



2011 Minerals Yearbook

SILICON

SILICON

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Starting in 2011, 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. Therefore, comparisons of domestic production and apparent consumption statistics could not be made between 2010 and 2011. In 2011, total domestic ferrosilicon and silicon metal production was 326,000 metric tons (t) of contained silicon (table 1) and 437,000 t on a gross-weight basis (table 2). On the basis of contained silicon, U.S. exports of silicon products increased by 23% and imports increased by 4%. Total U.S. apparent consumption of silicon materials was 564,000 t. Year-average import prices for the 50% and 75% ferrosilicon grades increased slightly and by 5%, respectively, and those for silicon metal increased by 13% compared with those in 2010.

Silicon is a light chemical element with metallic and nonmetallic characteristics. Silicon is rarely found free in nature. Silicon combines with oxygen and other elements to form silicates, which comprise more than 25% 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 further processed into ultrahigh-purity semiconductor or solar grades; these contain 99.9% or greater silicon. Semiconductor-grade silicon metal used in making computer chips is crucial to modern technology, but the quantity is less than 5% of total silicon metal demand (Roskill's Letter from Japan, 2000). Silicon metal may also be refined into an upgraded metallurgical form or into wafers to power solar batteries. The U.S. Geological Survey (USGS) does not survey the ultrahigh-purity silicon industry for production and related data; therefore, 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 (table 2).

In March, Optima Group LLC acquired ferrosilicon producer CC Metals and Alloys, Inc. (CCMA) for an undisclosed sum. Felman Trading, Inc., the marketing agent for U.S. silicomanganese producer Felman Production Inc., planned to sell CCMA output. Optima is controlled by investors in Felman Production, which is, in turn, owned by investors in Ukrainian

ferroalloy producer Privat Group (American Metal Market, 2011; Ryan's Notes, 2011a).

In November, Globe Specialty Metals, Inc. (GSM; owner of U.S.-based silicon producers Core Metals Group and Globe Metallurgical, Inc.) ceased production at its Bridgeport, AL, ferrosilicon plant because of a fire. The plant's production capacity was rated at 42,000 metric tons per year (t/yr). As a result of the fire, GSM lost about 4,000 t of output. The plant was reopened in late January 2012 at a cost of \$5 million (American Metal Market, 2012; Globe Specialty Metals, Inc., 2012a).

Silicon Metal.—Production-related statistics for silicon metal were aggregated with domestic silicon ferroalloys to avoid disclosing company proprietary data.

Total Silicon Materials.—Data for all silicon materials that were produced in the United States in 2011—ferrosilicon, miscellaneous silicon alloys, and silicon metal—are derived from monthly and annual voluntary surveys and estimates for nonrespondents by the USGS. The gross production-related data in table 2 were obtained from all operations listed in table 3 that are canvassed by means of the USGS "Silicon Alloys" survey. U.S. production reported in the world production table reflects net production of total silicon materials (table 9); that is, it includes adjustments in inventory and in-plant consumption of ferrosilicon and silicon metal to produce magnesium ferrosilicon, miscellaneous alloys, and different grades of silicon metal.

Upgraded-Metallurgical-Grade Silicon Metal.—Upgraded-metallurgical-grade silicon metal (UMG-Si) is used in silicon-based photovoltaic (solar) cells. UMG-Si does not require as much additional refinement as does polycrystalline silicon, which has been traditionally used in solar panel wafers. GSM did not produce UMG-Si commercially in 2011; rather, the company focused on research and development projects to improve UMG-Si production. GSM's UMG-Si production capacity was last reported in 2009 to be 360 t/yr at its Solsil plant in Beverly, OH. GSM ownership in Solsil, Inc. increased in fiscal year 2012 (July 1, 2011, to June 30, 2012) to 97.25% from 81% in fiscal year 2011 (Globe Specialty Metals, Inc., 2009, p. 3; 2012b, p. 2, 15–16).

