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2020 Minerals Yearbook

SILICON [ADVANCE RELEASE]

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Silicon

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Domestic 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 to avoid disclosing company proprietary data for both material categories. In 2020, the silicon content of total domestic ferrosilicon and silicon metal production was 277,000 metric tons (t) (table 1). This was an 11% decrease compared with 2019 production. On the basis of silicon content, U.S. exports of all silicon products decreased by 27% to 35,000 t in 2020 from 48,000 t in 2019. U.S. imports decreased by 6% to 237,000 t in 2020 from 251,000 t in 2019. Total U.S. apparent consumption of all silicon materials, on the basis of silicon content, was 481,000 t in 2020, a 7% decrease from that in 2019 (table 1). In 2020, U.S. annual averages of monthly average spot prices of 75%-grade ferrosilicon and silicon metal decreased slightly and by 8%, respectively, and the annual average 50%-grade ferrosilicon price increased slightly compared with the annual average price in 2019. Combined world production of ferrosilicon and silicon metal decreased by 5% to 11.0 million metric tons (Mt) on a gross-weight basis compared with 11.6 Mt (revised) in 2019 (table 7). China was the leading producer of silicon materials, providing 68% 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_2) 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) does not survey the ultra-high-purity silicon industry for production and related data; the only information in this report about these grades is 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). On July 1, CC Metals and Alloys shut down its Calvert City, KY, plant owing to adverse market conditions stemming from the global coronavirus disease 2019 (COVID-19) pandemic as well as competition from lower priced ferrosilicon imports. It was unknown when operations would resume (Schumacher, 2020).

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 The Dow Chemical Co.) (table 3).

Total Silicon Materials.—Data for all silicon materials that were produced in the United States in 2020—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 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 361,000 t (277,000 t silicon content) in 2020 from 419,000 t (310,000 t silicon content) in 2019 (table 1).

Semiconductor- and Solar-Battery-Grade Silicon.—Four companies in the United States produced polycrystalline silicon (polysilicon) in 2020—Hemlock Semiconductor Operations, LLC; Mitsubishi Polycrystalline Silicon America Corp.; REC Silicon ASA; and Wacker Polysilicon North America, LLC. Domestic production data 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.—A second USGS survey covered a broad range of metal-consuming companies, such as aluminum, nonferrous-alloy, and steel producers. 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 as well as chemicals such as silicones (table 4). Metallurgical-grade silicon carbide can 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 2020 USGS Minerals Yearbook, volume I, Metals and Minerals, and in the quarterly Mineral Industry Surveys.

In 2020, U.S. apparent consumption of silicon materials (ferrosilicon, miscellaneous silicon alloys, and silicon metal) decreased to 481,000 t of silicon content (table 1). Global apparent consumption of silicon metal was estimated by CRU Bulk Ferroalloys Monitor to have decreased by about 4% to 2.72 Mt in 2020 from 2.83 Mt in 2019. Apparent consumption

of ferrosilicon also was estimated to have decreased by approximately 4% to 5.63 Mt of silicon content in 2020 from 5.87 Mt in 2019. China accounted for about 66% of global apparent ferrosilicon consumption in 2020 (CRU Bulk Ferroalloys Monitor, 2021a, b).

Prices

Ferrosilicon and silicon metal prices were affected by changes in supply to and consumption requirements of the aluminum, chemical, ferrous foundry, and steel industries. The average annual spot prices reported by S&P Global Platts Metals Week in 2020 were 87.40 cents per pound for 75%-grade ferrosilicon and 96.84 cents per pound for silicon metal; prices were slightly less and 8% less, respectively, than the average prices in 2019 (table 1). The average annual North American transaction price for 50%-grade ferrosilicon, as calculated from CRU Group weekly listings, was 103.38 cents per pound, a slight increase from that in 2019.

