

IRON AND STEEL SLAG

(Data in million metric tons unless otherwise specified)

Domestic Production and Use: Iron and steel (ferrous) slags are formed by the combination of slagging agents and impurities during the production of crude (or pig) iron and crude steel. The slags are tapped separately from the metals, then cooled and processed, and are primarily used in the construction industry. Data were unavailable on actual U.S. ferrous slag production, but domestic slag sales¹ in 2023 were estimated to be 16 million tons valued at about \$900 million. Blast furnace slag was about 54% of the tonnage sold and accounted for 90% of the total value of slag, most of which was granulated. Steel slag produced from basic oxygen and electric arc furnaces accounted for the remainder of sales. Slag was processed by 25 companies servicing active iron and steel facilities or reprocessing old slag piles at about 123 processing plants (including some iron and steel plants with more than one slag-processing facility) in 33 States, including facilities that import and grind unground slag to sell as ground granulated blast furnace slag (GGBFS).

Iron slag and steel slag are used primarily as aggregates in concrete (air-cooled iron slag only) and as 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. Actual prices per ton ranged from a few cents for some steel slags at a few locations to about \$140 per ton or more for some GGBFS in 2023. Owing to low unit values, most slag types can be shipped only short distances by truck, but rail and waterborne transportation allow for greater travel distances. Because much higher unit values make it economical to ship GGBFS longer distances, much of the GGBFS consumed in the United States is imported.

Salient Statistics—United States:	2019	2020	2021	2022	2023^e
Production (sales) ^{e, 1, 2}	16.3	15	16	16	16
Imports for consumption ^{e, 3}	1.4	1.7	2.1	1.7	2.1
Exports	(4)	(4)	(4)	(4)	(4)
Consumption, apparent ^{e, 5}	16	15	16	16	16
Price, average unit value, free on board plant, dollars per metric ton ⁶	28.50	31.00	40.50	53	58
Employment, number ^e	1,500	1,500	1,500	1,500	1,500
Net import reliance ⁷ as a percentage of apparent consumption	9	11	13	10	13

Recycling: Following removal of entrained 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 slag processors; data on metal returns are unavailable.

Import Sources (2019–22): Japan, 40%; China, 23%; Brazil, 18%; Canada, 7%; and other, 12%.

Tariff:	Item	Number	Normal Trade Relations 12–31–23
	Granulated slag	2618.00.0000	Free.
	Slag, dross, scalings, and other waste from manufacture of iron and steel:		
	Ferrous scale	2619.00.3000	Free.
	Other	2619.00.9000	Free.

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Depletion Allowance: Not applicable.

Government Stockpile: None.

Events, Trends, and Issues: The availability of iron and steel slag is tied closely to the rates of pig iron and raw steel production and the cost consideration of recovering slag for use in low-value downstream applications. The majority of U.S. steel slag production is from electric arc furnaces, which accounted for an estimated 71% of U.S. steel production in 2023 owing to the overall cost advantages of environmental factors, such as less feedstock and power consumption and the price and availability of ferrous scrap feedstock. In recent years, the percentage of basic oxygen furnace steel production has continued to decline as capacity has idled or closed; however, slag stockpiling at furnaces allows for processing of slag for years after closures. The World Steel Association⁸ forecast global finished steel consumption to increase by 1.8% in 2023 and increase by 1.9% in 2024. Pig iron production in the United States was estimated to have increased by 6% to 21 million tons in 2023 from 19.8 million tons in 2022 despite the idling of one blast furnace in the fourth quarter. Raw steel production remained essentially unchanged at 80 million tons.

During 2023, domestic GGBFS remained in limited supply because granulation cooling was known to be available at only two active U.S. blast furnaces and only one other domestic plant produced pelletized slag in limited supply. Grinding of granulated blast furnace slag was only done domestically by cement companies. Much of the granulated blast furnace slag and some GGBFS was imported. Based on data through August, the quantity imported in 2023 was estimated to be 23% more than that in 2022.

The domestic supply of fly ash, which is used as an additive in concrete production, was expected to continue to decrease in upcoming years owing to restrictions on carbon dioxide (CO₂) and mercury emissions at coal-fired powerplants, closures of coal-fired powerplants, conversion of powerplants to natural gas, and increasing reliance on renewable energy sources. Demand for GGBFS is likely to increase because its use in cement yields a beneficial product in many applications and reduces the unit CO₂ emissions in the production of the cement. In 2023, several large Federal building and infrastructure projects were initiated that would promote the use of such cement and other lower carbon materials under the Federal Buy Clean Initiative.

World Production and Reserves: Because slag is not mined, the concept of reserves does not apply. World production data for slag were not available, but iron slag production from blast furnaces was estimated to be 25% to 30% of crude (pig) iron production, and steel furnace slag production was estimated to be 10% to 15% of raw steel production. In 2023, world iron slag production was estimated to be between 330 million and 390 million tons, and steel slag production was estimated to be between 190 million and 290 million tons.

World Resources: Not applicable.

Substitutes: In the construction sector, ferrous slags compete with natural aggregates (crushed stone and construction sand and gravel) 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. In this respect, GGBFS reduces the amount of portland cement per ton of concrete, thus allowing more concrete to be made per ton of portland cement. Portland-limestone cement can be used instead of GGBFS for the same purpose. 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 the supplies of these metallurgical slags are generally much more restricted than ferrous slags.

⁰Estimated.

¹Processed slag sold during the year, excluding entrained metal.

²Data include sales of domestic and imported granulated blast furnace slag and exclude sales of pelletized slag.

³U.S. Census Bureau data adjusted by the U.S. Geological Survey to remove 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. In some years, tonnages may be underreported.

⁴Less than 50,000 tons.

⁵Defined as sales – exports.

⁶Rounded to the nearest \$0.50 per ton.

⁷Defined as imports – exports.

⁸Source: World Steel Association, 2023, Short range outlook October 2023: Brussels, Belgium, World Steel Association press release, October 17, 5 p.