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# 2016 Minerals Yearbook

## SLAG—IRON AND STEEL [ADVANCE RELEASE]

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# Slag—Iron and Steel

By Hendrik G. van Oss

Total sales of iron and steel slags fell by about 12% in 2016 to an estimated 15.7 million metric tons (Mt) (table 1), following a 7% increase in 2015. Because of generally higher unit values, however, the overall value of slag sales increased slightly to $349 million.

Iron and steel (or ferrous) slags are silicate melts that result from the addition of slagging agents and fluxes (chiefly limestone or dolomite, lime, and silica sand) to blast furnaces and steel furnaces (and associated ladles) to remove impurities from iron ore, crude iron, direct reduced iron, steel scrap, and other ferrous feeds. The molten slag floats on top of the molten crude iron or steel and is tapped from the furnace or ladle separately from the liquid metal. After cooling by various means to solid form, the slag is processed and may then be stockpiled for eventual sale or, in some cases, returned to the furnace. Processed slags have much lower unit values than do iron and steel (metal); accordingly, the iron and steel (steel) companies generally contract with outside slag-processing companies to cool the slag and remove it. Typically, the processing company receives the slag for free, cools the slag, crushes it to various marketable sizes, uses screens and magnetic separators to recover entrained metal from the slag (metal generally to be sold back to the furnace), sells the slag on the open market, and may pay a small percentage of the net slag sales revenues or profits to the steel company. Although not included in the slag sales data, the value of the metal recovered from slag processing generally greatly exceeds that of the processed slag itself. At a number of sites, some slag is returned to the furnaces for use as flux and as a supplemental source of iron; despite having a value, this return flow is not always included in the reported sales tonnages.

A listing of slag processors, processing sites, slag types, and the steel companies serviced is provided in table 4. Apparent duplication at some sites results from the transfer of processing contracts to other companies during the year and also stems from integrated iron and steel plants that have processing or marketing contracts with various companies for the different types of slag produced at the plant. In some cases, the slag is cooled by one company but is then further processed or marketed by another company or at another site.

## Legislation and Government Programs

Most slag is sold into the construction sector, and the market for slag is influenced by Federal and State programs that affect construction spending, those that allow for or encourage the use of "alternative" raw materials in construction, and those that may restrict the use or availability of natural construction materials. Slags can substitute directly or indirectly for virgin materials in certain construction applications and are thus considered to be sustainable raw materials. The main examples of such substitution are for natural stone aggregates in concrete and for natural raw materials in cement manufacture. In the specific case of ground granulated blast furnace slag (GGBFS), the material is a supplementary cementitious material (SCM) that can partially substitute for clinker in finished cement or for some of the portland cement in concrete. In the manufacture of the clinker precursor to portland cement, substitution of slags for natural raw materials can reduce the unit consumption of fuel and limestone in the kiln, which then reduces the overall and unit emissions of certain pollutants, most notably carbon dioxide. Use of granulated blast furnace slag [either as GGBFS or as unground material (GBFS)] in the cement plant's finish mill allows more finished cement to be made from the same amount of clinker.

The 2010 final rule within the National Emissions Standards for Hazardous Air Pollutants (NESHAP) took effect in September 2015 and set very low limits for cement plant emissions of mercury, total hydrocarbons, hydrochloric acid, and particulates (U.S. Environmental Protection Agency, 2015). Some U.S. cement plants may find it uneconomic to install the monitoring and emissions abatement equipment or enact abatement procedures to comply with the NESHAP limits for the plants overall or for specific, currently idle kilns (commonly older, or of older technology), and such plants or specific kilns may thus be closed or used only sparingly in the future. The resulting loss of cement production capacity has the potential to increase demand for SCMs, such as GGBFS and fly ash. The NESHAP could make fly ash (typically high in mercury) less attractive as an alternative raw material for clinker manufacture and thus might increase demand for slag for this purpose.

## Production

Whereas furnace operators know the ferrous slag content of iron and steel furnaces while they are in use, the amount of slag tapped from the furnaces is not routinely measured and not all of the slag formed is tapped during a heat; accordingly, data on annual production of slag are usually unavailable. Production of slag can, however, be estimated broadly based on typical slag-to-metal production ratios, which in turn are related to the chemistry of the ferrous feeds to the furnaces. For typical iron ore grades (60% to 66% iron), a blast furnace normally will produce about 0.25 to 0.30 metric ton (t) of slag per ton of crude or pig iron produced. For ores of lower than average grade, the slag output will be higher (in some cases, as much as 1.0 to 1.2 t of slag per ton of crude iron). Steel furnaces typically produce about 0.2 t of slag per ton of crude steel, but up to 50% of this melt is entrained metal, much of which would likely be recovered during slag processing and returned to the furnace. The amount of marketable steel slag remaining after entrained metal removal is thus usually equivalent to about 10% to 15% of the crude steel output. Using these ratios and data for U.S. and world iron and steel production from the World Steel Association (2017, p. 1–2, 91–92), domestic blast furnace slag production in 2016 was estimated to be in the range of about 6 to 7 Mt, and world output was 290 to 349 Mt. Steel slag (after metal removal) output by U.S. furnaces was estimated to be in the range of 8 to 12 Mt, and world output of steel slag, 163 to 244 Mt.