The monthly average spot price for 50%-grade ferrosilicon was relatively flat throughout 2020, at 104.00 cents per pound for the first 7 months of the year and falling to 102.50 cents per pound in August through December. The monthly average spot price for 75%-grade ferrosilicon began the year at 78.00 cents per pound and increased through May. For the remainder of the year, the monthly average price decreased until December, when the average price increased to 92.60 cents per pound. The monthly average spot price for silicon metal was also relatively flat throughout the year, ranging from 94.70 to 96.75 cents per pound during the first 10 months of 2020, and then increasing to 105.30 cents per pound by the end of 2020.

Foreign Trade

Trade quantities discussed are based on silicon content. Total U.S. ferrosilicon exports decreased by 48% to 4,400 t, and their value decreased by 35% to $14.2 million, from those in 2019. The annual average unit value of exported ferrosilicon with greater than 55% silicon content (ferrosilicon trade category of "more than 55% silicon") increased by 28% in 2020, and the annual average unit value of exported ferrosilicon with less than 55% silicon content (ferrosilicon trade category of "other ferrosilicon") increased by 7% in 2020 compared with 2019 annual average unit values. The two leading destinations, Mexico (1,990 t) and Canada (1,190 t), accounted for 72% of total United States ferrosilicon exports in 2020 (table 5). Exports of silicon metal decreased by 21% to 31,400 t, though their value increased slightly to $817 million from that in 2019. The four leading destinations of United States silicon metal—Japan (9,040 t), Germany (5,480 t), Vietnam (4,600 t), and the Republic of Korea (4,200 t)—accounted for 74% of United States silicon metal exports in 2020. Shipments of ultra-high-purity silicon containing more than 99.99% silicon accounted for 94% of total silicon metal exports and 98% of the total value of combined ferrosilicon and silicon metal exports (table 5).

U.S. ferrosilicon imports increased by 11% to 140,000 t, and the value of those imports decreased by 5% to $240 million compared with that in 2019. The annual average unit value of total imported ferrosilicon decreased by 14% in 2020 compared with the 2019 annual average unit value. All ferrosilicon import trade categories decreased in 2020 compared with 2019, with the exception of "55%–80% silicon, other" which increased. Imports of "55%–80% silicon, other" accounted for 93% of total ferrosilicon imports and 86% of total ferrosilicon value. The three leading sources of ferrosilicon imports—Russia (49,000 t), Brazil (22,000 t), and Canada (18,600 t)—accounted for 64% of the total ferrosilicon imported into the United States in 2020 (table 6).

Silicon metal imports (96,900 t) decreased by 22% from those in 2019, and the value of those imports decreased by 32% to $277 million from $410 million in 2019. However, the annual average unit value of imported silicon metal from the "more than 99.99% silicon" trade category increased by 85% to $43,400 per metric ton compared with $23,400 per metric ton in 2019. Silicon metal in the "99.00%–99.99% silicon" trade category accounted for 76% of the total quantity and 55% of the value of all silicon metal imported in 2020. The four leading sources of silicon metal imports—Brazil (26,900 t), Canada (21,200 t), Norway (13,600 t), and Malaysia (10,000 t)—accounted for 74% of the total silicon metal imported into the United States in 2020 (table 6).

World Industry Structure

In 2020, on a gross-weight basis, the leading producers of ferrosilicon and silicon metal, combined, were China (7.50 Mt), Russia (857,000 t), Brazil (520,000 t), Norway (460,000 t), and the United States (361,000 t). Excluding production by the United States, estimated world production of ferrosilicon, on a gross-weight basis, was 7.77 Mt in 2020 compared with 8.18 Mt (revised) in 2019. The major ferrosilicon producers in 2020 were China (68%), Russia (10%), Brazil (4%), and Norway (4%) and together accounted for 87% of total world ferrosilicon production (table 7).

Estimated world production of silicon metal, excluding that produced by the United States, was 2.85 Mt in 2020 compared with 2.96 Mt (revised) in 2019 (table 7). China was, by far, the leading producer of silicon metal in the world in 2020 with an estimated 2.20 Mt, 77% of the world total. Other leading producers of silicon metal in 2020 were Brazil (7%) and Norway (5%); together with China, these leading producers accounted for 89% of total world silicon metal production (table 7).

