



# 2019 Minerals Yearbook

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## SILICON [ADVANCE RELEASE]

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# SILICON

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Domestic survey data and tables were prepared by Joshua A. Braunstein, statistical assistant.

Domestic production and consumption statistics for silicon metal containing less than 99.9% silicon—silicon metal used as feedstocks for chemical, electronic, and metallurgical applications—were aggregated with those of ferrosilicon in this report to avoid disclosing company proprietary data for both material categories. In 2019, total domestic ferrosilicon and silicon metal production equaled 310,000 metric tons (t) of silicon content (table 1). This was a 28% decrease compared with 2018 production. U.S. exports of all silicon products (on a silicon content basis) decreased to 48,000 t in 2019 from 57,000 t in 2018, a 16% decrease. U.S. imports increased slightly to 251,000 t in 2019 from 256,000 t in 2018. Total U.S. apparent consumption of all silicon materials (on a silicon content basis) was 517,000 t in 2019, a 19% decrease from that in 2018. U.S. annual averages of monthly average spot prices decreased in 2019; silicon metal decreased by 21%, 75%-grade ferrosilicon decreased by 17%, and 50%-grade ferrosilicon decreased slightly compared with the annual average prices in 2018. Combined world production of ferrosilicon and silicon metal increased by 4% to 11.4 million metric tons (Mt) on a gross-weight basis compared with 10.9 Mt (revised) in 2018 (table 7). China was the leading producer of silicon materials, providing 67% of the world total.

Silicon is a light chemical element with metallic and nonmetallic characteristics. Silicon is rarely found free in nature; it combines with oxygen and other elements to form silicates, which compose more than 90% of the Earth's crust. Silica (SiO<sub>2</sub>) as quartz or quartzite is used to produce silicon ferroalloys for the iron and steel industries and silicon metal for the aluminum and chemical industries. Silicon metal may be processed further into ultra-high-purity semiconductor or solar grades; these contain 99.9% or greater silicon. The U.S. Geological Survey (USGS) did not survey the ultra-high-purity silicon industry for production and related data; the only information in this report about these grades came from foreign trade statistics and published sources. Unless otherwise noted, silicon metal in this report refers to silicon metal containing less than 99.9% silicon.

## Production

**Silicon Ferroalloys.**—Domestic gross production data for silicon ferroalloys were withheld to avoid disclosing company proprietary data; they were combined with U.S. silicon metal production statistics and reported as total silicon materials (tables 1, 2). Ferrosilicon was produced in the United States by two companies at three facilities—CC Metals and Alloys, LLC and Ferroglobe PLC. Ferroglobe operated in the United States through two subsidiaries—Globe Metallurgical, Inc. (GMI) and Core Metals Group, LLC (table 3). Ferrosilicon production at the Core Metals plant in Bridgeport, AL, was idled in September with orders transferred to the GMI facility in Beverly, OH, to

streamline operations and adjust production because of reduced demand (Poole, 2019).

**Silicon Metal.**—Production-related statistics for silicon metal were aggregated with domestic silicon ferroalloys to avoid disclosing company proprietary data. Four companies produced silicon metal at four facilities in the United States—DC Alabama, Inc. (a wholly owned subsidiary of The Dow Chemical Co.); GMI; Mississippi Silicon, LLC; and WVA Manufacturing, LLC (a joint venture between Ferroglobe and Dow Chemical) (table 3). GMI shut down and idled, respectively, its silicon metal plants in Niagara Falls, NY, and Selma, AL, at the end of 2018 to improve its global operational and economic efficiency (Gambini, 2018; Poole, 2019).

**Total Silicon Materials.**—Data for all silicon materials that were produced in the United States in 2019—ferrosilicon, miscellaneous silicon alloys, and silicon metal—were derived from company responses to voluntary monthly surveys collected by the USGS. The gross-production data in table 2 were obtained from all operations listed in table 3 that were canvassed by means of the USGS “Silicon Alloys” survey. Annual domestic production of total silicon materials decreased to 419,000 t (310,000 t silicon content) in 2019 from 541,000 t (430,000 t silicon content) in 2018.

**Semiconductor- and Solar-Battery-Grade Silicon.**—Four companies in the United States produced polycrystalline silicon (polysilicon) in 2019—Hemlock Semiconductor Operations, LLC; Mitsubishi Polycrystalline Silicon America Corp.; REC Silicon ASA; and Wacker Polysilicon North America, LLC. Domestic production data for polysilicon were not collected by the USGS. Silicon wafers produced from polysilicon were used in the production of photovoltaic solar cells and to produce monocrystalline silicon for use in semiconductors (Roskill Information Services Ltd., 2019).

## Consumption

**Silicon Ferroalloys and Metal.**—Most ferrosilicon (including miscellaneous silicon alloys) was used to produce steel, whereas the majority of silicon metal consumed in the United States was used in the production of aluminum castings and chemicals such as silicones (table 4). Metallurgical-grade silicon carbide could be substituted for ferrosilicon, especially in iron foundries. Data on North American production and U.S. imports of silicon carbide are reported in the Manufactured Abrasives chapter of the 2019 USGS Minerals Yearbook, volume I, Metals and Minerals, and in the quarterly Mineral Industry Surveys.