The main determinant of the commercial uses of ferrous slag is the method by which the slag is cooled. Blast furnace slags are cooled to three main product types—air-cooled, granulated, and pelletized (or expanded). Air-cooled blast furnace slag results from allowing the molten slag to cool relatively slowly under ambient conditions; final cooling can be accelerated with a water spray. Although commonly having a vesicular texture with closed pores, air-cooled slag is hard and dense and is especially suitable for use as construction aggregates. To make GBFS, molten slag is quenched in water to form sand-sized particles of glass. The disordered structure of this glass gives the material inherent moderate ("latent") hydraulic cementitious properties when the slag is finely ground into GGBFS, and the cementitious properties become strong if the GGBFS accesses free lime. In concrete with GGBFS in the mix, hydration of portland cement releases the lime needed to fully activate the slag. Concretes incorporating GGBFS generally develop strength more slowly than concretes that contain only portland cement but can have similar or even superior long-term strength, release less heat during hydration, generally exhibit improved resistance to chemical attack, and have reduced permeability. Pelletized or expanded slag is cooled through a water jet, which leads to rapid steam generation and the development of innumerable vesicles within the slag, which itself is glassy. The vesicles reduce the overall density of the slag and allow for good mechanical binding with hydraulic cement paste. This slag type is most commonly used as a lightweight aggregate but, if very finely ground, pelletized slag has cementitious properties similar to those of GGBFS. Blast furnace slag (generally air-cooled) also can be made into mineral wool. To make mineral wool, slag is remelted and then poured through an air stream or jet of steam or other gas to produce a spray of molten droplets; alternatively, the droplets can be formed by passing the melt through a perforated or fast spinning disc. The droplets elongate into long fibers that are collected and layered, and this material is suitable for use as thermal insulation.

Steel furnace slag is cooled similarly to air-cooled blast furnace slag, has similar properties to it, and is used for some of the same purposes. Steel slags, especially those commingled with ladle slags, containing large amounts of dicalcium silicate are prone to expansion and commonly are cured in piles for several months to allow for the expansion and for leaching out of lime.

Iron and steel slags are also used in environmental applications, such as water filtration, although the data on such uses are incomplete.

## Consumption

The data in this report are based on an annual U.S. Geological Survey (USGS) canvass of slag processors and importers and pertain to sales of processed slag rather than the amount of slag produced or processed during the year. In 2016, canvasses were sent to 27 companies, covering 132 processing and (or) importation sites, and at least partial data (some within consolidated responses) were received for 125 sites, accounting for 88% of the total slag tonnage (including 87% of the GBFS tonnage) listed for 2016 in table 1. In 2015, canvasses to 27 companies, covering 132 sites, yielded data for 118 sites or almost 86% of the total tonnage (including 96% of the GBFS tonnage) for that year. Responses to the USGS canvasses varied greatly in the detail provided and estimates for missing data were made where needed; accordingly, the tonnage data in table 1 have been rounded to the nearest 0.1 Mt and the value data to the nearest $1 million. For both years, data on pelletized blast furnace slag have been withheld to avoid disclosing company proprietary information, but the quantities sold were very small. Sales data for granulated slag (mostly GGBFS) in both years miss some material sold by a few importers who as yet do not take part in the USGS canvass. The data in table 1 also do not include the free metal recovered from the slag; this metal was sold separately.

Processed slag sales volumes bear little relation to slag production (and hence apparent slag availability) in a given year because of a combination of undocumented returns of slag to the furnaces, stockpiling of slag by processors, changes in processing protocols that affect slag marketability (such as segregating ladle from steel furnace slags as opposed to processing a commingled steel slag), and the fact that all slag sales are from stockpiles, including material in old piles (slag banks) from iron and steel plants long-since closed. For example, whereas U.S. production of crude iron fell by 12.4% in 2016 (World Steel Association, 2017, p. 1–2, 91–92), overall U.S. sales of blast furnace slag fell by almost 7% (table 1). Domestic production of crude steel fell only by 0.5%, but sales of steel furnace slags fell by about 16%; the sales decline may partly reflect a relative increase in undocumented returns of slag to the furnaces (in contrast to the decline in documented slag returns in table 3).

