

IRON AND STEEL SLAG

(Data in million metric tons unless otherwise noted)

Domestic Production and Use: Iron and steel (ferrous) slags are coproducts of iron and steel manufacturing. After cooling and processing, ferrous slags are sold primarily to the construction industry. Data are unavailable on actual U.S. ferrous slag production, but it is estimated to have been in the range of 15 to 20 million tons in 2016. Domestic slag sales¹ in 2016 amounted to an estimated 18 million tons, valued at about \$350 million (ex-plant). Iron (blast furnace) slag accounted for about 47% of the tonnage sold and had a value of about \$300 million; about 85% of this value was from sales of granulated slag. Steel slag produced from basic oxygen and electric arc furnaces accounted for the remainder.² Slag was processed by about 29 companies servicing active iron and steel facilities or reprocessing old slag piles at about 135 processing plants in 31 States; included in this tally are some facilities that grind and sell ground granulated blast furnace slag (GGBFS) based on imported unground feed.

Prices listed in the table below are weighted averages (rounded) for iron and steel slags sold for a variety of applications. Actual prices per ton ranged widely in 2016, from a few cents for some steel slags at a few locations to about \$110 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. Almost 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 only short distances by truck, but rail and waterborne transportation allow for greater distances. Because of much higher unit values, GGBFS can be shipped longer distances, including from overseas.

Salient Statistics—United States:	2012	2013	2014	2015	2016^e
Production (sales) ^{1,3}	16.0	15.5	16.6	17.7	18.0
Imports for consumption ⁴	1.2	1.7	1.8	1.4	2.0
Exports	(5)	(5)	0.1	(5)	(5)
Consumption, apparent ^{4,6}	16.0	15.5	16.5	17.7	18.0
Price average value, dollars per ton, f.o.b. plant ⁷	17.00	17.50	19.00	19.50	19.50
Employment, number ^e	1,800	1,700	1,700	1,700	1,600
Net import reliance ⁸ as a percentage of apparent consumption	7	11	10	8	11

Recycling: Following removal of metal, slag can 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, and is an important revenue source for the slag processors, but data on metal returns are unavailable.

Import Sources (2012–15): The dominant imported ferrous slag type is granulated blast furnace slag (mostly unground), but official import data in recent years have included 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 2012–15 were Japan, 33%; Canada, 31%; Spain, 16%; Germany, 5%; and other, 15%; however, much of the tonnage from Spain in 2013–14 may in fact have been from Italy, and slag from the Netherlands and Switzerland in 2015 may have been from Germany.

Tariff:	Item	Number	Normal Trade Relations
			<u>12–31–16</u>
	Granulated slag	2618.00.0000	Free.
	Slag, dross, scale, from manufacture of iron and steel	2619.00.0000	Free.

Depletion Allowance: Not applicable.

Government Stockpile: None.

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Events, Trends, and Issues: The supply of blast furnace slag continues to be 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, including one in 2015, the lack of construction of new furnaces, and the depletion of old slag piles. Only a limited quantity of locally produced granulated blast furnace slag was available. At yearend 2016, granulation cooling was available at only two active U.S. blast furnaces, down from three in 2014. Installation of granulation cooling was being evaluated at a few blast furnaces, but it was unclear if this would be economic. Pelletized blast furnace slag was in very limited supply (one site only), and it was uncertain if any additional pelletizing capacity was planned.

Basic oxygen furnace steel slag from domestic furnaces has 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, which now contribute the majority of U.S. steel production. Where not in short supply, slag (as aggregate) sales to the construction sector tend to fluctuate less than those of natural aggregates. Domestic- and import-supply constraints appear to have limited domestic demand for GGBFS in recent years. Although prices have increased, sales volumes have failed to match the relative 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 (CO₂) emissions footprint of the concrete related to the portland cement (clinker) content.

Recent regulations to restrict emissions of CO₂ and mercury by coal-fired powerplants, together with some powerplant closures or conversion of others to 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, but the availability of material to supply this demand will increasingly depend on imports, either of ground or unground material. Imported slag availability 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 may 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 global iron slag output in 2016 was on the order of 300 to 360 million tons, and steel slag about 160 to 240 million tons, based on typical ratios of slag to crude iron and steel output.

World Resources: Not applicable.

Substitutes: In the construction sector, ferrous slags compete with crushed stone and sand and gravel as aggregates, but are far less widely available than the natural materials. As a cementitious additive in blended cements and concrete, GGBFS mainly competes with fly ash, metakaolin, and volcanic ash pozzolans, and to a lesser degree with silica fume. In this respect, GGBFS also competes 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.

⁶Estimated.

¹Data 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 then sold separately or returned to iron and, especially, steel furnaces. The data are incomplete regarding slag returns to the furnaces.

²There were very minor sales of open hearth furnace steel slag from stockpiles but no domestic production of this slag type in 2012–16.

³Data 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.

⁴Based on official (U.S. Census Bureau) data. In some years, the official data appear to have understated the true imports; the apparent discrepancy was small for 2012, but may have been nearly 0.4 million tons in 2013 and 2014, depending on whether imports from Italy were mischaracterized as being from Spain or not. The U.S. Geological Survey canvass captures only part of the imported slag.

⁵Less than 0.05 million tons.

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

⁷Rounded to the nearest \$0.50 per ton.

⁸Defined as imports minus exports.