In 2019, U.S. apparent consumption of silicon materials (ferrosilicon, miscellaneous silicon alloys, and silicon metal) was 517,000 t of silicon content (table 1). Global apparent consumption of silicon metal was estimated by CRU Bulk Ferroalloys Monitor (2020a, b) to have decreased by 5% to 2.83 Mt in 2019 from 2.97 Mt in 2018. Apparent consumption

of ferrosilicon also was estimated to have decreased by more than 5% to 6.00 Mt (silicon content) in 2019 from 6.35 Mt in 2018. China accounted for 62% of global apparent ferrosilicon consumption during that period.

## Prices

Ferrosilicon and silicon metal prices are affected by changes in supply to, and consumption requirements of, the aluminum, chemical, ferrous foundry, and steel industries. The average annual prices reported by S&P Global Platts in 2019 were 89.15 cents per pound for 75% ferrosilicon and 105.70 cents per pound for silicon metal; prices were 17% and 21% less, respectively, than their average prices in 2018 (table 1). The average annual North American transaction price for 50% ferrosilicon, as calculated from CRU Group weekly listings, was 102.35 cents per pound, a slight decrease from that in 2018.

The monthly average spot price for 50%-grade ferrosilicon was relatively flat throughout 2019, at 102.00 cents per pound for the first three quarters and rising to 104.00 cents per pound in November and December. The monthly average spot price for 75%-grade ferrosilicon began the year at 102.50 cents per pound and decreased over the course of 2019, ending at 76.88 cents per pound in December. The availability of less expensive ferrosilicon from Brazil and Malaysia contributed to the price decline (Bell, 2019). The monthly average spot price for silicon metal also decreased steadily throughout 2019, starting at 116.85 cents per pound in January, falling to 93.63 cents per pound in December.

## Foreign Trade

Trade quantities discussed in this section are based on contained weight basis. Total U.S. ferrosilicon exports decreased by 27% to 8,480 t and their value decreased by 32% to \$21.7 million, from those in 2018. The average unit value of exported ferrosilicon with greater than 55% silicon content (ferrosilicon trade category of “more than 55% silicon”) decreased by 14% in 2019, and exported ferrosilicon with less than 55% silicon content (ferrosilicon trade category of “Other ferrosilicon”) increased by 7% compared with 2018 unit values. The three leading destinations, Canada (3,260 t), Mexico (1,680 t), and Hong Kong (1,480 t), accounted for 76% of total United States ferrosilicon exports in 2019 (table 5). Exports of silicon metal decreased by 11% to 39,600 t, and the value decreased by 21% to \$805 million from that in 2018. The four leading destinations of United States silicon metal, Japan (9,050 t), the Republic of Korea (7,150 t), China (6,020 t), and Germany (5,680 t), accounted for 70% of United States silicon metal exports in 2019. Shipments of ultra-high-purity silicon containing more than 99.99% silicon accounted for 96% of total silicon metal exports and 97% of the total value of combined ferrosilicon and silicon metal exports (table 5).

U.S. ferrosilicon imports decreased by 10% to 127,000 t and the value of those imports decreased by 18% to \$252 million compared with that in 2018 (table 6). All ferrosilicon import trade categories decreased in 2019 compared with those in 2018, except the “80%–90% ferrosilicon” category. Imports of “55%–80% silicon, other” accounted for 91% of total

ferrosilicon quantity and 84% of total ferrosilicon value. The three leading sources of ferrosilicon imports, Russia (46,300 t), Canada (18,300 t), and Malaysia (16,300 t), accounted for 64% of the total ferrosilicon imported into the United States in 2019.

Silicon metal imports (124,000 t) increased by 7% from those in 2018; however, the value decreased by 3% to \$410 million from \$423 million in 2018. Silicon metal in the “99.00%–99.99% silicon” trade category accounted for 76% of the total quantity and 57% of the value of all silicon metal imported in 2019. Brazil (29%) was the leading source of total silicon metal imports, followed by Canada (23%) and Norway (12%) (table 6).

## World Industry Structure

In 2019, on a gross-weight basis, the leading producers of ferrosilicon and silicon metal, combined, were China (7.60 Mt), Russia (906,000 t), Norway (500,000 t), and the United States (419,000 t). Excluding production by the United States, estimated world production of ferrosilicon, on a gross-weight basis, was 7.95 Mt in 2019 compared with 7.23 Mt (revised) in 2018. The major ferrosilicon producers in 2019 were China (67%), Russia (11%), and Norway (4%); together they accounted for 82% of total world ferrosilicon production (table 7).

Estimated world production of silicon metal, excluding that of the United States, was 3.00 Mt in 2019 compared with 3.16 Mt (revised) in 2018 (table 7). China was, by far, the leading producer of silicon metal in the world in 2019 with an estimated 2.30 Mt, 77% of the world total. Other leading producers of silicon metal in 2019 were Brazil (7%), Norway (5%), and France (3%); together with China, these leading producers accounted for 92% of total world silicon metal production (table 7).