Semiconductor- and Solar-Battery-Grade Silicon.—U.S. production capacity for polycrystalline silicon used in semiconductor and solar cells was reported to have increased by 9% to 69,500 t in 2011 from the revised amount (63,500 t) in 2010. China led the world in polycrystalline production capacity for the first time with 39% of the total, followed by the United States with 22%, and the Republic of Korea with 18%. Total annual domestic polycrystalline production capacity by company was as follows: Hemlock Semiconductor Group, 40,000 t; REC Group (includes REC Advanced Silicon

Materials LLC and REC Solar Grade Silicon LLC), 19,000 t; MEMC Electronic Materials, 9,000 t; and Mitsubishi Materials Group, 1,500 t (Roskill's Letters from Japan, 2012, p. 4).

Two new polycrystalline silicon plants were under construction in Tennessee—Hemlock Semiconductor Group's 10,000-t/yr plant in Clarksville, and Wacker Chemie AG's 15,000-t/yr plant in Cleveland. Startup at the \$1.2 billion Hemlock Semiconductor plant was scheduled for 2012, and for late 2013 at the €1.1 billion (\$1.6 billion) Wacker Chemie plant. Production at both plants would primarily target solar cell applications. Hemlock Semiconductor is owned by Dow Corning Corp. (63.25%), Shin-Etsu Handotai (24.5%), and Mitsubishi Materials Corp. (12.25%). Wacker Chemie is a German-based chemical and ultrahigh-purity silicon manufacturer (Dow Corning Corp., 2009; Wacker Chemie AG, 2011; Hemlock Semiconductor Group, 2012).

Consumption

Most ferrosilicon (including miscellaneous silicon alloys) was used to produce steel (70%) (table 4). Silicon metal was used mainly to produce chemicals, such as silanes, silicones, and others (79%). Metallurgical-grade silicon carbide can substitute 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 2011 USGS Minerals Yearbook, volume I, Metals and Minerals.

In 2011, U.S. apparent consumption of silicon materials (ferrosilicon, miscellaneous silicon alloys, and silicon metal) was 564,000 t (table 1). Consumption of ferrosilicon and silicon metal was estimated by CRU International Ltd. to have each increased throughout the western world in 2011, except in Japan where ferrosilicon consumption decreased by 10% and in the European Union (EU) where silicon metal consumption decreased slightly. In terms of contained silicon, ferrosilicon consumption increased to 2.00 million metric tons (Mt) in 2011 from 1.98 Mt (revised) in 2010, and silicon metal consumption increased to 1.58 Mt from 1.49 Mt. Areas with the largest year-to-year increase in consumption of ferrosilicon, in terms of volume and as categorized by CRU International, were Europe, other western world countries (excluding Europe, all Asian countries, and the United States), and the United States. Areas with the largest year-over-year increase in silicon metal consumption, in terms of volume and as categorized by CRU International, were other Asian countries (excluding China, Japan, and North Korea) and the United States. In decreasing order of consumption, Europe, other Asian countries (excluding China, Japan, and North Korea), and Japan accounted for 73% of the ferrosilicon consumption in 2011. Also in decreasing order of consumption, the EU, the United States, and other Asian countries (excluding China, Japan, and North Korea) accounted for 72% of the silicon metal consumed in 2011 (CRU Bulk Ferroalloys Monitor, 2012a, b).

Prices

Ferrosilicon and silicon metal prices tend to vary in response to changes in supply to, and consumption requirements by, the aluminum, chemical, ferrous foundry, and steel industries.

Silicon material prices were higher in 2011 than they were in 2010 because of increased consumption in the United States. The year-average spot prices given by Platts Metals Week were 102.2 cents per pound for 75% ferrosilicon and 157.6 cents per pound for silicon metal; these prices were 5% and 13% higher, respectively, than those of 2010. The year-average North American transaction price for 50% ferrosilicon as calculated from Ryan's Notes listings was 111.3 cents per pound, a slight increase from that of 2010. Average monthly ferrosilicon and silicon metal spot prices were at their highest in January 2011 before generally trending downward until hitting a low in December—145 cents per pound for silicon metal, 102 cents per pound for 50% ferrosilicon, and 90.5 cents per pound for 75% ferrosilicon. The range for spot market prices, in cents per pound, ended the year as follows: silicon metal, 142 to 145; 50% ferrosilicon, 100 to 104; and 75% ferrosilicon, 89 to 91. The prices were lower at yearend because of oversupply that resulted from increases in imports that were diverted to the United States from European markets in the third quarter.