World Review

Brazil.—In 2020, Brazil was the world's second leading producer of silicon metal (200,000 t); both Brazil and Norway were the third largest producers of ferrosilicon (each produced 320,000 t) (table 7). Brazil was also the leading source of silicon metal imported into the United States (27,300 t, gross weight) and second leading source of imported ferrosilicon (29,600 t, gross weight) (table 6).

China.—In 2020, China led the world in ferrosilicon and silicon metal production with a combined estimated total of 7.50 Mt (gross weight), 3% less than the 7.70 Mt (revised) produced in 2019 (table 7). China also led the world in consumption of ferrosilicon and silicon metal with an apparent

consumption of 3.71 Mt (silicon content) of ferrosilicon and 1.25 Mt of silicon metal in 2020 (CRU Bulk Ferroalloys Monitor, 2021a, b).

China's ferrosilicon exports (276,000 t) were 28% less than those in 2019 (386,000 t); ferrosilicon containing more than 55% silicon accounted for the bulk of those exports (93%). The leading countries of destination for ferrosilicon containing more than 55% silicon were Japan (24%) and the Republic of Korea (27%). China's silicon metal exports decreased by 11% to 619,000 t in 2020 from 695,000 t in 2019. The leading countries of destination for silicon metal from China were Japan (25%) and the Republic of Korea (13%). Ferrosilicon imported into China was 23,000 t, a 57% decrease compared with that in 2019 (TEX Report, The, 2021a–c).

China's ferrosilicon production and exports both decreased in 2020 owing to lockdown measures as well as reduced demand from steelmakers and international consumers during the global COVID-19 pandemic (Argus Media group—Argus Metals International, 2021a, b). Hoshine Silicon Industry Co., Ltd., China's leading silicon metal producer reported a 12% decrease in silicon metal production and a 26% decrease in sales compared with that in 2019. The decreases in production and sales were attributed to lockdowns during the global COVID-19 pandemic as well as reduced demand from aluminum alloy producers (Argus Media group—Argus Metals International, 2021c).

Owing to strong demand from the photovoltaic and semiconductor markets, polysilicon production in China was 396,000 t in 2020, a 15% increase from that in 2019. DAQO New Energy Co., Ltd., GCL-Poly Energy Holdings, Ltd., Xinte Energy Co., Ltd., and Yongxiang Polysilicon Co., Ltd., the top four producers in the country, accounted for 76% of the country's production in 2020 (Argus Media group—Argus Metals International, 2021d).

Malaysia.—OM Materials Sarawak SDN BHD, the only ferrosilicon producer in Malaysia, consisted of 16 furnaces, with 10 dedicated to ferrosilicon. However, owing to difficulties obtaining skilled workers during the global COVID-19 pandemic, the company only operated six ferrosilicon furnaces in 2020. Total ferrosilicon production was 167,000 t, a 27% decrease compared with that in 2019 (OM Holdings Ltd., 2021, p. 10, 11).

Norway.—Norway was a global leader in the production of both ferrosilicon and silicon metal, ranking third for ferrosilicon production (320,000 t) (Brazil also ranked third, producing the same amount) and third for silicon metal production (140,000 t) (table 7). Elkem ASA was Norway's leading producer of both ferrosilicon and silicon metal (Roskill Information Services Ltd., 2019). Operating its Silicon Product division from plants in Canada, China, Iceland, India, Norway, and Paraguay, Elkem's global sales of silicon products increased in 2020 to 526,000 t compared with 499,000 t in 2019 (Elkem ASA, 2021, p. 11).

Russia.—Russia was the world's second leading ferrosilicon producer with an estimated 800,000 t produced in 2020 (table 7). Russia exported 369,000 t of ferrosilicon in 2020, 3% less than the 381,000 t exported in 2019. Ferrosilicon with greater than 55% silicon content accounted for 97% of the total ferrosilicon exported by Russia in 2020. In 2020, Russia imported 46,900 t of ferrosilicon, 18% more than the amount imported in 2019 (TEX Report, The, 2021d).