## World Review

**China.**—In 2019, China led the world in ferrosilicon and silicon metal production with a combined estimated total of 7.60 Mt (gross weight), 10% more than the 6.90 Mt (revised) produced in 2018 (table 7). China also led the world in consumption of ferrosilicon and silicon metal with an apparent consumption of 3.71 Mt (contained weight) of ferrosilicon and 1.20 Mt of silicon metal in 2019 (CRU Bulk Ferroalloys Monitor, 2020a, b). Silicon metal production capacity in China was estimated to be 7.40 million metric tons per year from almost 300 producers (Roskill Information Services Ltd., 2019).

China’s ferrosilicon exports (386,000 t) were 37% less than those in 2018 (612,000 t) but only 6% less than those in 2017 (410,000 t) (TEX Report, The, 2019, 2020c). The decrease in ferrosilicon exports in 2019 from those in 2018 was attributed to the availability of comparatively lower priced bulk ferroalloys from Malaysia and Russia (Argus Media group—Argus Metals International, 2020). Ferrosilicon containing more than 55% silicon accounted for most of the ferrosilicon exports at 355,000 t (92%). The leading countries of destination for this ferrosilicon grade were Japan (32%) and the Republic of Korea (27%) (TEX Report, The, 2020b). China’s silicon metal exports decreased by 15% to 695,000 t in 2019 from 815,000 t in 2018. The leading countries of destination for silicon metal

from China were Japan (24%) and the Republic of Korea (17%) (TEX Report, The, 2020a).

**France.**—FerroPem SAS, a fully owned subsidiary of FerroGlobe PLC, was the sole ferrosilicon and silicon metal producer in France. Owing to low spot prices, FerroPem reduced production of both ferrosilicon and silicon metal at its Château-Feuillet, Laudun, and Montricher plants (Argus Media group—Argus Metals International, 2019b; Poole, 2019).

**Malaysia.**—OM Materials Sarawak SDN BHD, the only ferrosilicon producer in Malaysia, operated 16 furnaces, 10 of which were dedicated to ferrosilicon production. Production in 2019 was 231,000 t, almost 5% greater than that of the previous year, exceeding the company's capacity of 200,000 to 221,000 metric tons per year (t/yr) (Macmillan, 2020; OM Holdings Ltd., 2020, p. 11).

**Russia.**—Russia exported 381,000 t of ferrosilicon in 2019, 11% less than the 428,000 t exported in 2018. Ferrosilicon containing more than 55% silicon accounted for 96% of the total ferrosilicon exported by Russia in 2019. Japan was the leading recipient of Russia's exported ferrosilicon of this grade, receiving 132,000 t in 2019. Russia imported 40,000 t of ferrosilicon, 13% more than the amount imported in 2018 (TEX Report, The, 2020d, e).

**South Africa.**—FerroGlobe PLC, which produced approximately 90% of South Africa's ferrosilicon and was the country's sole silicon metal producer, temporarily idled silicon metal production at its Polokwane plant in August to streamline operations and adjust production because of reduced demand. FerroGlobe's sales value in South Africa decreased by almost 35% compared with sales in 2018 owing to a decrease in average selling price and a decrease in sales volume owing to the temporary shutdown at Polokwane (FerroGlobe PLC, 2019, 2020, p. 73; Roskill Information Services Ltd., 2019).

**Spain.**—FerroGlobe PLC, the only ferrosilicon and silicon metal producer in Spain, sold its Cee-Dumbria ferroalloys plant, with a combined capacity of 80,000 t/yr, in August (Argus Media group—Argus Metals International, 2019b; Roskill Information Services Ltd., 2019). FerroGlobe reduced its output of ferrosilicon at its operations in Europe owing to low prices. Ferrosilicon price decreases in Europe in 2019 were attributed to the availability of lower priced ferrosilicon from Bhutan, Egypt, Iran, Kazakhstan, and Malaysia and a decrease in demand from steel producers in Europe owing to an increase in lower priced steel imports from China and Turkey (Argus Media group—Argus Metals International, 2019a).

## Outlook

Domestic and global consumption of ferrosilicon are expected to closely follow the trends in steel production. Details of the outlook for the steel industry are discussed in the "Outlook" section of the Iron and Steel chapter of the 2019 USGS Minerals Yearbook, volume I, Metals and Minerals.

Global crude steel production in 2019 was 1.87 billion metric tons (Gt), compared with 1.81 Gt in 2018 (World Steel Association, 2020a, p. 9). China, the world's leading producer of crude steel, produced 996 Mt in 2019, an 8% increase from the 920 Mt produced in 2018. U.S. crude steel production in 2019 was 87.8 Mt, a slight increase compared with 86.6 Mt

produced in 2018. World apparent consumption of finished steel products increased by 3% to 1.77 Gt in 2019 (World Steel Association, 2020a, p. 17). China, the leading world consumer of steel products, increased steel consumption by 9% to 908 Mt in 2019 from 836 Mt in 2018. The combined steel consumption in China, India, Japan, the Republic of Korea, and the United States increased by 6% to 1,220 Mt from 1,150 Mt; these five countries accounted for about 69% of the world total in 2019. The World Steel Association's short-range forecast for global steel consumption is 1.65 Gt in 2020 and 1.72 Gt in 2021 (World Steel Association, 2020b).