Overall sales of ferrous slags fell by nearly 12% in 2016, largely because of an almost 13% decline in sales of air-cooled blast furnace slag and a 16% decrease in sales of steel furnace slags (table 1). These two slag types are mainly used as general construction aggregates (table 3) and accounted for about 85% of total slag sales in 2015 (a rather typical fraction in recent years) and 81% in 2016. Because of their low unit values (table 2), these slags generally can only compete with natural aggregates in market regions close to active iron and steel furnaces or to slag banks so as to avoid long-distance transportation charges. Because of transportation costs, the common existence of long-term sales contracts, more restricted geographic availability, and tendencies by processors to stockpile slag to allow bidding on large contracts, trends in external (not returned to furnaces) sales volumes for slag commonly differ significantly from those for competing natural aggregates and for portland and blended cement (a proxy for concrete). In 2015, the approximately 7% increase (relative to 2014) in overall sales of air-cooled and steel slags closely matched that (USGS data) of sales of crushed stone (up by 7.2%), but the slag sales were significantly higher than the 3.8% increase in the sales of portland and blended cement. However, in 2016, the overall 15% decline in sales of air-cooled and steel slags was in sharp contrast to the 1.4% increase in sales of crushed stone and the 2.3% increase in sales of portland and blended cement.

Potential expansion problems with steel slag, especially ladle slags or commingled ladle and steel furnace slags, reduce its applicability for uses that require maintenance of a fixed volume (for example, ready-mixed concrete). Both air-cooled and steel slags can be used as a raw material for cement (clinker) manufacture, but steel slag has proven to be especially suitable for this use. Relative changes, especially small percentages, in sales by type of use are difficult to evaluate because the data incorporate estimates (more so in 2015–16 than in recent previous years) and much of the plant-level data reported in recent years have revealed only the dominant use(s) for the slag or have combined the uses as "Other," leaving the minor use categories understated. The percentage of air-cooled blast furnace slag sold for ready-mixed concrete appeared to have more than doubled in 2016 (table 3), whereas in 2015, this use category had decreased by about 21% relative to its market share in 2014. The use of steel furnace slag for asphaltic concrete and for fill appears to have increased significantly in 2016; the increase in use for asphaltic concrete appears to have offset a decline in use for road bases and surfaces and may thus represent reporting inconsistencies. No such significant changes in these use categories were evident for air-cooled blast furnace slag.

Sales of granulated slag (all reported as GGBFS in 2015–16) increased by about 0.2 Mt (table 1). Although this slag type accounted for almost 19% of the total iron and steel slag sales tonnage in 2016, it accounted for 85% of the total value of blast furnace slag sales and 74% of the total slag sales value; the relative value contribution of GGBFS in 2015 was similar and, for both years, reflected the high unit price for this material in its primary role as an SCM. Actual sales of GGBFS in some years have been higher than those shown in table 1 because some imports were missed by the USGS canvass; however, it was unclear if this was significant in 2015–16. The USGS slag survey does not distinguish between GGBFS sold for cementitious use to cement companies (to make blended cement) from that sold as an SCM to concrete companies, but data from USGS canvasses of cement producers continue to indicate that by far the major component of GGBFS sales are to the concrete industry. An alternative source of data for sales of GGBFS, under the designation "slag cement," is the Slag Cement Association (SCA), whose members account for much of the country's GGBFS output and sales. The SCA reported sales of slag cement of 2.4 Mt in 2015 and 2.7 Mt in 2016, but these tonnages excluded the content of GGBFS in blended hydraulic cements (Slag Cement Association, 2018) and are thus not strictly comparable to the data in table 1; data published by the SCA for 2014 and earlier years have been similar to those presented by the USGS.

## Prices

Many slag canvasses sent to the USGS lacked price data or, for a number of forms, an average price was given for the total tons sold but not for the breakout of sales by use. Accordingly, the data in table 2 include many estimates or assignments of reported averages to all use types but have been left unrounded to better show the range of reported values. Small unit differences (less than $1 per metric ton) are likely of no statistical significance and commonly reflect a modest difference in the tonnages sold at the upper or lower bounds of the price ranges or a change in the amount of detail provided in the use breakouts. The average prices did not change significantly for the three slag types listed in table 2, but the upper price range bounds showed a significant increase for air-cooled blast furnace slags and decreases for GGBFS and steel furnace slags.

As noted above, air-cooled blast furnace slag and steel slags have many similar (mainly aggregates) market uses. Market factors affecting the prices of these two slag types include local competition from natural aggregates, the overall level of construction activity (particularly for roads), and the existence of long-term supply contracts. Air-cooled and steel furnace slags sold for uses other than aggregates can command higher prices than slags sold as aggregates. Pelletized slag (not shown in tables 1–3) can sell for prices well above those for air-cooled slag. Unit prices for GGBFS (shown in table 2 only for cementitious uses) are much higher than those for air-cooled blast furnace and steel slags because GGBFS is mainly used as a partial substitute for portland cement in blended cements and, especially, in concrete. For many years, GGBFS sold for unit prices that were 20% to 25% lower than those for gray portland cement, but more recently the price difference has been more in the range of 10% to 15% lower owing to relative stability of GGBFS prices compared with those for portland cement.