Outlook

The steel industry is the primary consumer of ferrosilicon. Global crude steel production in 2020 was 1.88 billion metric tons (Gt), compared with 1.87 Gt in 2019 (World Steel Association, 2021a, p. 9). China, the world's leading producer of raw steel, produced 1,060 Mt in 2020, a 7% increase from the 995 Mt produced in 2019. U.S. crude steel production in 2020 was 72.7 Mt, a 17% decrease compared with 87.8 Mt produced in 2019. World apparent consumption of finished steel products was 1.77 Gt, essentially unchanged from that in 2019 (World Steel Association, 2021a, p. 16). China, the leading world consumer of steel products, increased steel consumption by 9% to 995 Mt in 2020 from 912 Mt in 2019. The combined steel consumption in China, India, Japan, the Republic of Korea, and the United States increased by 3% to 1.27 Gt from 1.23 Gt; these five countries accounted for about 71% of the world total in 2020. The World Steel Association's short-range forecast for global steel consumption is 1.87 Gt in 2021 and 1.92 Gt in 2022 (World Steel Association, 2021b). Further details of the outlook for the steel industry are discussed in the "Outlook" section of the Iron and Steel chapter of the 2020 USGS Minerals Yearbook, volume I, Metals and Minerals.

The aluminum and chemical industries are the leading consumers of silicon metal, which also is used in the production of polysilicon, which is used for solar cells and semiconductors. The global aluminum casting market is projected to grow by a compound annual growth rate (CAGR) of 6.4% by 2027 owing to increased demand for lightweight vehicles (Grand View Research, Inc., 2020). The global market for polysilicon is estimated to grow at a CAGR of 11.8% from 2020 through 2027 (Business Wire, Inc., 2021).

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TABLE 1
SALIENT SILICON STATISTICS[1]

(Silicon content, unless otherwise specified)

		2016	2017	2018	2019	2020
United States:						
Production:						
Ferrosilicon	thousand metric tons	W	W	W	W	W
Silicon metal[2]	do.	W	W	W	W	W
Total silicon materials[3]	do.	384	415	430	310	277
Exports:						
Ferrosilicon	do.	7	11	12	8	4
Silicon metal	do.	60	71	45	40	31
Imports for consumption:						
Ferrosilicon	do.	155	147	140	127	140
Silicon metal	do.	122	136	116	124	97
Apparent consumption:[4]						
Ferrosilicon	do.	W	W	W	W	W
Silicon metal[2]	do.	W	W	W	W	W
Total silicon materials[3]	do.	601	616	637	517	481
Price, average:						
Ferrosilicon, 50% Si[5]	cents per pound	82.70	94.47	104.24	102.35	103.38
Ferrosilicon, 75% Si[6]	do.	70.76	86.88	107.58	89.15	87.40
Silicon metal[6]	do.	91.14	116.56	134.15	105.70	96.84
World production, gross weight:[7]						
Ferrosilicon[8]	thousand metric tons	6,960	6,130	8,180 r	8,180 r	7,770
Silicon metal[9]	do.	2,850 r	2,890	3,180 r	2,960 r	2,850
U.S. total silicon materials	do.	471	518	541	419	361
Total silicon materials[3]	do.	10,300	9,530	11,900 r	11,600 r	11,000

rRevised. do. Ditto. W Withheld to avoid disclosing company proprietary data.
[1]Table includes data available through July 26, 2021. Data are rounded to no more than three significant digits, except prices; may not add to totals shown. Includes U.S. Geological Survey estimates.
[2]Does not include semiconductor and solar grades of silicon metals.
[3]Includes ferrosilicon, miscellaneous silicon alloys, and silicon metal, excluding semiconductor and solar grades.
[4]Defined as production plus imports for consumption minus exports plus adjustments for industry stock changes.
[5]CRU Group transaction prices based on weekly averages.
[6]S&P Global Platts Metals Week mean import prices based on monthly averages.
[7]May include estimated data.
[8]Does not include production of ferrosilicon in the United States.
[9]Does not include production of silicon in the United States.