Foreign Trade

Trade volumes discussed are based on gross weight. U.S. ferrosilicon exports increased by 34% to 34,000 t, and their value increased by 37% to \$40.6 million from those of 2010. In decreasing order of quantity, Canada and Mexico accounted for 76% of the total 2011 ferrosilicon exports (table 5). Exports of silicon metal increased by 21% to 79,500 t, but their value decreased slightly to \$2.64 billion from that of 2010. In decreasing order of quantity, Japan, China, the Republic of Korea, and Germany accounted for 67% of silicon metal exports. Shipments of ultrahigh-purity silicon containing more than 99.99% silicon accounted for 69% of total silicon metal exported and 96% of the total value of combined ferrosilicon and silicon metal exports.

U.S. ferrosilicon imports increased slightly to 233,000 t, and the value of those imports increased by 12% to \$383 million compared with that in 2010. These imports increased primarily because of increases in the "55% to 80% silicon, more than 3% calcium" and "magnesium ferrosilicon" trade categories. Imports of standard 75% ferrosilicon (ferrosilicon trade category of "55% to 80% silicon, other") accounted for 80% of total ferrosilicon imports by gross weight and 81% of total ferrosilicon value (table 6). Russia (37%) was the leading source of total ferrosilicon imports, followed by China (31%) and Canada (13%).

Silicon metal imports (190,000 t) increased by 9% from those in 2010, and increased by 18% in value to \$884 million from \$748 million in 2010. The increase in silicon metal imports was attributable to increases in the "silicon, other" (19,200 t) trade category. Brazil was the leading source of total silicon metal imports at 42%, followed by South Africa at 19%, and Canada at 13%. Silicon metal in the "99.00% to 99.99% silicon" trade category accounted for 72% of the quantity, and 50% of the value, respectively, of all silicon metal imported in 2011. The quantity of silicon metal imports in this trade category decreased slightly compared with that of 2010.

The estimated U.S. net import reliance for ferrosilicon and silicon metal in 2011 as a percentage of apparent consumption was 48%.

Antidumping Duty Administrative Reviews.—Final antidumping duty rates assessed in 2011 on imports of silicon materials to the United States are listed in table 7. Results of appeals of import antidumping duty reviews made in 2011 are listed in table 8.

Foreign-Trade Zone Designations.—On June 29, the Foreign-Trade Zones Board of the U.S. Department of Commerce granted foreign-trade zone (FTZ) subzone status with restrictions to REC Silicon Inc.'s polysilicon (polycrystalline silicon) and silane gas manufacturing facility in Butte, MT. The FTZ manufacturing authority could exempt REC Silicon from customs duty payments on imported silicon metal that is used to manufacture polysilicon and silane gas for export. However, the company would not be allowed to import silicon metal duty free if those imports were covered by an antidumping duty or countervailing duty order, such as silicon metal imports from China and Russia (U.S. Department of Commerce, Foreign-Trade Zones Board, 2011).

U.S.-World Trade Organization (WTO) Chinese Raw Material Export Dispute Settlement Proceedings.—On July 5, a WTO Dispute Settlement Body (DSB) agreed with the United States that China's curbs placed on exports of various materials in 2009, including a 15% tax on silicon metal exports, were inconsistent with China's WTO obligations. In January 2012, the WTO Appellate Body affirmed the DSB decision after China appealed. By doing so, the Appellate Body rejected China's attempts to portray the export restraints as conservation or environmental protection measures or measures taken to manage critical supply shortages (Office of the United States Trade Representative, 2011; 2012).