## Foreign Trade

Most of the iron and steel slag imported into the United States is GBFS (for grinding at domestic facilities) or GGBFS; both forms of the slag are covered by the dedicated Harmonized Tariff Schedule of the United States (HTS) code 2618.00. Import data within HTS code 2618.00 commonly contain entries that, based on excessively high or low unit dollar values, are either slags of other metallurgical industries (especially copper slag) or are unrelated materials altogether (such as silica fume, fly ash pozzolan, cenospheres from fly ash, other industrial residues, or metal concentrates). Trade data from the U.S. Census Bureau showed total supposed granulated slag imports in 2016 under HTS code 2618.00 of 2.05 Mt, but only about 1.84 Mt of this appeared to be GBFS or GGBFS, based on unit values (and including some imports miscoded as clinker imports). This total increases to 1.97 Mt if likely granulated slag imports within HTS code 2619.00 (which otherwise mainly includes various metallic residues of high unit value) are included. The major sources of the apparent granulated slag in 2016 were, in descending order, Canada, Japan, France (but the material is likely all or mostly from Spain), Spain (as listed), Italy, Germany (including material listed as from the Netherlands), and China. The equivalent likely granulated slag imports in 2015 were 1.36 Mt under HTS code 2618.00 and 0.13 Mt under HTS code 2619.00. Much of the material excluded in the adjusted totals in both years was inexpensive copper slag (mostly from Japan) imported for use mainly as sand-blasting grit and as an iron-rich raw material for clinker manufacture.

Import data from Trade Mining LLC's trade database showed somewhat higher totals for likely granulated slag imports than those of the U.S. Census data. For 2016, the Trade Mining data had imports of likely granulated blast furnace slag of about

2.2 Mt, including significant imports into Florida, which were missing from the U.S. Census data.

After exclusion of very high unit value materials, U.S. Census Bureau exports of apparent granulated slag under HTS code 2618.00 totaled only about 36,900 t in 2016 with an additional 1,600 t under HTS code 2619.00; exports of likely granulated slag under these two tariff codes totaled about 47,000 t in 2015.

### Outlook

Most ferrous slag will continue to be sold in the United States for use as construction aggregate. Sales for more specialized uses, such as raw materials for clinker and glass manufacture and as media for water treatment and filtration, have significant growth potential, but data on such sales are likely to remain incomplete. The domestic supply of blast furnace slag remains limited by the fact that several blast furnaces have closed or been idled in recent years; only 21 were operating in 2015 and just 17 in 2016 (Iron & Steel Technology, 2017). The long-term economic viability of the remaining blast furnaces was in doubt, and no prospects for the construction of new furnaces were likely. Demand for GGBFS (and other SCMs) is likely to increase because of the utility of SCMs in reducing the clinker content of finished hydraulic cement and concrete, thus reducing the overall and unit emissions of carbon dioxide associated with concrete construction. The quality of the concrete is generally improved by use of SCMs as well. Domestic output of GBFS remains, however, severely limited; throughout 2015–16, only two U.S. blast furnaces were equipped with granulation cooling. Although some other blast furnaces were being evaluated for the addition of granulation cooling, the required apparatus is very expensive and further requires that a grinding plant for the slag also be available or constructed. Installation of granulators would thus only make economic sense for blast furnaces expected to remain in production for many years, which is problematic considering the recent closures or idlings of blast furnaces. Thus, higher demand for GGBFS most likely will be met by increased slag imports, but the availability of imported granulated slag itself faces constraints from increasing demand for GGBFS in many countries overseas.

Basic oxygen furnace (BOF) steel slag faces the same supply constraints as blast furnace slag because the BOFs are at the same integrated plants and largely rely on the crude iron (hot metal) feed supplied by the blast furnaces. In contrast, slag from domestic electric arc steel furnaces (EAFs) is in more assured supply because the EAFs are numerous, and most of them are not part of, or dependent upon, integrated iron and steel complexes, instead relying on scrap for all or most of their ferrous feeds. In the production of portland cement, carbon dioxide emissions can be reduced through the substitution of noncarbonate calcium-rich raw materials for some of the limestone that is the traditional major raw material for this manufacture. Ferrous slags (especially steel furnace slags) have proven to be highly suitable for such substitution but, in this use, commonly compete with fly ash and bottom ash from coal-fired power plants. Demand for ferrous slag for clinker manufacture could increase if the cement industry reduces its consumption of fly ash to meet more stringent NESHAP limits on mercury emissions, especially if the cement plants are unable to substitute bottom ash for fly ash. Closure of U.S. coal-fired powerplants, or their conversion to natural gas, is already constraining the supply of coal combustion ashes in many market regions and is also constraining the domestic supply of SCM-grade fly ash.