Consumption for silicon metal comes primarily from the aluminum and chemical industries and in the production of polysilicon, which is used for solar cells and semiconductors. Domestic aluminum casting sales by the U.S. aluminum castings industry are projected to increase by 2.2% annually from 2018 to 2021 and by 3.4% annually from 2018 to 2027 (Modern Casting, 2020, p. 25). Global consumption of silicones is forecast to increase by 4.6% annually through 2023 (Freedonia Group, Inc., The, 2019).

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TABLE 1  
SALIENT SILICON STATISTICS<sup>1,2</sup>

(Silicon content, unless otherwise specified)

	2015	2016	2017	2018	2019
<b>United States:</b>					
<b>Production:</b>					
Ferrosilicon	thousand metric tons	W	W	W	W
Silicon metal <sup>3</sup>	do.	W	W	W	W
Total silicon materials <sup>4</sup>	do.	411	384	415	430
<b>Exports:</b>					
Ferrosilicon	do.	9	7	11	8
Silicon metal	do.	37	60	71	45
<b>Imports for consumption:</b>					
Ferrosilicon	do.	162	155	147	140
Silicon metal	do.	140	122	136	116
<b>Apparent consumption:<sup>5</sup></b>					
Ferrosilicon	do.	W	W	W	W
Silicon metal <sup>3</sup>	do.	W	W	W	W
Total silicon materials <sup>4</sup>	do.	661	601	616	637
<b>Price, average:</b>					
Ferrosilicon, 50% Si <sup>6</sup>	cents per pound	101.19	82.70	94.47	104.24
Ferrosilicon, 75% Si <sup>7</sup>	do.	88.11	70.76	86.88	107.58
Silicon metal <sup>7</sup>	do.	126.63	91.14	116.56	134.15
<b>World production, gross weight:</b>					
Ferrosilicon <sup>8</sup>	thousand metric tons	7,450 <sup>r</sup>	6,960 <sup>r</sup>	6,130 <sup>r</sup>	7,230 <sup>r</sup>
Silicon metal <sup>9</sup>	do.	2,600 <sup>r</sup>	2,860 <sup>r</sup>	2,890 <sup>r</sup>	3,160 <sup>r</sup>
U.S. total silicon materials <sup>4</sup>	do.	514	471	518	541
Total silicon materials <sup>4,10</sup>	do.	10,600 <sup>r</sup>	10,300 <sup>r</sup>	9,530 <sup>r</sup>	10,900 <sup>r</sup>

<sup>r</sup>Revised. do. Ditto. W Withheld to avoid disclosing company proprietary data.

<sup>1</sup>Table includes data available through July 8, 2020. Data are rounded to no more than three significant digits, except prices; may not add to totals shown.

<sup>2</sup>Includes U.S. Geological Survey estimates.

<sup>3</sup>Does not include semiconductor and solar grades of silicon metals.

<sup>4</sup>Includes ferrosilicon, miscellaneous silicon alloys, and silicon metal, excluding semiconductor and solar grades.

<sup>5</sup>Defined as production plus imports for consumption minus exports plus adjustments for industry stock changes.

<sup>6</sup>CRU Group transaction prices based on weekly averages.

<sup>7</sup>S&P Global Platts mean import prices based on monthly averages.

<sup>8</sup>Does not include production of ferrosilicon in the United States.

<sup>9</sup>Does not include production of silicon in the United States.

<sup>10</sup>Includes total gross production of ferrosilicon and silicon metal in the United States. In previous reports, U.S. production was reported as net production in this total.

TABLE 2  
 PRODUCTION, SHIPMENTS, AND STOCKS OF SILICON  
 ALLOYS AND METAL IN THE UNITED STATES<sup>1, 2, 3</sup>

(Metric tons, gross weight)

	Gross production <sup>4</sup>	Net shipments	Producers' <sup>7</sup> stocks, December 31
2018:			
Ferrosilicon	W	W	W
Silicon metal	W	W	W
Total silicon materials	541,000	364,000	24,000
2019:			
Ferrosilicon	W	W	W
Silicon metal	W	W	W
Total silicon materials	419,000	321,000	18,900

W Withheld to avoid disclosing company proprietary data.

<sup>1</sup>Table includes data available through July 8, 2020. Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>Includes U.S. Geological Survey estimates.

<sup>3</sup>Includes ferrosilicon, miscellaneous silicon alloys, and silicon metal, excluding semiconductor and solar grades.

<sup>4</sup>Ferrosilicon production includes material consumed in the production of miscellaneous silicon alloys.