TABLE 2
PRODUCTION, SHIPMENTS, AND STOCKS OF SILICON ALLOYS AND METAL IN THE UNITED STATES[1, 2, 3]

(Metric tons, gross weight)

	Gross production[4]	Net shipments	Producers' stocks, December 31
2019:			
Ferrosilicon	W	W	W
Silicon metal	W	W	W
Total silicon materials	419,000	321,000	18,900
2020:			
Ferrosilicon	W	W	W
Silicon metal	W	W	W
Total silicon materials	361,000	275,000	18,600

W Withheld to avoid disclosing company proprietary data.
[1]Table includes data available through July 26, 2021. Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Includes U.S. Geological Survey estimates.
[3]Includes ferrosilicon, miscellaneous silicon alloys, and silicon metal, excluding semiconductor and solar grades, unless otherwise noted.
[4]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 2020[1]

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

Do. Ditto.
[1]Silicon metal producers do not include semiconductor and solar-grade silicon manufacturers.
[2]A wholly owned subsidiary of Ferroglobe PLC.
[3]A wholly owned subsidiary of The Dow Chemical Co.
[4]Owned by Rima Industrial S.A. and CleanTech, LLC.
[5]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 2020[1, 2]

(Metric tons, gross weight)

End use	Silvery pig iron[3]	Ferrosilicon, 50%[4]	Ferrosilicon, 75%[5]	Silicon metal[6]	Miscellaneous silicon alloys[7]	Silicon carbide[8]
Steel:						
Carbon and high-strength, low-alloy	20	W	25,000	W	(9)	1,280
Stainless and heat-resisting	--	W	43,300	586	(9)	W
Full alloy	--	W	7,420	W	(9)	--
Electric	--	--	W	--	--	W
Electric and tool	--	--	W	--	--	--
Unspecified	--	--	W	W	540	--
Total	20	W	106,000	1,960	540	W
Cast irons	W	18,700	24,000	(10)	13,100	16,100
Superalloys	--	(11)	(12)	37	--	--
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)	6	(11)	--
Tungsten alloys	--	--	--	(10)	--	--
Chemical carbides	--	--	--	--	(11)	--
Other alloys, excluding superalloys and alloy steel	--	(11)	--	20,000 [13]	(11)	--
Miscellaneous and unspecified	--	--	270	W [14]	(11)	--
Grand total	W	66,400	130,000	207,000	13,600	21,400
Consumers' stocks, December 31	96	614	9,050	12,600	512	1,060

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

[1]Table includes data available through July 26, 2021. Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Includes U.S. Geological Survey estimates.

[3]Typically 18% silicon content but ranges between 5% and 24% silicon content.

[4]Typically 48% silicon content but ranges between 25% and 55% silicon content; includes briquets.

[5]Typically 76% silicon content but ranges between 56% and 95% silicon content; includes briquets.

[6]Typically 98% silicon content but ranges between 96% and 99% silicon content.

[7]Typically 48% silicon content. Primarily magnesium-ferrosilicon but also includes other silicon alloys.

[8]Typically 64% silicon content but ranges between 63% and 70% silicon content. Does not include silicon carbide for abrasive or refractory uses.

[9]Included with "Steel: Unspecified," to avoid disclosing company proprietary data.

[10]Included with "Other alloys, excluding superalloys and alloy steel" to avoid disclosing company proprietary data.

[11]Included with "Cast irons," to avoid disclosing company proprietary data.

[12]Included with "Miscellaneous and unspecified," to avoid disclosing company proprietary data.

[13]Primarily aluminum alloys.

[14]Primarily silicones and other chemicals.