### References Cited


Iron & Steel Technology, 2017, AIST 2017 North American blast furnace roundup: Iron & Steel Technology, v. 14, no. 3, p. 222–223.

Slag Cement Association, 2018, Shipments: Farmington Hills, MI, Slag Cement Association. (Accessed June 5, 2018, at https://www.slagcement.org/resources/shipments.aspx.)

U.S. Environmental Protection Agency, 2015, 40 CFR Parts 60 and 63—National emissions standards for hazardous air pollutants from the portland cement manufacturing industry and standards of performance for portland cement plants: Federal Register, v. 80, no. 143, July 27, p. 44772–44793.

World Steel Association, 2017, Steel statistical yearbook 2017: Brussels, Belgium, World Steel Association, 123 p. (Accessed June 5, 2018, at https://www.worldsteel.org/en/dam/jcr:3e275c73-6f11-4e7f-a5d8-23d9bc5c508f/Steel+Statistical+Yearbook+2017_updated+version090518.pdf.)


## GENERAL SOURCES OF INFORMATION

### U.S. Geological Survey Publications

Historical Statistics for Mineral and Material Commodities in the United States. Data Series 140.

Iron and Steel Slag. Ch. in Mineral Commodity Summaries, annual.

### Other

National Slag Association.

Portland Cement Association.

Slag Cement Association.

TABLE 1
IRON AND STEEL SLAG SOLD OR USED IN THE UNITED STATES[1]

(Million metric tons and million dollars)

| | 2015 | | | | | 2016 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Blast furnace slag[2] | | | Steel | Total iron | Blast furnace slag[2] | | | Steel | Total iron |
| | Air-cooled | Granulated | Total | furnace slag | and steel slag | Air-cooled | Granulated | Total | furnace slag | and steel slag |
| Quantity[e] | 6.1 | 2.7 | 8.8 | 8.9 | 17.7 | 5.3 | 2.9 | 8.2 | 7.4 | 15.7 |
| Value[e] | 48 | 248 | 296 | 49 r | 345 | 45 | 260 | 306 | 44 | 349 |

[e]Estimated. [r]Revised.
[1]Table includes data available through May 16, 2018. Data may not add to totals because of independent rounding.
[2]Excludes expanded (pelletized) slag to protect company proprietary data. The quantities are very small (about 0.1 unit or less).

TABLE 2
SELLING PRICES FOR IRON AND STEEL SLAG IN THE UNITED STATES[1]

(Dollars per metric ton)

| | 2015 | | 2016 | |
|---|---|---|---|---|
| Slag type | Range | Average | Range | Average |
| Blast furnace slag: | | | | |
| Air-cooled | 3.31–13.32 | 7.87 | 3.31–23.42 | 8.53 |
| Granulated[2] | 78.10–110.23 | 90.37 | 81.30–103.40 | 89.18 |
| Steel furnace slag | 1.65–36.93 | 5.46 | 1.10–20.39 | 5.88 |

[1]Table includes data available through May 16, 2018. Data, although unrounded, contain a large component of estimates and some respondents provide values only on their total sales of a slag type, not value by type of use. Thus, the value ranges shown are likely too restrictive.
[2]Values are for material reported for use as a cementitious additive in cement or concrete manufacture. No sales of unground material were reported in 2015–16, although such sales certainly took place; the price ranges shown are thus just for ground material.

TABLE 3
SALES OF FERROUS SLAGS IN THE
UNITED STATES, BY USE[1]

(Percentage of total tons sold)

| | 2015 | | | 2016 | | |
|---|---|---|---|---|---|---|
| | Blast furnace slag[2] | | Steel furnace | Blast furnace slag[2] | | Steel furnace |
| Use | Air-cooled | Granulated | slag | Air-cooled | Granulated | slag |
| Ready-mixed concrete | 7.7 | -- | -- | 18.8 | -- | -- |
| Concrete products | 2.7 | -- | 1.1 | 1.6 | -- | -- |
| Asphaltic concrete | 21.9 | -- | 11.8 | 18.3 | -- | 20.3 |
| Road bases and surfaces | 49.7 | -- | 50.7 | 46.7 | -- | 42.3 |
| Fill | 8.0 | -- | 9.9 | 3.8 | -- | 15.5 |
| Cementitious material | -- | 99.8 | -- | -- | 99.7 | -- |
| Clinker raw material | -- | -- | 2.9 | -- | -- | 2.4 |
| Miscellaneous[3] | 5.8 | 0.2 | 1.3 | 8.2 | 0.3 | 2.0 |
| Other or unspecified[4] | 4.2 | -- | 22.3 | 2.6 | -- | 17.5 |

-- Zero.
[1]Table includes data available through May 16, 2018. A number of respondents provided breakouts that represent only the dominant use(s) of their slag; accordingly, the minor use categories are likely underreported. The data also incorporate some estimates; precision is probably no more than two significant digits.
[2]Excludes expanded or pelletized slag; this material is generally sold as a lightweight aggregate.
[3]Used for railroad ballast, for roofing, for mineral wool, or as a soil conditioner.
[4]Includes return to furnaces (likely underreported) and other uses.