TABLE 3  
 PRINCIPAL PRODUCERS OF SILICON ALLOYS AND (OR) SILICON  
 METAL IN THE UNITED STATES IN 2019<sup>1</sup>

Producer	Plant location	Product
CC Metals and Alloys, LLC	Calvert City, KY	Ferrosilicon.
Core Metals Group, LLC <sup>2</sup>	Bridgeport, AL	Do.
DC Alabama, Inc. <sup>3</sup>	Mt. Meigs, AL	Silicon metal.
Globe Metallurgical, Inc. <sup>2</sup>	Beverly, OH	Ferrosilicon and silicon metal.
Mississippi Silicon, LLC <sup>4</sup>	Burnsville, MS	Silicon metal.
WVA Manufacturing, LLC <sup>5</sup>	Alloy, WV	Do.

Do. Ditto.

<sup>1</sup>Silicon metal producers do not include semiconductor- and solar-grade silicon manufacturers.

<sup>2</sup>A wholly owned subsidiary of Ferroglobe PLC.

<sup>3</sup>A wholly owned subsidiary of The Dow Chemical Co.

<sup>4</sup>Owned by Rima Industrial S.A. and CleanTech, LLC.

<sup>5</sup>A joint venture between Ferroglobe PLC and The Dow Chemical Co.

TABLE 4  
 REPORTED CONSUMPTION, BY END USE, AND STOCKS OF SILICON FERROALLOYS AND METAL IN THE  
 UNITED STATES IN 2019<sup>1,2</sup>

(Metric tons, gross weight)

End use	Silvery pig iron <sup>3</sup>	Ferrosilicon, 50% <sup>4</sup>	Ferrosilicon, 75% <sup>5</sup>	Silicon metal <sup>6</sup>	Miscellaneous silicon alloys <sup>7</sup>	Silicon carbide <sup>8</sup>
<b>Steel:</b>						
Carbon and high-strength, low-alloy	21	W	28,800	W	(9)	1,280
Stainless and heat-resisting	--	W	43,200	370	(9)	W
Full alloy	--	W	7,430	W	(9)	--
Electric steel	--	--	W	--	--	W
Electric and tool	--	--	W	--	--	--
Unspecified	--	--	W	W	544	--
Total	21	W	112,000	1,740	544	W
Cast irons	W	18,800	24,200	(10)	13,900	17,500
Superalloys	--	(11)	(12)	48	--	--
Welding and alloy hard-facing rods and materials	--	(11)	--	14	--	--
Wear- and corrosion-resistant alloys	--	--	(12)	(10)	(11)	--
Aluminum alloys	--	--	(12)	(10)	--	--
Copper alloys	--	--	--	(10)	--	--
Nickel alloys	--	--	(12)	4	(11)	--
Tungsten alloys	--	--	--	(10)	--	--
Chemical carbides	--	--	--	--	(11)	--
Other alloys, excluding superalloys and alloy steel	--	(11)	--	21,000 <sup>13</sup>	(11)	--
Miscellaneous and unspecified	--	--	271	W <sup>14</sup>	(11)	--
Grand total	W	66,600	136,000	207,000	14,400	22,800
Consumers' stocks, December 31	97	855	9,560	12,700	708	1,200

W Withheld to avoid disclosing company proprietary data. -- Zero.

<sup>1</sup>Table includes data available through July 8, 2020. Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>Includes U.S. Geological Survey estimates.

<sup>3</sup>Typically 18% silicon content but ranges between 5% and 24% silicon content.

<sup>4</sup>Typically 48% silicon content but ranges between 25% and 55% silicon content; includes briquets.

<sup>5</sup>Typically 76% silicon content but ranges between 56% and 95% silicon content; includes briquets.

<sup>6</sup>Typically 98% silicon content but ranges between 96% and 99% silicon content.

<sup>7</sup>Typically 48% silicon content. Primarily magnesium-ferrosilicon but also includes other silicon alloys.

<sup>8</sup>Typically 64% silicon content but ranges between 63% and 70% silicon content. Does not include silicon carbide for abrasive or refractory uses.

<sup>9</sup>Included with "Steel: Unspecified" to avoid disclosing company proprietary data.

<sup>10</sup>Included with "Other alloys, excluding superalloys and alloy steel" to avoid disclosing company proprietary data.

<sup>11</sup>Included with "Cast irons" to avoid disclosing company proprietary data.

<sup>12</sup>Included with "Miscellaneous and unspecified" to avoid disclosing company proprietary data.

<sup>13</sup>Primarily aluminum alloys.

<sup>14</sup>Primarily silicones and other chemicals.



TABLE 5  
U.S. EXPORTS OF FERROSILICON AND SILICON METAL IN 2019<sup>1,2</sup>

(Metric tons, unless otherwise specified)

