

## IRON AND STEEL SLAG

(Data in million metric tons unless otherwise noted)

**Domestic Production and Use:** Ferrous slags are produced during the making of iron and steel and, after cooling and processing, are sold primarily to the construction industry. Data on actual U.S. slag production are unavailable, but it is estimated to have been in the range of 16 to 22 million tons in 2014. Domestic slag sales<sup>1</sup> in 2014 amounted to an estimated 16 million tons, valued at about \$270 million (f.o.b. plant). Iron (blast furnace) slag accounted for about 45% of the tonnage sold and had a value of about \$210 million; nearly 85% of this value was from sales of granulated slag. Steel slag produced from basic oxygen and electric arc furnaces accounted for the remainder.<sup>2</sup> Slag was processed by about 25 companies servicing active iron and (or) steel facilities or reprocessing old slag piles at about 140 processing plants 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 weighted, but rounded, averages for iron and steel slags sold for a variety of applications. Actual prices per ton ranged widely in 2014, from nil to a few cents for some steel slags at a few locations to about \$100 for some GGBFS. Air-cooled iron slag and steel slag are used primarily as aggregates in concrete (air-cooled iron slag only), asphaltic paving, fill, and road bases; both slag types also can be used as a feed for cement kilns. Virtually 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 low unit values, most slag types can be shipped by truck only over short distances, but rail and waterborne transportation allow greater distances. The much higher unit value of GGBFS likewise permits long distance transportation, including from overseas.

<b>Salient Statistics—United States:</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>2013<sup>e</sup></b>	<b>2014<sup>e</sup></b>
Production, marketed <sup>1, 3</sup>	15.8	15.4	16.0	15.5	16.0
Imports for consumption <sup>4</sup>	1.4	1.6	1.2	1.3	1.3
Exports	0.1	(5)	(5)	(5)	(5)
Consumption, apparent <sup>4, 6</sup>	15.8	15.4	16.0	15.5	16.0
Price average value, dollars per ton, f.o.b. plant <sup>7</sup>	17.00	17.00	17.00	17.00	17.00
Employment, number <sup>e</sup>	2,100	2,000	1,800	1,700	1,700
Net import reliance <sup>8</sup> as a percentage of apparent consumption	8	9	7	8	8

**Recycling:** Slag is commonly 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 (2010–13):** Granulated blast furnace slag (mostly unground) is the dominant ferrous slag imported, but official import data in some years include significant tonnages of nonslag materials (such as cenospheres, fly ash, and silica fume) and slags or other residues of various metallurgical industries (such as copper slag) whose unit values are outside the range expected for granulated slag. The official data appear to have underreported the granulated slag imports in some recent years, but likely not in 2011–12. Based on official data, the principal country sources for 2010–13 were Canada, 38%; Japan, 35%; Spain, 7%; Italy, 6%, but likely underreported; and other, 14%.

<b>Tariff: Item</b>	<b>Number</b>	<b>Normal Trade Relations 12–31–14</b>
Granulated slag	2618.00.0000	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 is becoming problematic in the United States because of the closure and (or) continued idling of a number of active U.S. blast furnaces in recent years, the lack of construction of new furnaces, and the depletion of old slag piles. At yearend 2014, granulation cooling was available at only three active U.S. blast furnaces and was unlikely to be installed at any other sites. Pelletized blast furnace slag was in very limited supply (one site only), and it was uncertain if any additional pelletizing capacity was being planned. Basic oxygen furnace steel slags have become less available recently because of the closure of several integrated iron and steel complexes, thus, the long-term supply of steel slag will be increasingly reliant on electric arc furnaces. Where slag availability has not been a problem, slag (as aggregate) sales to the construction sector have sometimes been less volatile than those of natural aggregates. Domestic and import supply constraints appear to have limited U.S. demand for GGBFS in recent years, and sales have failed to match the relative volume and price increases that have characterized the overall U.S. cement market since 2010. Long-term demand for GGBFS likely will increase because its use in concrete yields a superior product in many applications and reduces the unit carbon dioxide (CO<sub>2</sub>) emissions footprint of the concrete related to the portland cement content. Recent draft regulations to restrict emissions of CO<sub>2</sub> and mercury by coal-fired power plants, together with the plant closures or switchover at many such plants to low-cost natural gas, have led to a reduction in the supply of fly ash in some areas, including that of material for use as cementitious additive for concrete. This has the potential to increase future demand for GGBFS. Long-term growth in the supply of GGBFS will mainly depend on imports, either of ground or unground material. Imports may be constrained by increasing international demand for the same material and because not all granulated slag produced overseas is of high quality. New restrictions on mercury emissions by cement plants will likely reduce demand for fly ash as a raw material for clinker manufacture, and this could lead to use of air-cooled and steel slags as replacement raw materials.

**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 2014 was on the order of 310 to 370 million tons, and steel slag about 170 to 250 million tons, based on typical ratios of slag to crude iron and steel output.

**World Resources:** Not applicable.

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

<sup>6</sup>Estimated.

<sup>1</sup>Data are from an annual survey of slag processors and 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 2010–14.

<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>Based on official (U.S. Census Bureau) data. Comparisons with unofficial import data suggest that the official data may have understated the true imports of granulated slag, at least prior to 2010, by amounts of up to about 1 million tons per year; the apparent underreporting was relatively small for 2011–12, but is estimated at 0.4 million tons in 2013. The U.S. Geological Survey canvass captures only part of the imported slag.

<sup>5</sup>Less than 0.05 million tons.

<sup>6</sup>Although definable as total sales of slag (including those from imported feed) minus exports, apparent consumption of slag does not significantly differ from total sales owing to the very small export tonnages.

<sup>7</sup>Rounded to the nearest \$1.00 per metric ton; component data include a large proportion of estimates.

<sup>8</sup>Defined as total imports of slag minus exports of slag.