World Industry Structure

Data on annual world production of ferrosilicon and silicon metal by country from 2007 through 2011 are provided in table 9. The leading producers of ferrosilicon and silicon metal combined were China (6.8 Mt), Russia (970,000 t), the United States (437,000 t), and Norway (370,000 t). Excluding the United States, world production of ferrosilicon, on a gross-weight basis, was estimated to have been 7.77 Mt in 2011 compared with 8.04 Mt (revised) in 2010. The major ferrosilicon producers in 2011 were, in decreasing order, China, Russia, Norway, and Ukraine; they accounted for 86% of total world production.

World production of silicon metal, excluding that from the United States, was estimated to have been 2.13 Mt in 2011 compared with 1.99 Mt (revised) in 2010. China was by far the leading producer of silicon metal in the world in 2011 with an estimated 1.4 Mt; this was 66% of the world total. Other major producers of silicon metal in 2011 were, in decreasing order, Norway, Brazil, and France; they accounted for 20% of total world production.

New ferrosilicon and silicon metal projects scheduled for completion around the world from 2011 through 2015 are listed in table 10.

World Review

China.—China's exports of silicon materials in 2011 were significantly lower than those in 2010 primarily because overseas buyers made large purchases during the fourth quarter of 2010 in response to electricity supply cuts in so-called Silicon Land—the area comprised of Gansu Province, Inner Mongolia Autonomous Region, Ningxia Hui Autonomous Region, and Qinghai Province. The electricity cuts were a direct result of reduced energy consumption and carbon dioxide (CO₂) emission targets imposed by the Central Government of China via their twelfth 5-year plan published in September 2010.

China's exports of ferrosilicon decreased by 20% to about 622,000 t from the revised amount of 780,000 t exported in 2010. Ferrosilicon containing more than 55% silicon comprised the bulk of the 2011 ferrosilicon exports at 579,000 t. The leading countries of destination for this category of Chinese ferrosilicon were Japan (47%), the Republic of Korea (18%), the United States (8%), and India (3%). China's exports of silicon metal were also significantly lower in 2011 compared with those in 2010; they were down 8% to 584,000 t from 633,000 t. The leading countries of destination for Chinese silicon metal were Japan (30%), the Republic of Korea (18%), Germany (5%), and Thailand (5%) (TEX Report, The, 2012a-d).

Chinese export tariffs in 2011 for ferrosilicon and silicon metal remained at 25% and 15%, respectively (Metal-Pages, 2012b). With these duties, the Chinese Government aimed to reduce exports of these materials from the country so more material would be available for the domestic market. As of September 17, 2012, China had yet to repeal the 15% silicon metal export tax after losing its appeal to the WTO Appellate Body.

One goal contained in China's twelfth 5-year plan was the elimination of backward production capacity, which included ferrosilicon and silicon metal production in small electric arc furnaces (EAFs). Ferrosilicon and silicon metal production in EAFs of 6,300 kilovoltampere capacity would be phased out by yearend 2012 (Metal-Pages, 2012a).

Metal-Pages (2011b) reported that Yunnan Province was one of the leading areas of silicon metal production in China because of its hydropower resources. Silicon metal production capacity in the province was estimated to be 1.25 Mt/yr in 68 plants, which was 35% of national total capacity. In 2011, silicon metal production in Yunnan Province was forecast to be about 700,000 t; this would be one-half the USGS estimate of silicon metal production for the entire country.

In 2011, Grupo FerroAtlántica S.L. (Ferroatlantica) purchased Chinese silicon metal producer Mangshi Sinice Silicon Industry located in Yunnan Province. The company planned to reconstruct the plant's three furnaces by yearend 2012 at an estimated cost of €25 million (\$32 million). Ferroatlantica (through its subsidiary Ganzi FerroAtlántica Silicon Industry Company, Ltd.) also began construction of a new silicon metal plant in Kanding, Ganzi Prefecture, Sichuan Province. It was planned to be the largest silicon metal plant in the world upon project completion in 2014, with an estimated production capacity of 128,000 t/yr (table 10) (Metal-Pages, 2011a; Grupo FerroAtlántica S.L., 2012, p. 14).