Country or locality	Gross weight	Silicon content	Value
<b>Ferrosilicon:</b>			
<b>More than 55% silicon:</b>			
Brazil	24	14	\$37,000
Canada	5,140	3,080	7,040,000
Dominican Republic	39	23	86,200
Germany	62	37	63,000
Hong Kong	2,470	1,480	1,370,000
Malaysia	20	12	24,000
Mexico	1,680	1,030	3,600,000
South Africa	171	125	174,000
Sweden	200	120	242,000
United Kingdom	21	12	30,900
Other [6 countries and (or) localities]	26	16	45,600
<b>Total</b>	<b>9,850</b>	<b>5,960</b>	<b>12,700,000</b>
<b>Other ferrosilicon:</b>			
Belgium	536	244	529,000
Brazil	430	215	836,000
Canada	346	173	523,000
France	200	91	312,000
Korea, Republic of	580	253	661,000
Luxembourg	218	101	341,000
Mexico	1,630	649	3,060,000
Spain	260	130	446,000
Turkey	299	140	522,000
United Kingdom	775	351	1,280,000
Other [8 countries and (or) localities]	374	173	506,000
<b>Total</b>	<b>5,650</b>	<b>2,520</b>	<b>9,020,000</b>
<b>Total ferrosilicon</b>	<b>15,500</b>	<b>8,480</b>	<b>21,700,000</b>
<b>Metal:</b>			
<b>More than 99.99% silicon:</b>			
China	5,860	5,860	53,700,000
Germany	5,680	5,680	95,000,000
Hong Kong	820	820	4,360,000
Japan	9,040	9,040	357,000,000
Korea, Republic of	7,110	7,110	146,000,000
Malaysia	671	671	28,200,000
Norway	985	985	6,220,000
Taiwan	3,310	3,310	43,500,000
United Kingdom	270	270	5,670,000
Vietnam	3,640	3,640	51,200,000
Other [41 countries and (or) localities]	509	509	11,200,000
<b>Total</b>	<b>37,900</b>	<b>37,900</b>	<b>803,000,000</b>
<b>99.00–99.99% silicon:</b>			
Argentina	18	18	25,900
China	5	5	7,640
Dominican Republic	5	5	6,800
France	10	10	14,300
India	7	7	10,400
Japan	2	2	2,660
Mexico	24	24	59,500
Netherlands	58	58	59,200
Taiwan	2	2	2,780
United Kingdom	244	206	343,000
<b>Total</b>	<b>376</b>	<b>338</b>	<b>532,000</b>

See footnotes at end of table.

TABLE 5—Continued  
 U.S. EXPORTS OF FERROSILICON AND SILICON METAL IN 2019<sup>1,2</sup>

(Metric tons, unless otherwise specified)

Country or locality	Gross weight	Silicon content	Value
Metal:—Continued			
Other silicon:			
Belgium	391	380	483,000
Canada	228	221	491,000
China	168	163	225,000
France	22	22	21,200
Japan	12	11	15,600
Korea, Republic of	37	36	60,700
Mexico	40	39	134,000
Netherlands	409	397	465,000
South Africa	114	110	181,000
United Kingdom	14	14	78,100
Other [9 countries and (or) localities]	20	19	197,000
Total	1,450	1,410	2,350,000
Total silicon metal	39,700	39,600	805,000,000

<sup>1</sup>Table includes data available through June 25, 2020. Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>Countries and (or) localities listed are the leading importers in terms of quantity (gross weight).

Source: U.S. Census Bureau.

TABLE 6  
U.S. IMPORTS FOR CONSUMPTION OF FERROSILICON AND SILICON METAL IN 2019<sup>1,2</sup>

(Metric tons, unless otherwise specified)

Country or locality	Gross weight	Silicon content	Value
<b>Ferrosilicon:</b>			
<b>55%–80% silicon, more than 3% Ca:</b>			
Azerbaijan	48	37	\$50,600
Brazil	691	517	773,000
China	229	147	545,000
France	612	381	1,750,000
Germany	4	3	11,600
India	19	12	51,000
South Africa	112	70	262,000
Total	1,720	1,170	3,440,000
<b>55%–80% silicon, other:</b>			
Brazil	17,000	12,800	20,100,000
Canada	13,600	9,880	29,000,000
France	1,420	1,000	7,890,000
Iceland	13,000	10,200	15,500,000
Kazakhstan	10,800	8,290	15,200,000
Kuwait	804	614	849,000
Malaysia	21,300	16,300	25,800,000
Paraguay	8,300	6,510	10,200,000
Russia	60,800	46,200	74,800,000
South Africa	2,330	1,630	4,920,000
Other [8 countries and (or) localities]	2,150	1,580	6,430,000
Total	152,000	115,000	211,000,000
80–90% ferrosilicon, Brazil	566	484	727,000
<b>More than 90% ferrosilicon:</b>			
Bosnia and Herzegovina	37	34	60,200
Brazil	185	176	389,000
Total	222	210	449,000
<b>Magnesium ferrosilicon:</b>			
Argentina	470	214	518,000
Brazil	178	83	233,000
Canada	10,900	5,000	19,900,000
China	31	16	66,500
France	72	36	21,700
Germany	86	27	245,000
India	1,050	439	1,390,000
Norway	176	82	345,000
Thailand	75	34	130,000
Total	13,000	5,930	22,900,000
<b>Other ferrosilicon:</b>			
Canada	9,920	3,440	11,900,000
China	139	55	277,000
France	62	28	142,000
Germany	17	6	86,700
India	328	139	490,000
Mexico	14	6	23,200
Russia	197	96	384,000
Slovakia	332	68	560,000
Turkey	22	10	15,500
United Kingdom	10	5	89,000
Other [2 countries and (or) localities]	9	4	16,200
Total	11,100	3,850	14,000,000
Total ferrosilicon	178,000	127,000	252,000,000

See footnotes at end of table.