TABLE 5
U.S. EXPORTS OF FERROSILICON AND SILICON METAL IN 2020[1, 2]

(Metric tons, unless otherwise specified)

Country or locality	Gross weight	Silicon content	Value
Ferrosilicon:			
More than 55% silicon:			
Belgium	188	128	$180,000
Brazil	19	11	29,600
Canada	1,680	1,010	2,490,000
Dominican Republic	25	15	48,900
France	80	48	95,100
Mexico	1,770	1,080	3,530,000
Netherlands	9	5	18,700
Singapore	7	4	10,100
South Africa	114	78	85,200
United Kingdom	86	51	134,000
Other (1 country or locality)	1	(3)	2,780
Total	3,980	2,430	6,620,000
Other ferrosilicon:			
Belgium	667	300	640,000
Brazil	388	194	760,000
Canada	375	183	745,000
Finland	20	10	29,800
France	20	9	37,000
Mexico	2,150	908	4,020,000
Spain	239	119	376,000
Switzerland	240	109	408,000
Turkey	100	44	176,000
United Kingdom	199	93	336,000
Other [3 countries and (or) localities]	13	6	25,300
Total	4,410	1,980	7,550,000
Total ferrosilicon	8,390	4,400	14,200,000
Metal:			
More than 99.99% silicon:			
China	2,140	2,140	62,800,000
Germany	5,450	5,450	171,000,000
Hong Kong	189	189	778,000
Japan	9,030	9,030	366,000,000
Korea, Republic of	4,170	4,170	91,800,000
Malaysia	224	224	25,000,000
Norway	740	740	7,210,000
Singapore	956	956	19,000,000
Taiwan	1,810	1,810	14,500,000
Vietnam	4,600	4,600	41,500,000
Other [33 countries and (or) localities]	359	359	14,000,000
Total	29,700	29,700	814,000,000
99.00–99.99% silicon:			
Belgium	4	4	6,000
Brazil	11	11	15,600
Costa Rica	9	9	13,300
Dominican Republic	5	5	6,800
Germany	26	26	30,300
Guatemala	4	4	5,860
Mexico	30	30	61,100
Netherlands	57	52	58,700
Pakistan	5	5	7,400
United Kingdom	117	117	137,000
Other [2 countries and (or) localities]	4	4	5,790
Total	273	267	347,000

See footnotes at end of table.

TABLE 5—Continued
U.S. EXPORTS OF FERROSILICON AND SILICON METAL IN 2020[1, 2]

(Metric tons, unless otherwise specified)

Country or locality	Gross weight	Silicon content	Value
Metal:—Continued			
Other silicon:			
Belgium	299	291	$364,000
Canada	122	118	321,000
China	105	101	144,000
Malaysia	42	41	55,200
Mexico	290	282	678,000
Netherlands	247	239	203,000
South Africa	59	57	116,000
Sweden	54	53	57,900
Taiwan	62	59	88,700
United Kingdom	118	115	137,000
Other [14 countries and (or) localities]	107	104	275,000
Total	1,500	1,460	2,440,000
Total silicon metal	31,400	31,400	817,000,000

[1]Table includes data available through June 25, 2021. Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Countries listed are the leading importers in terms of quantity (gross weight).
[3]Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 6
U.S. IMPORTS FOR CONSUMPTION OF FERROSILICON AND SILICON METAL IN 2020[1, 2]

(Metric tons, unless otherwise specified)

Country or locality	Gross weight	Silicon content	Value
Ferrosilicon:			
55%–80% silicon, more than 3% Ca:			
China	219	121	$463,000
France	426	265	1,130,000
India	18	11	52,700
Kazakhstan	80	66	88,300
South Africa	126	81	312,000
Total	870	544	2,040,000
55%–80% silicon, other:			
Brazil	28,200	21,200	27,800,000
Canada	15,500	11,400	27,300,000
Iceland	15,200	11,900	15,700,000
Kazakhstan	13,000	10,000	16,500,000
Malaysia	11,700	9,070	11,300,000
Netherlands	3,400	2,590	3,760,000
Norway	10,200	7,770	11,200,000
Paraguay	5,970	4,630	6,530,000
Russia	64,300	49,000	74,600,000
South Africa	2,260	1,600	3,760,000
Other [7 countries and (or) localities]	2,680	1,900	7,920,000
Total	172,000	131,000	206,000,000
80–90% ferrosilicon:			
Bosnia and Herzegovina	8	7	13,500
Brazil	501	414	721,000
China	4	3	3,520
Total	513	424	738,000
More than 90% ferrosilicon, Bosnia and Herzegovina	85	78	154,000
Magnesium ferrosilicon:			
Argentina	437	198	402,000
Brazil	652	296	806,000
Canada	9,500	4,370	16,700,000
Germany	118	29	319,000
India	443	200	651,000
Norway	73	35	141,000
Total	11,200	5,130	19,000,000
Other ferrosilicon:			
Brazil	216	93	248,000
Canada	8,110	2,760	9,790,000
China	183	81	307,000
France	18	8	44,400
Germany	23	10	109,000
India	73	32	103,000
Russia	183	87	364,000
Slovakia	448	102	670,000
South Africa	70	9	164,000
United Kingdom	14	7	61,300
Other [1 country or locality]	13	5	42,400
Total	9,350	3,190	11,900,000
Total ferrosilicon	194,000	140,000	240,000,000