Japan.—Japan did not produce ferrosilicon and, therefore, was 100% import reliant for its consumption needs. Ferrosilicon imports were down by 8.6% to 470,000 t in 2011 from the amount imported in 2010. The TEX Report (2012e) attributed the decrease in ferrosilicon imports to large purchases of ferrosilicon from China in the 4th quarter of 2010. The decrease was also likely a result of the March 11, 2011, Tohoku earthquake and tsunami which affected steel production in the country (Beroe Inc., 2011).

Laos.—Starting in 2007, Laos became a new silicon metal-producing country. By 2010, the sole silicon metal producer, Lao Silicon Co., Ltd., had an estimated production capacity of 15,000 t/yr (Ryan's Notes, 2012).

Norway.—In April, the sale of Orkla ASA's Elkem AS silicon-related businesses to China National Bluestar Group Co., Ltd. for \$2 billion was completed. China National Blue Star is owned by Chinese state-owned company ChemChina (80%) and the New York-based investment firm Blackstone Group (20%) (Orkla ASA, 2011; Ryan's Notes, 2011b). Elkem had total ferrosilicon production capacity of 76,000 t/yr; 40,000 t/yr at the Bjolvefossen plant and 36,000 t/yr in Bremanger. Elkem's silicon metal capacity was as follows: Salten, 65,000 t/yr; Thamshavn, 40,000 t/yr; and Bremanger, 28,000 t/yr.

Russia.—Russia exported 838,000 t of ferrosilicon in 2011, a decrease of 11% from the alltime high in 2010. The amount exported in 2011 was the second highest in the country's history, as Russian producers continued to fill the void left by a decrease in Chinese ferrosilicon exports to Europe and Asia (TEX Report, The, 2012f).

Outlook

Domestic and global consumption for ferrosilicon was expected to follow closely the trend in steel production, for which the annual growth rate has been typically in the range of 1% to 2% in the United States. Details of the outlook for the steel industry are discussed in the Outlook section of the Iron and Steel chapter of the 2011 USGS Minerals Yearbook, volume I, Metals and Minerals. According to the World Steel Association (2012), raw steel production in 2011, compared with that in 2010, increased by 7.1% to 86.2 Mt in the United States and by 6.8% worldwide to slightly more than 1.5 billion metric tons (Gt). Raw steel production in China, the leading world producer of raw steel, increased by 8.9% to about 696 Mt. MEPS (International) Ltd. (2012) forecast a 4% increase in world raw steel production to 1.6 Gt in 2012 from that in 2011.

Demand for silicon metal comes primarily from the aluminum and chemical industries. Consumption of silicon metal by the U.S. aluminum castings industry was expected to mirror the short-term annual growth rate of 5.1% from 2011 through 2014 in aluminum casting sales, and the long-term annual growth rate of 2.8% from 2011 through 2020 (Modern Casting, 2012). U.S. chemical production in 2011 increased by 3.8% compared with that in 2010; it then was expected to increase slightly (0.5%) in 2012 (Chemical & Engineering News, 2012; McCoy, 2012).

World production capacity for polycrystalline silicon can be used as a rough indicator of ultrahigh-purity silicon consumption. World polycrystalline silicon output increased by 62% to 235,000 t in 2011 from that in 2010. Of that amount,

the solar cell market accounted for 89% and the semiconductor market 11%. World production capacity for polycrystalline silicon was forecast to increase by 68% to 317,500 t in 2011 from that in 2010; by 2015, it would increase to about 491,000 t. In 2015, China was forecast to lead the world in polycrystalline production capacity with 130,000 t/yr, followed by the Republic of Korea (123,000 t/yr), and the United States (120,000 t/yr) (Roskill's Letters from Japan, 2012, p. 1, 3–4).