TABLE 6—Continued  
 U.S. IMPORTS FOR CONSUMPTION OF FERROSILICON AND SILICON METAL IN 2019<sup>1,2</sup>

(Metric tons, unless otherwise specified)

Country or locality	Gross weight	Silicon content	Value
<b>Metal:</b>			
<b>More than 99.99% silicon:</b>			
Brazil	3,610	3,610	10,800,000
China	67	67	8,050,000
Denmark	4	4	16,900,000
Finland	2	2	644,000
Germany	493	493	29,200,000
Japan	755	755	35,300,000
Korea, Republic of	11	11	334,000
Norway	52	52	490,000
Taiwan	242	242	20,600,000
Ukraine	2	2	121,000
Other [12 countries and (or) localities]	3	3	219,000
<b>Total</b>	<b>5,240</b>	<b>5,240</b>	<b>123,000,000</b>
<b>99.00%-99.99% silicon:</b>			
Australia	4,170	4,140	10,000,000
Bosnia and Herzegovina	9,260	9,200	18,700,000
Brazil	21,100	20,900	53,400,000
Canada	27,600	27,400	75,100,000
Iceland	5,260	5,220	9,810,000
Kazakhstan	7,450	7,380	14,400,000
Laos	2,920	2,890	6,990,000
Malaysia	3,230	3,210	5,670,000
Norway	8,210	8,150	23,800,000
Thailand	5,550	5,520	13,600,000
Other [7 countries and (or) localities]	563	559	1,300,000
<b>Total</b>	<b>95,300</b>	<b>94,600</b>	<b>233,000,000</b>
<b>Other silicon:</b>			
Australia	2,690	2,580	6,730,000
Bosnia and Herzegovina	341	324	771,000
Brazil	11,500	11,200	27,300,000
Canada	1,060	1,030	2,670,000
France	285	273	459,000
Iceland	1,080	1,060	1,740,000
Japan	342	329	453,000
Kazakhstan	326	315	494,000
Netherlands	312	302	870,000
Norway	6,350	6,220	10,400,000
Other [10 countries and (or) localities]	861	835	2,390,000
<b>Total</b>	<b>25,100</b>	<b>24,500</b>	<b>54,200,000</b>
<b>Total silicon metal</b>	<b>126,000</b>	<b>124,000</b>	<b>410,000,000</b>

<sup>1</sup>Table includes data available through June 25, 2020. Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>Countries and (or) localities listed are the leading importers in terms of quantity (gross weight).

Source: U.S. Census Bureau.

TABLE 7  
FERROSILICON AND SILICON METAL: WORLD PRODUCTION, BY COUNTRY OR LOCALITY<sup>1,2</sup>

(Metric tons, gross weight)