TABLE 4
PROCESSORS OF IRON AND STEEL SLAG IN THE UNITED STATES IN 2016

| | | | Slag and furnace types[3] | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Blast furnace slag | | | Steel furnace slag | | |
| Slag processing company | Plant location | Steel company serviced[1, 2] | AC | GG | Exp | BOF | OHF | EAF |
| Alexander Mill Services Inc. | Hollsopple, PA | North American Höganäs, Inc. | | | | | | X |
| Argos USA Corp. | Tampa, FL | Foreign | | X | | | | |
| Ash Grove Cement Co. | Portland, OR | do. | | X | | | | |
| Barfield Enterprises, Inc. | LaPlace, LA | Bayou Steel Group[4] | | | | | | X |
| Beaver Valley Slag, Inc. | Aliquippa, PA | Old slag pile site | X | | | X | X | |
| Beelman Truck Co. | Granite City, IL[5] | United States Steel Corp. | X | | | | | |
| Beemsterboer Slag Corp. | East Chicago, IN | ArcelorMittal USA ("East side") | X | | | | | |
| Do. | Gary, IN | United States Steel Corp. | X | | | X | | |
| Blackheart Slag Co. | Muscatine (Montpelier), IA | SSAB Americas | | | | | | X |
| City Slag LLC | Sharon (Hermitage), PA | Old slag pile site | | | | | X | |
| Diproinduca (USA) Ltd. | Sparrows Point, MD | Slag pile (former RG Steel LLC) | | | | X | | |
| Dragon Products Co., Inc. | Thomaston, ME | Domestic and foreign | | X | | | | |
| Edw. C. Levy Co. | Butler, IN | Steel Dynamics, Inc. | | | | | | X |
| Do. | Columbia City, IN | do. | | | | | | X |
| Do. | Crawfordsville, IN | Nucor Corp. | | | | | | X |
| Do. | Detroit (Dearborn), MI | AK Steel Corp. | X | | | X | | |
| Do. | Detroit (Ecorse), MI | United States Steel Corp. | X | | | X | | |
| Do. | Columbus, MS | Steel Dynamics, Inc. | | | | | | X |
| Do. | Canton, OH | The Timken Co. | | | | | | X |
| Do. | Delta, OH | North Star BlueScope Steel LLC | | | | | | X |
| Do. | Huger, SC | Nucor Corp. | | | | | | X |
| Do. | Memphis, TN | do. | | | | | | X |
| Do. | Seattle, WA | do. | | | | | | X |
| Essroc Corp. | Camden, NJ[6] | Foreign | | X | | | | |
| Do. | Middlebranch, OH[6] | Miscellaneous domestic and foreign | | X | | | | |
| Fritz Enterprises, Inc. | Fairfield, AL | United States Steel Corp. | X | | | X | | |
| Gerdau Longsteel North America | Jacksonville, FL | Gerdau Long Steel North America | | | | | | X |
| Harsco Metals & Minerals | Blytheville (Armorel), AR | Nucor-Yamato Steel Co. | | | | | | X |
| Do. | Newport, AR | Arkansas Steel Associates, LLC | | | | | | X |
| Do. | Pueblo, CO | Evraz Inc. NA | | | | | | X |
| Do. | Wilton (Muscatine), IA | SSAB Americas | | | | | | X |
| Do. | Pittsboro, IN | Steel Dynamics, Inc. | | | | | | X |
| Do. | Ahoskie (Cofield), NC | Nucor Corp. | | | | | | X |
| Do. | Brackenridge, PA | Allegheny Technologies Inc. (ATI) | | | | | | X |
| Do. | Butler, PA | AK Steel Corp. | | | | | | X |
| Do. | Koppel, PA | TMK IPSCO | | | | | | X |
| Do. | Latrobe (Natrona Heights), PA | Allegheny Technologies Inc. (ATI) | | | | | | X |
| Do. | Steelton, PA | ArcelorMittal USA | | | | | | X |
| Do. | Midlothian, TX | Gerdau Long Steel North America | | | | | | X |
| Do. | Geneva (Provo), UT | Old slag pile site | X | | | | | |
| LafargeHolcim | South Chicago, IL | ArcelorMittal USA | | X | | | | |
| Do. | East Chicago (Indiana Harbor), IN[7] | do. | | X | X | | | |
| Do. | Sparrows Point, MD | Domestic and foreign | | X | | | | |
| Do. | Detroit, MI | do. | | X | | | | |
| Do. | Cleveland (Cuyahoga Co.), OH[5] | ArcelorMittal USA | X | | | | | |
| Do. | Lordstown, OH | Old slag pile site | | | | | X | |
| Do. | West Mifflin (Duquesne), PA | United States Steel Corp. (ET Works) | X | | | | | |
| Do. | Seattle, WA | Foreign | | X | | | | |
| Lehigh Hanson, Inc. | San Francisco, CA | do. | | X | | | | |
| Do. | Cape Canaveral, FL | do. | | X | | | | |
| Do. | Camden, NJ[6] | do. | | X | | | | |
| Do. | Cementon, NY | do. | | X | | | | |
| Do. | Middlebranch, OH[6] | do. | | X | | | | |
| Do. | Evansville, PA | do. | | X | | | | |
| LoMc LLC | Mingo Junction, OH | Old slag pile site | X | | | X | | X |
| Mountain Materials, Inc. | Ashland, KY[5] | AK Steel Corp. | X | | | | | |

