

## IRON AND STEEL SLAG

(Data in million metric tons unless otherwise noted)

**Domestic Production and Use:** Iron and steel slags are coproducts of iron- and steelmaking and find a market primarily in the construction center. Although data on U.S. slag production are unavailable, the range of output is estimated as having increased by about 30% to about 11 to 15 million tons in 2010, owing to a restart of many of the iron and steel furnaces that had been idled at least part time in 2009. Better slag availability led to a modest increase in slag sales in 2010, although volumes remained constrained by continued low levels of construction spending. An estimated 15 million tons of iron and steel slag, valued at about \$290 million<sup>1</sup> (f.o.b. plant), was sold in 2010. Iron or blast furnace slag accounted for about 60% of the tonnage sold and had a value of about \$250 million; nearly 85% of this value was granulated slag. Steel slag produced from basic oxygen and electric arc furnaces accounted for the remainder.<sup>2</sup> Slag was processed by nearly 30 companies servicing active iron and/or steel facilities or reprocessing old slag piles at about 120 sites in 32 States; included in this tally are a number of facilities that grind and sell ground granulated blast furnace slag (GGBFS) based on imported unground feed.

The prices listed in the table below are the weighted, rounded averages for iron and steel slags sold for a variety of applications. Actual prices per ton ranged widely in 2010 from about \$0.20 for steel slags for some uses to about \$100 for some GGBFS. The major uses of air-cooled iron slag and for steel slag are as aggregates for asphaltic paving, fill, and road bases and as a feed for cement kilns; air-cooled slag also is used as an aggregate for concrete. Nearly all GGBFS is used as a partial substitute for portland cement in concrete mixes or in blended cements. Pelletized slag is generally used for lightweight aggregate but can be ground into material similar to GGBFS. Owing to their low unit values, most slag types can be shipped by truck only over short distances, but rail and waterborne transportation can be longer. Because of its much higher unit value, GGBFS can be shipped economically over longer distances.

<b>Salient Statistics—United States:</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010<sup>e</sup></b>
Production, marketed <sup>1,3</sup>	20.3	19.6	18.8	12.5	15.0
Imports for consumption <sup>4</sup>	1.6	1.9	1.3	1.3	1.5
Exports	0.1	0.1	( <sup>5</sup> )	( <sup>5</sup> )	( <sup>5</sup> )
Consumption, apparent <sup>4,6</sup>	20.2	19.6	18.8	12.5	15.0
Price average value, dollars per ton, f.o.b. plant	20.00	22.00	18.00	19.00	20.00
Stocks, yearend	NA	NA	NA	NA	NA
Employment, number <sup>e</sup>	2,500	2,200	2,100	2,000	2,100
Net import reliance <sup>7</sup> as a percentage of apparent consumption	8	9	7	10	10

**Recycling:** Slag may be returned to the blast and steel furnaces as ferrous and flux feed, but data on these returns are incomplete. Entrained metal, particularly in steel slag, is routinely recovered during slag processing for return to the furnaces, but data on metal returns are unavailable.

**Import Sources (2006–09):** Granulated blast furnace slag (mostly unground) is the dominant ferrous slag type imported, but official import data show significant year-to-year variations in tonnage and unit value and commonly include some shipments of industrial residues other than ferrous slags (such as fly ash, silica fume, cenospheres) or of slags of other metallurgical industries. Further, the official data in recent years appear to underrepresent true import levels of granulated slag. Based on official data, the principal country sources for 2006–09 were Japan, 44%; Canada, 38%; Italy, 13%; South Africa, 4%; and other, 1%.

<b>Tariff:</b>	<b>Item</b>	<b>Number</b>	<b>Normal Trade Relations</b>
	Granulated slag	2618.00.0000	<u>12-31-10</u> Free.
	Slag, dross, scale, from manufacture of iron and steel	2619.00.3000	Free.

**Depletion Allowance:** Not applicable.

**Government Stockpile:** None.

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**Events, Trends, and Issues:** The availability of blast furnace slag has been in general decline in recent years because of the closure or idling of a number of U.S. blast furnaces, the lack of construction of new furnaces, and the depletion of old slag piles. Granulation cooling is currently installed at only four active blast furnaces, but is being evaluated for installation at other sites, contingent on the sites remaining active. Pelletized blast furnace slag remains in limited supply, but it is unclear if any additional pelletizing capacity is being planned. Supplies of basic oxygen furnace steel slag from integrated iron and steel works have become constrained as plants have been idled and because of an increasing volume of slag that is being returned to the furnaces. Slag from electric arc steel furnaces (largely fed with steel scrap) remains relatively abundant. Where slag availability has not been a problem, slag (as aggregate) sales into the construction sector have tended to be less volatile than those of natural aggregates or of cement. Sales of granulated slag have trended more in line with those of cement, but, for both environmental and performance reasons, there has been a general growth in granulated slag's share of the cementitious material market in recent years, albeit still at a very small percentage of the total. Draft regulations were released in 2009–10 to restrict emissions (especially of mercury) by U.S. cement plants and to reclassify fly ash as a hazardous waste for disposal purposes; both regulations have the potential to reduce the supply of these cementitious materials to the U.S. market and, if so, then sales and the market share of GGBFS would be expected to increase. Long-term growth in the supply of GGBFS is likely to hinge on imports, either of ground or unground material.

**World Mine Production and Reserves:** Slag is not a mined material and thus the concept of reserves does not apply to this mineral commodity. Slag production data for the world are unavailable, but it is estimated that annual world iron slag output in 2010 was on the order of 230 to 270 million tons, and steel slag about 120 to 180 million tons, based on typical ratios of slag to crude iron and steel output.

**World Resources:** Not applicable.

**Substitutes:** Slag competes with crushed stone and sand and gravel as aggregates in the construction sector. Fly ash, natural pozzolans, and silica fume are common alternatives to GGBFS as cementitious additives in blended cements and concrete. Slags (especially steel slag) can be used as a partial substitute for limestone and some other natural (rock) materials as raw material for clinker (cement) manufacture. Some other metallurgical slags, such as copper slag, can compete with ferrous slags for some specialty markets, but are generally in much more restricted supply than ferrous slags.

<sup>0</sup>Estimated. NA Not available.

<sup>1</sup>The data (obtained from an annual survey of slag processors) pertain to the quantities of processed slag sold rather than that processed or produced during the year. The data exclude any entrained metal that may be recovered during slag processing and returned to iron and, especially, steel furnaces, and are incomplete regarding slag returns to the furnaces.

<sup>2</sup>There were very minor sales of open hearth furnace steel slag from stockpiles but no domestic production of this slag type in 2006–10.

<sup>3</sup>Data include sales of imported granulated blast furnace slag, either after domestic grinding or still unground, and exclude sales of pelletized slag (proprietary but very small). Overall, actual production of blast furnace slag may be estimated as equivalent to 25% to 30% of crude (pig) iron production and steel furnace slag as about 10% to 15% of crude steel output.

<sup>4</sup>Comparison of official (U.S. Census Bureau) with unofficial import data suggest that the official data significantly understate the true imports of granulated slag. The USGS canvass appears to capture only part of the imported slag. Thus the apparent consumption statistics are likely too low by about 0.3 to 1.3 million tons per year.

<sup>5</sup>Less than ½ unit.

<sup>6</sup>Defined as total sales of slag (includes that from imported feed) minus exports. Calculation is based on unrounded original data.

<sup>7</sup>Defined as total sales of imported slag minus exports of slag. Data are not available to allow adjustments for changes in stocks.