See footnotes at end of table.

TABLE 6—Continued
U.S. IMPORTS FOR CONSUMPTION OF FERROSILICON AND SILICON METAL IN 2020[1, 2]

(Metric tons, unless otherwise specified)

Country or locality	Gross weight	Silicon content	Value
Metal:			
More than 99.99% silicon:			
Brazil	988	988	$2,490,000
Canada	9	9	25,700
China	115	115	8,870,000
Germany	259	259	28,300,000
Japan	159	159	10,500,000
Laos	36	36	792,000
Malaysia	19	19	150,000
Norway	31	31	314,000
Singapore	6	6	75,200
Taiwan	279	279	30,200,000
Other [12 countries and (or) localities]	14	14	1,280,000
Total	1,910	1,910	83,000,000
99.00%–99.99% silicon:			
Australia	1,980	1,970	4,140,000
Bosnia and Herzegovina	7,610	7,550	14,000,000
Brazil	17,100	17,000	34,200,000
Canada	20,900	20,700	49,100,000
Iceland	4,300	4,270	6,650,000
Kazakhstan	1,150	1,150	1,770,000
Laos	720	713	1,580,000
Malaysia	9,620	9,530	15,500,000
Norway	8,660	8,600	22,600,000
Thailand	1,200	1,190	2,230,000
Other [6 countries and (or) localities]	504	499	688,000
Total	73,700	73,200	152,000,000
Other silicon:			
Australia	5,520	5,330	10,900,000
Brazil	9,220	8,920	19,000,000
Canada	505	488	1,180,000
China	254	244	277,000
Iceland	281	276	416,000
Japan	288	276	377,000
Malaysia	509	496	868,000
Netherlands	208	199	636,000
Norway	5,110	4,990	6,950,000
Sweden	209	200	227,000
Other [9 countries and (or) localities]	368	358	1,250,000
Total	22,500	21,800	42,000,000
Total silicon metal	98,100	96,900	277,000,000

[1]Table includes data available through June 25, 2021. Data are rounded to no more than three significant digits; may not add to totals shown.
[2]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[1, 2]

(Metric tons, gross weight)