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TABLE 1
SALIENT SILICON STATISTICS¹
(Contained silicon, unless otherwise noted)

	2007	2008	2009	2010	2011	
United States:						
Production:						
Ferrosilicon	thousand metric tons	155	180	139	176	W
Silicon metal ²	do.	W	W	W	W	W
Total silicon materials ³	do.	W	W	W	W	326
Exports:						
Ferrosilicon	do.	7	10	9	15	20
Silicon metal	do.	28	35	38	65	79
Imports for consumption:						
Ferrosilicon	do.	208	190	70	157	156
Silicon metal	do.	147	168	113	171	187
Apparent consumption:						
Ferrosilicon	do.	359	352	207	312	W
Silicon metal ²	do.	W	W	W	W	W
Total silicon materials ³	do.	W	W	W	W	564
Price, average:						
Ferrosilicon, 50% Si ⁴	cents per pound	73.96	115.86	76.93	109.33	111.30
Ferrosilicon, 75% Si ⁵	do.	65.62	108.71	68.91	97.18	102.20
Silicon metal ⁵	do.	112.69	162.29	116.37	140.05	157.57
World production, gross weight:						
Ferrosilicon	thousand metric tons	7,310	7,430	7,300 ^r	8,040 ^r	7,770 ⁶
Silicon metal ⁷	do.	1,600	1,680	1,800 ^r	1,990 ^r	2,130
Total silicon materials ³	do.	8,900 ⁷	9,110 ⁷	9,110 ⁷	10,000 ⁷	10,300 ⁸

¹Revised. do. Ditto. W Withheld to avoid disclosing company proprietary data.

²Data are rounded to no more than three significant digits, except prices; may not add to totals shown.

³Excludes semiconductor- and solar-grades of silicon metals.

⁴Includes ferrosilicon, miscellaneous silicon alloys, and silicon metal, excluding semiconductor and solar grades.

⁵Ryan's Notes North American transaction prices based on weekly averages.

⁶Platts Metals Week mean import prices based on monthly averages.

⁷Excludes net production of ferrosilicon in the United States.

⁸Excludes net production of silicon metal in the United States.

⁹Includes total net production of ferrosilicon and silicon metal in the United States.

TABLE 2
PRODUCTION, SHIPMENTS, AND STOCKS OF SILICON
ALLOYS AND METAL IN THE UNITED STATES^{1,2}

(Metric tons, gross weight)

	Gross production ³	Net shipments	Producers' stocks, December 31
2010:			
Ferrosilicon	288,000 ^r	251,000	31,000
Silicon metal	W	W	W
Total silicon materials	W	W	W
2011:			
Ferrosilicon	W	W	W
Silicon metal	W	W	W
Total silicon materials ⁴	437,000	359,000	42,600

^rRevised. W Withheld to avoid disclosing company proprietary data.

¹Data are rounded to no more than three significant digits.

²Includes ferrosilicon, miscellaneous silicon alloys, and silicon metal, excluding semiconductor and solar grades, unless otherwise noted.

³Ferrosilicon production includes material consumed in the production of miscellaneous silicon alloys.

⁴January 2011 data included ferrosilicon and miscellaneous silicon alloys only.

TABLE 3
PRINCIPAL PRODUCERS OF SILICON ALLOYS AND (OR) SILICON
METAL IN THE UNITED STATES IN 2011¹

Producer	Plant location	Product
CC Metals and Alloys, Inc.	Calvert City, KY	Ferrosilicon.
Globe Metallurgical, Inc. ²	Alloy, WV	Ferrosilicon and silicon metal.
Do.	Beverly, OH	Do.
Do.	Niagara Falls, NY	Silicon metal.
Do.	Selma, AL	Do.
Core Metals Group ²	Bridgeport, AL	Ferrosilicon.
Simcala, Inc. ³	Mt. Meigs, AL	Silicon metal.
Do. Ditto.		

¹Silicon metal producers excludes semiconductor- and solar-grade silicon manufacturers.

²Owned by Globe Specialty Metals, Inc.

³Owned by Dow Corning Corp.