See footnotes at end of table.

TABLE 4—Continued

PROCESSORS OF IRON AND STEEL SLAG IN THE UNITED STATES IN 2016

| Slag processing company | Plant location | Steel company serviced[1, 2] | Slag and furnace types[3] | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Blast furnace slag | | | Steel furnace slag | | |
| | | | AC | GG | Exp | BOF | OHF | EAF |
| Phoenix Services, LLC | Blytheville, AR | Nucor Corp. | | | | | | X |
| Do. | Riverdale, IL | ArcelorMittal USA | | | | X | | |
| Do. | Burns Harbor, IN | do. | X | | | X | | |
| Do. | Indiana Harbor, East Chicago, IN | do. ("East" and "West" sides) | X | | | X | | |
| Do. | Wilton, IA | Gerdau Long Steel North America | | | | | | X |
| Do. | Ghent, KY | Gallatin Steel Co. | | | | | | X |
| Do. | Sparrows Point, MD | Slag pile (former RG Steel LLC) | | | | X | | |
| Do. | Cool Springs/Steubenville, OH | Old slag pile site | | | | X | | |
| Do. | Marion, OH | Nucor Corp. | | | | | | X |
| Do. | Johnstown, PA | Old slag pile site | X | | | | | |
| Do. | Latrobe, PA | Latrobe Specialty Steel Co. | | | | | | X |
| Do. | Vinton (El Paso), TX | Vinton Steel, LLC (ex-ArcelorMittal USA)[4] | | | | | | X |
| Do. | Roanoke, VA | Steel Dynamics, Inc. | | | | | | X |
| Do. | Weirton, WV | Old slag pile site | | | | | X | |
| Skyway Cement Co. (Eagle Materials) | Gary, IN | United States Steel Corp. | | X | | | | |
| St. Marys Cement Inc. | Detroit, MI | Foreign | | X | | | | |
| Do. | Milwaukee, WI | do. | | X | | | | |
| Stein, Inc. | Decatur (Trinity), AL | Nucor Corp. | | | | | | X |
| Do. | Alton, IL | Alton Steel Inc. | | | | | | X |
| Do. | Granite City, IL[5] | United States Steel Corp. | X | | | X | | |
| Do. | Sterling, IL | Sterling Steel Co., LLC | | | | | | X |
| Do. | Ashland, KY[5] | AK Steel Corp. | X | | | X | | |
| Do. | Canton, OH | Republic Engineered Products, Inc. | | | | | | X |
| Do. | Cleveland, OH[5] | ArcelorMittal USA | X | | | X | | |
| Do. | Lorain, OH | Republic Engineered Products, Inc. | X | | | X | | X |
| Do. | Mansfield, OH | AK Steel Corp. | | | | X | | |
| Do. | Coatesville, PA | ArcelorMittal USA | | | | | | X |
| Tervita Corp. | Rancho Cucamonga, CA | Gerdau Long Steel North America | | | | | | X |
| TMS International Corp.[8] | Axis, AL | SSAB North America | | | | | | X |
| Do. | Birmingham, AL | Nucor Corp. | | | | | | X |
| Do. | Calvert, AL | Outokumpu Stainless USA, LLC | | | | | | X |
| Do. | Tuscaloosa, AL | Nucor Corp. | | | | | | X |
| Do. | Mesa, AZ | CMC Steel | | | | | | X |
| Do. | Fort Smith, AR | Gerdau Special Steel North America | | | | | | X |
| Do. | Cartersville, GA | Gerdau Long Steel North America | | | | | | X |
| Do. | Kankakee, IL | Nucor Corp. | | | | | | X |
| Do. | Peoria, IL | Keystone Steel & Wire Co. | | | | | | X |
| Do. | Gary, IN | United States Steel Corp. | | | | X | | |
| Do. | Portage, IN | NLMK Indiana | | | | | | X |
| Do. | Jackson, MI | Gerdau Special Steel North America | | | | | | X |
| Do. | Monroe, MI | do. | | | | | | X |
| Do. | St. Paul, MN | Gerdau Long Steel North America | | | | | | X |
| Do. | Jackson, MS | Nucor Corp. | | | | | | X |
| Do. | Norfolk, NE | do. | | | | | | X |
| Do. | Sayreville, NJ | Gerdau Long Steel North America | | | | | | X |
| Do. | Auburn, NY | Nucor Corp. | | | | | | X |
| Do. | Charlotte, NC | Gerdau Long Steel North America | | | | | | X |
| Do. | Middletown, OH | AK Steel Corp. | X | | | X | | |
| Do. | Youngstown, OH | Vallourec Star, LP (ex-V&M Star, LP) | | | | | | X |
| Do. | McMinnville, OR | Cascade Steel Rolling Mills, Inc. | | | | | | X |
| Do. | Braddock, PA | United States Steel Corp. | | | | X | | |
| Do. | Bridgeville, PA | Universal Stainless & Alloy Products, Inc. | | | | | | X |
| Do. | Burnham, PA | Standard Steel | | | | | | X |
| Do. | New Castle, PA | Ellwood Quality Steels Co. | | | | | | X |
| Do. | Park Hill (Johnstown), PA | Old slag pile site | X | | | | X | |
| Do. | Pricedale, PA | do. | X | | | | X | |