Country or locality[3]	2016	2017	2018	2019	2020
Argentina, ferrosilicon[e]	12,000	13,000	13,000	13,000	11,000
Australia, silicon metal[e]	48,000	50,000	40,000	49,000 r	43,000
Bhutan, ferrosilicon[4]	106,234	108,387 r	120,431 r	138,651 r	103,486
Bosnia and Herzegovina:					
Ferrosilicon	--	--	10,000 e	5,000 e	2,000 e
Silicon metal	28,138	30,473	31,460 r	31,911 r	25,000 e
Brazil:[e]					
Ferrosilicon	230,000 r	190,000 r	220,000 r	270,000 r	320,000
Silicon metal	190,000 r	160,000 r	200,000 r	200,000	200,000
Canada:[e]					
Ferrosilicon	38,000	40,000	36,000	37,000	34,000
Silicon metal	27,000	28,000 r	34,000	34,000	25,000
China:					
Ferrosilicon	4,300,000	3,650,000	5,450,000 r	5,490,000 r	5,300,000 e
Silicon metal	2,101,000	2,205,000	2,405,000 r	2,210,000 r	2,200,000 e
Egypt, ferrosilicon[5]	60,477	60,500 e	60,500 e	60,500 e	60,000 e
France:[e]					
Ferrosilicon	50,000	50,000	50,000	48,000	41,000
Silicon metal	151,000	149,000	138,000	105,000 r	87,000
Germany, silicon metal[e]	30,500	30,000	30,000	30,000	28,000
Iceland:					
Ferrosilicon	128,020	116,811	116,889	120,255 r	117,000 e
Silicon metal	--	7,160	7,036	28,396 r	27,000 e
India, ferrosilicon	90,000 [6]	90,000	90,000	93,000 e	90,000 e
Kazakhstan:					
Ferrosilicon	68,779	60,001	65,405	79,930 r	85,000 e
Silicon metal	--	--	14,000 r	13,000 r	12,000 e
Korea, Republic of, ferrosilicon[e]	30,000	30,000	30,000	30,000	29,000
Laos, silicon metal[7]	6,836	1,886	8,873	4,624 r	889
Macedonia, ferrosilicon	24,431	21	--	117 r	-- e
Malaysia, ferrosilicon	126,261	174,540	220,515	230,735	167,443
Norway:[e]					
Ferrosilicon	350,000	350,000	350,000	350,000	320,000
Silicon metal	150,000	150,000	150,000	150,000	140,000
Paraguay, ferrosilicon	--	--	8,000 e	10,000 e	10,000 e
Poland, ferrosilicon	77,682	65,732	63,618	65,523 r	64,000 e
Russia:					
Ferrosilicon	935,912	840,352	928,797	846,579	800,000 e
Silicon metal	59,300	59,000 r, e	59,000 r, e	59,000 r, e	57,000 e
Slovakia, ferrosilicon	38,030	52,436	50,392	38,060 r	24,000 e
South Africa:					
Ferrosilicon	73,200	48,200	98,000 e	98,000 e	51,000 e
Silicon metal	26,600	4,700	51,000 e	33,000 e	-- e
Spain:[e]					
Ferrosilicon	80,000	95,000	95,000	90,000	77,000
Silicon metal	30,000	7,500	7,500	7,500	5,000
Turkey, ferrosilicon[8]	2,374 r	2,278 r	3,160 r	2,005 r	994
Ukraine, ferrosilicon	101,420	92,910	97,084	62,560 r	60,800
United States, ferrosilicon and silicon materials[9]	471,000	518,000	541,000	419,000	361,000
Uzbekistan, silicon metal[e]	3,000	3,000	--	--	--
Venezuela, ferrosilicon[e]	37,000	--	--	--	--
Grand total	10,300,000	9,530,000	11,900,000 r	11,600,000 r	11,000,000
Of which:					
Ferrosilicon[10]	6,960,000	6,130,000	8,180,000 r	8,180,000 r	7,770,000
Silicon metal[11]	2,850,000	2,890,000	3,180,000 r	2,960,000 r	2,850,000
U.S. total silicon materials[9]	471,000	518,000	541,000	419,000	361,000

See footnotes at end of table.

TABLE 7—Continued
FERROSILICON AND SILICON METAL: WORLD PRODUCTION, BY COUNTRY OR LOCALITY[1, 2]

[e]Estimated. [r]Revised. -- Zero.
[1]Table includes data available through July 1, 2021. All data are reported unless otherwise noted; totals may include estimated data. Grand totals, U.S. data, and estimated data are rounded to no more than three significant digits; may not add to totals shown.
[2]Does not include semiconductor and solar grades of silicon metal.
[3]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.
[4]Imports received by all countries from Bhutan. Source: UN Comtrade.
[5]Production is based on fiscal year, with a starting date of July 1 of the year shown.
[6]Production is based on fiscal year, with a starting date of April 1 of the year shown.
[7]Imports received by all countries from Laos. Source: UN Comtrade
[8]Imports received by all countries from Turkey. Source: UN Comtrade.
[9]Includes total U.S. gross production of ferrosilicon and silicon metal. In previous reports, U.S. production was reported as net production.
[10]Does not include U.S. production of ferrosilicon.
[11]Does not include U.S. production of silicon metal.