IRON AND STEEL SLAG

(Data in million metric tons unless otherwise noted)

Domestic Production and Use: In the making of crude (or pig) iron and crude steel, slagging agents are added to strip impurities from the iron ore in the blast furnaces and from the crude iron and scrap steel feeds to the steel furnaces. The impurities and slagging agents combine to form iron and steel (ferrous) slags, which are tapped separately from the metals and which, after cooling and processing, primarily find a ready market in 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 2017. Domestic slag sales[1] in 2017 amounted to an estimated 15 million tons, valued at about $350 million (ex-plant). Blast furnace slag accounted for about 50% 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 almost all of the remainder.[2] Slag was processed by about 25 companies servicing active iron and steel facilities or reprocessing old slag piles at about 175 processing plants (including some iron and steel plants with more than one slag-processing facility) in 30 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 2017, from a few cents for some steel slags at a few locations to about $104 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:	**2013**	**2014**	**2015**	**2016[e]**	**2017[e]**
Production (sales)[1, 3]	15.5	16.6	17.7	16.0	15.0
Imports for consumption[4]	1.7	1.8	1.5	2.0	2.2
Exports	(5)	0.1	(5)	(5)	(5)
Consumption, apparent[6]	15.5	16.5	17.7	16.0	15.0
Price, average value, dollars per ton, f.o.b. plant[7]	17.50	19.00	19.50	22.00	23.00
Employment, number[e]	1,700	1,700	1,700	1,600	1,500
Net import reliance[8] as a percentage of apparent consumption	11	10	8	12	15

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 (2013–16): Canada, 27%; Japan, 26%; Spain, 19%; Germany (including the Netherlands and Switzerland in 2015), 7%; and other, 21%.

Tariff: Item	**Number**	**Normal Trade Relations 12–31–17**
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.

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 U.S. blast furnaces in recent years (including four in 2015), the lack of construction of new furnaces, and the depletion of old slag piles. Locally produced granulated blast furnace slag was available only in limited supplies because, at yearend 2017, granulation cooling was available at only two active U.S. blast furnaces (down from three in 2014). Installation of granulation cooling was continuing to be evaluated at a few blast furnaces, but it remained unclear if this would be cost-effective given the economic uncertainties in operating blast furnaces. Pelletized blast furnace slag was in very limited supply (one site only), and it was uncertain if any additional pelletizing capacity was planned.

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Basic oxygen furnace steel slag from domestic furnaces also has become less available recently because of the closure or idling of several integrated iron and steel complexes, although the existence at many sites of large slag stockpiles can allow for slag processing to continue even several years after the cessation of furnace operations. Nonetheless, the long-term supply of steel slag will increasingly rely on electric arc furnaces, which now contribute the majority of U.S. steel production. Domestic- and import-supply constraints appear to have limited domestic consumption of GGBFS in recent years. Although prices have increased, sales volumes for GGBFS 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 (CO_2) emissions footprint of the concrete related to the portland cement (clinker) content.

Recent regulations to restrict emissions of CO_2 and mercury by coal-fired powerplants, together with 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, with the result that fly ash imports have increased. Fly ash shortages have the potential to increase future demand for GGBFS, but the availability of granulated slag 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. Restrictions on mercury emissions by cement plants enacted in 2015 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 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. On this basis, it is estimated that global iron slag output in 2017 was on the order of 300 million to 360 million tons, and steel slag about 170 million to 250 million tons.

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 and compete in this use with fly ash and bottom ash. Some other metallurgical slags, such as copper slag, can compete with ferrous slags in some specialty markets, such as a ferrous feed in clinker manufacture, but are generally in much more restricted supply than ferrous slags.

[e]Estimated.

[1]Processed slag sold rather than that processed or produced during the year. Excludes any entrained metal that may be recovered during slag processing and then sold separately or returned to iron and, especially, steel furnaces. Data are incomplete regarding slag returns to the furnaces.

[2]There were very minor sales of open hearth furnace steel slag from stockpiles but no domestic production of this slag type in 2013–17.

[3]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).

[4]Official (U.S. Census Bureau) data adjusted by the U.S. Geological Survey. In some years, the official data, which are supposed to be granulated blast furnace slag only, appear to have understated the true imports of this material by as much as 0.4–0.5 million tons annually for the period shown, and have included significant tonnages of nonslag materials (such as cenospheres, fly ash, and silica fume), and slags or other residues of other metallurgical industries (especially copper slag), whose unit values are outside the range expected for granulated slag.

[5]Less than 0.05 million tons.

[6]Defined as total sales of slag (including those from imported feed) − exports, but does not significantly differ from total sales owing to the very small export tonnages.

[7]Rounded to the nearest $0.50 per ton.

[8]Defined as imports – exports.