See footnotes at end of table.

TABLE 4—Continued
PROCESSORS OF IRON AND STEEL SLAG IN THE UNITED STATES IN 2016

| | | | Slag and furnace types[3] | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Blast furnace slag | | | Steel furnace slag | | |
| Slag processing company | Plant location | Steel company serviced[1, 2] | AC | GG | Exp | BOF | OHF | EAF |
| TMS International Corp.[8]—Continued | Reading, PA | Carpenter Technology Corp. | | | | | | X |
| Do. | Cayce, SC | CMC Steel | | | | | | X |
| Do. | Darlington, SC | Nucor Corp. | | | | | | X |
| Do. | Gallatin, TN | Hoeganaes Corp. | | | | | | X |
| Do. | Jackson, TN | Gerdau Long Steel North America | | | | | | X |
| Do. | Knoxville, TN | do. | | | | | | X |
| Do. | Beaumont, TX | do. | | | | | | X |
| Do. | Jewett, TX | Nucor Corp. | | | | | | X |
| Do. | Lone Star, TX | United States Steel Corp. | | | | | | X |
| Do. | Longview, TX | Nucor Corp. (ex-Joy Global Inc.)[9] | | | | | | X |
| Do. | Seguin, TX | CMC Steel | | | | | | X |
| Do. | Plymouth, UT | Nucor Corp. | | | | | | X |
| Do. | Petersburg, VA | Gerdau Long Steel North America | | | | | | X |
| Do. | Saukville, WI | Charter Steel | | | | | | X |

[1]"Foreign" refers to the fact that the facility imports unground granulated blast furnace slag and grinds it on site to make ground granulated blast furnace slag—commonly now referred to as "slag cement." "Domestic" implies grinding of slag sourced from the domestic market.
[2]Currently operating iron and (or) steel company. Company is not shown for old slag pile sites.
[3]Blast furnace slag type abbreviations: AC = air-cooled; GG = granulated; Exp = expanded. Steel furnace slag types: BOF = basic oxygen furnace; OHF = open hearth furnace; EAF = electric arc furnace.
[4]The LaPlace, LA, and Vinton, TX, plants were sold by ArcelorMittal USA to Black Diamond Capital Management L.L.C. in April 2016, under the name Bayou Steel Group. The Vinton, TX, plant (Bayou Steel Vinton) was subsequently sold to Kyoei Steel Ltd. in December 2016, at which time Kyoei renamed the facility Vinton Steel, LLC.
[5]For the air-cooled slag, Stein, Inc. was responsible for the cooling, but the processing and marketing were handled by Beelman Truck Co. (Granite City, IL), LafargeHolcim (Cleveland, OH), and Mountain Materials, Inc. (Ashland, KY).
[6]The Camden, NJ, and Middlebranch, OH, grinding plants were acquired by Lehigh Hanson, Inc. in July 2016 as part of the purchase by HeidelbergCement AG (Lehigh's parent company) of Italcementi Group (Essroc Corp.'s parent company).
[7]LafargeHolcim ground some of the granulated slag from East Chicago, IN, at some of its cement plants located elsewhere.
[8]Tube City IMS, LLC was renamed TMS International Corp. at the end of February 2016.
[9]Joy Global Inc. sold the Longview, TX, plant to Nucor Corp. in August 2016.