<u>12-31-11</u> Free.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

Events, Trends, and Issues: The annual average price of indium increased by approximately 25% in 2011 from that of 2010. The U.S. producer price for indium began the year at \$570 per kilogram, increased to \$690 per kilogram in April, and rose further to \$785 per kilogram in May; the price remained at that level through early November. The New York dealer price range for indium began the year at \$520 to \$570 per kilogram and increased through early June, reaching a high of \$800 to \$875 per kilogram. The price range then decreased to \$630 to \$670 per kilogram by early November.

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In 2011, world production of primary indium increased by 5% from that of 2010 to 640 tons. Secondary production, which accounts for a greater share of global production than primary, was thought to have increased as well, as many ITO producers were reported to have increased their recycling rates during the year. Global consumption of primary and secondary indium was estimated to be more than 1,800 tons, of which approximately 60% was consumed in Japan.

The Chinese indium export quota remained unchanged in 2011 from that of 2010 at 233 tons, of which the quota for the first half of the year was set at 140 tons, and the quota for the second half of the year totaled 93 tons. However, the number of companies that received export licenses dropped to 18 in 2011 from 21 in 2010.

World Refinery Production and Reserves:

	Refinery production		Reserves ⁶
	<u>2010</u>	<u>2011^e</u>	
United States	—	—	Quantitative estimates of reserves are not available.
Belgium	30	30	
Brazil	5	5	
Canada	67	65	
China	340	340	
Japan	70	70	
Korea, Republic of	70	100	
Russia	NA	NA	
Other countries	<u>27</u>	<u>30</u>	
World total (rounded)	609	640	

World Resources: Indium's abundance in the continental crust is estimated to be approximately 0.05 part per million. Trace amounts of indium occur in base metal sulfides—particularly chalcopyrite, sphalerite, and stannite—by ionic substitution. Indium is most commonly recovered from the zinc-sulfide ore mineral sphalerite. The average indium content of zinc deposits from which it is recovered ranges from less than 1 part per million to 100 parts per million. Although the geochemical properties of indium are such that it occurs with other base metals—copper, lead, and tin—and to a lesser extent with bismuth, cadmium, and silver, most deposits of these metals are subeconomic for indium.

Vein stockwork deposits of tin and tungsten host the highest known concentrations of indium. However, the indium from this type of deposit is usually difficult to recover economically. Other major geologic hosts for indium mineralization include volcanic-hosted massive sulfide deposits, sediment-hosted exhalative massive sulfide deposits, polymetallic vein-type deposits, epithermal deposits, active magmatic systems, porphyry copper deposits, and skarn deposits.

Substitutes: Indium's recent price volatility and various supply concerns associated with the metal have accelerated the development of ITO substitutes. Antimony tin oxide coatings, which are deposited by an ink-jetting process, have been developed as an alternative to ITO coatings in LCDs and have been successfully annealed to LCD glass. Carbon nanotube coatings, applied by wet-processing techniques, have been developed as an alternative to ITO coatings in flexible displays, solar cells, and touch screens. Poly(3,4-ethylene dioxythiophene) (PEDOT) has also been developed as a substitute for ITO in flexible displays and organic light-emitting diodes. PEDOT can be applied in a variety of ways, including spin coating, dip coating, and printing techniques. Graphene quantum dots have been developed to replace ITO electrodes in solar cells and also have been explored as a replacement for ITO in LCDs. Researchers have recently developed a more adhesive zinc oxide nanopowder to replace ITO in LCDs. The technology was estimated to be commercially available within the next 3 years. Gallium arsenide can substitute for indium phosphide in solar cells and in many semiconductor applications. Hafnium can replace indium in nuclear reactor control rod alloys.

^eEstimated. NA Not available. — Zero.

¹Imports for consumption of unwrought indium and indium powders (Tariff no. 8112.92.3000).

²Indium Corp.'s price for 99.97% purity metal; 1-kilogram bar in lots of 10,000 troy ounces. Source: Platts Metals Week.

³Price is based on 99.99% minimum purity indium at warehouse (Rotterdam); cost, insurance, and freight (in minimum lots of 50 kilograms). Source: Platts Metals Week.

⁴Price is based on 99.99% purity indium, primary or secondary, shipped to Japan. Source: Platts Metals Week.

⁵Defined as imports – exports + adjustments for Government and industry stock changes; exports were assumed to be no greater than the difference between imports and consumption.

⁶See Appendix C for resource/reserve definitions and information concerning data sources.