Country or locality <sup>3</sup>	2015	2016	2017	2018	2019
Argentina, ferrosilicon <sup>c</sup>	12,700	12,000	13,000	13,000	13,000
Australia, silicon metal <sup>e</sup>	48,000	48,000	50,000	40,000	40,000
Bhutan, ferrosilicon <sup>4</sup>	104,406	106,234	108,410 <sup>r</sup>	120,857 <sup>r</sup>	138,616
Bosnia and Herzegovina:					
Ferrosilicon	--	--	--	10,000 <sup>r, e</sup>	5,000 <sup>e</sup>
Silicon metal	18,716	28,138	30,473	29,000 <sup>e</sup>	27,000 <sup>e</sup>
Brazil: <sup>e</sup>					
Ferrosilicon	119,000 <sup>r</sup>	226,000 <sup>r</sup>	185,000 <sup>r</sup>	221,000 <sup>r</sup>	225,000
Silicon metal	104,000 <sup>r</sup>	194,000 <sup>r</sup>	164,000 <sup>r</sup>	203,000 <sup>r</sup>	200,000
Canada: <sup>e</sup>					
Ferrosilicon	38,000	38,000	40,000	36,000	37,000
Silicon metal	30,000	27,000	28,300	34,000	34,000
China:					
Ferrosilicon	4,730,000	4,300,000	3,650,000	4,500,000 <sup>r</sup>	5,300,000 <sup>e</sup>
Silicon metal	1,954,000	2,101,000	2,205,000 <sup>r</sup>	2,400,000 <sup>e</sup>	2,300,000 <sup>e</sup>
Egypt, ferrosilicon <sup>5</sup>	56,093	60,477	60,500 <sup>e</sup>	60,500 <sup>e</sup>	60,500 <sup>e</sup>
France: <sup>e</sup>					
Ferrosilicon	40,000	50,000	50,000	50,000	48,000
Silicon metal	123,000 <sup>r</sup>	151,000 <sup>r</sup>	149,000 <sup>r</sup>	138,000 <sup>r</sup>	100,000
Germany, silicon metal <sup>e</sup>	30,500	30,500	30,000	30,000	30,000
Iceland:					
Ferrosilicon	121,556	128,020	116,811	116,889	117,000
Silicon metal	--	--	7,160	7,036	12,000
India, ferrosilicon	92,000 <sup>6</sup>	90,000 <sup>6</sup>	90,000	90,000 <sup>r</sup>	93,000 <sup>e</sup>
Kazakhstan:					
Ferrosilicon	86,984	68,779	60,001 <sup>r</sup>	65,405 <sup>r</sup>	65,400 <sup>e</sup>
Silicon metal	866	--	--	-- <sup>e</sup>	-- <sup>e</sup>
Korea, Republic of, ferrosilicon <sup>c</sup>	30,000	30,000	30,000	30,000	30,000
Laos, silicon metal <sup>7</sup>	5,673	6,836	1,886 <sup>r</sup>	8,873 <sup>r</sup>	4,382
Malaysia, ferrosilicon	104,554	126,261	174,540	220,515	230,735
North Macedonia, ferrosilicon	45,698	24,431	21	--	-- <sup>e</sup>
Norway: <sup>e</sup>					
Ferrosilicon	350,000	350,000	350,000	350,000	350,000
Silicon metal	150,000	150,000	150,000	150,000	150,000
Paraguay, ferrosilicon	--	--	--	8,000 <sup>e</sup>	10,000 <sup>e</sup>
Poland, ferrosilicon	77,754	77,682	65,732	63,618 <sup>r</sup>	37,500 <sup>e</sup>
Russia:					
Ferrosilicon	1,057,909	935,912	840,352 <sup>r</sup>	928,797 <sup>r</sup>	846,579
Silicon metal	60,000 <sup>e</sup>	59,300	59,300 <sup>e</sup>	59,300 <sup>e</sup>	59,300 <sup>e</sup>
Slovakia, ferrosilicon	45,961	38,030	52,436	50,392 <sup>r</sup>	50,400 <sup>e</sup>
South Africa:					
Ferrosilicon	91,800	73,200	48,200 <sup>r</sup>	98,000 <sup>r, e</sup>	98,000 <sup>e</sup>
Silicon metal	46,300	26,600	4,700 <sup>r</sup>	51,000 <sup>r, e</sup>	33,000 <sup>e</sup>
Spain: <sup>e</sup>					
Ferrosilicon	80,000	80,000	95,000	95,000	90,000
Silicon metal	24,000	30,000	7,500	7,500	7,500
Turkey, ferrosilicon <sup>8</sup>	1,400	2,900	2,900	3,500	3,000
Ukraine, ferrosilicon	90,200	101,420	92,910	97,084 <sup>r</sup>	97,100 <sup>e</sup>
United States, ferrosilicon and silicon materials <sup>9</sup>	514,000	471,000	518,000	541,000	419,000
Uzbekistan, silicon metal <sup>e</sup>	5,000	3,000	3,000	-- <sup>r</sup>	--
Venezuela, ferrosilicon <sup>e</sup>	74,300	37,000	--	--	--
Total	10,600,000 <sup>r</sup>	10,300,000 <sup>r</sup>	9,530,000 <sup>r</sup>	10,900,000 <sup>r</sup>	11,400,000
Of which:					
Ferrosilicon <sup>10</sup>	7,450,000 <sup>r</sup>	6,960,000 <sup>r</sup>	6,130,000 <sup>r</sup>	7,230,000 <sup>r</sup>	7,950,000
Silicon metal <sup>11</sup>	2,600,000 <sup>r</sup>	2,860,000 <sup>r</sup>	2,890,000 <sup>r</sup>	3,160,000 <sup>r</sup>	3,000,000
U.S. total silicon materials <sup>9</sup>	514,000	471,000	518,000	541,000	419,000

See footnotes at end of table.

TABLE 7—Continued  
FERROSILICON AND SILICON METAL: WORLD PRODUCTION, BY COUNTRY OR LOCALITY<sup>1,2</sup>

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<sup>6</sup>Estimated. <sup>7</sup>Revised. -- Zero.

<sup>1</sup>Table includes data available through July 22, 2020. All data are reported unless otherwise noted. Totals, U.S. data, and estimated data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>Does not include semiconductor and solar grades of silicon metal.

<sup>3</sup>In addition to the countries and (or) localities listed, Iran and Uruguay may have produced ferrosilicon and Thailand may have produced silicon metal, but available information was inadequate to make reliable estimates of output.

<sup>4</sup>Imports received to all countries and (or) localities from Bhutan. Source: UN Comtrade.

<sup>5</sup>Production is based on fiscal year, with a starting date of July 1 of the year shown.

<sup>6</sup>Production is based on fiscal year, with a starting date of April 1 of the year shown.

<sup>7</sup>Imports received to all countries and (or) localities from Laos. Source: UN Comtrade.

<sup>8</sup>Exports. Source: UN Comtrade.

<sup>9</sup>Includes total U.S. gross production of ferrosilicon and silicon metal. In previous reports, U.S. production was reported as net production.

<sup>10</sup>Does not include U.S. production of ferrosilicon.

<sup>11</sup>Does not include U.S. production of silicon metal.