TABLE 4
 REPORTED CONSUMPTION, BY END USE, AND STOCKS OF SILICON FERROALLOYS AND METAL IN THE
 UNITED STATES IN 2011^{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	(9)	31,900	27,100	(10)	1,290	(10)
Stainless and heat-resisting	--	(10)	46,800	285	(10)	(10)
Full alloy	--	5,030	9,640	(10)	(10)	--
Electric and tool	--	--	(10)	--	--	(10)
Unspecified	--	694	31,200	1,230	405	7,620
Total	--	37,600	115,000	1,520	1,700	7,620
Cast irons	4,540	25,000	22,900	(11)	14,900	18,700
Superalloys	--	(11)	(11)	164	(9)	--
Alloys, excluding superalloys and alloy steel	(9)	(11)	(11)	52,500 ¹²	--	--
Miscellaneous and unspecified	--	2,450	1,020	200,000 ¹³	(9)	(9)
Grand total	4,540	65,100	139,000	254,000	16,600	26,300
Consumers' stocks, December 31	359	1,510	8,030	2,860	834	926

-- Zero.

¹Data are rounded to no more than three significant digits; may not add to totals shown.

²Includes U.S. Geological Survey estimates.

³Typically 18% silicon content but ranges between 5% to 24% silicon content.

⁴Typically 48% silicon content but ranges between 25% to 55% silicon content; includes briquets.

⁵Typically 76% silicon content but ranges between 56% to 95% silicon content; includes briquets.

⁶Typically 98% silicon content but ranges between 96% to 99% silicon content.

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

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

⁹Included with "Cast irons," to avoid disclosing company proprietary data.

¹⁰Included with "Steel: Unspecified," to avoid disclosing company proprietary data.

¹¹Included with "Miscellaneous and unspecified," to avoid disclosing company proprietary data.

¹²Primarily aluminum alloys.

¹³Primarily silicones and other chemicals.

TABLE 5
U.S. EXPORTS OF FERROSILICON AND SILICON METAL IN 2011^{1,2}

(Metric tons, unless otherwise specified)

Country	Gross weight	Contained weight	Value
Ferrosilicon:			
More than 55% silicon:			
Brazil	141	87	\$322,000
Canada	20,100	12,000	11,600,000
Italy	380	292	757,000
Japan	1,120	857	2,340,000
Mexico	2,290	1,390	5,200,000
Netherlands	274	247	461,000
Spain	140	105	308,000
Sweden	95	71	191,000
Turkey	220	148	639,000
United Kingdom	60	44	107,000
Other (6 countries)	102	71	255,000
Total	24,900	15,400	22,200,000
Other ferrosilicon:			
Belgium	721	360	1,590,000
Brazil	226	99	559,000
Canada	1,810	903	3,040,000
Japan	1,210	584	2,330,000
Korea, Republic of	722	321	959,000
Mexico	1,640	643	3,290,000
Portugal	200	82	440,000
Spain	180	82	405,000
Turkey	1,680	762	4,230,000
United Kingdom	127	62	302,000
Other (13 countries)	584	281	1,290,000
Total	9,090	4,180	18,400,000
Total ferrosilicon	34,000	19,500	40,600,000
Metal:			
More than 99.99% silicon:			
China	17,400	XX	707,000,000
Germany	5,410	XX	236,000,000
Hong Kong	1,800	XX	32,000,000
Japan	13,000	XX	690,000,000
Korea, Republic of	2,780	XX	167,000,000
Malaysia	552	XX	50,500,000
Norway	4,290	XX	210,000,000
Singapore	3,500	XX	166,000,000
Taiwan	4,600	XX	197,000,000
Ukraine	702	XX	30,400,000
Other (41 countries)	969	XX	77,200,000
Total	55,000	55,000^c	2,560,000,000
99.00%–99.99% silicon:			
Belgium	41	41	68,600
China	125	124	241,000
Germany	87	87	251,000
Japan	3,420	3,400	10,900,000
Korea, Republic of	3,650	3,620	14,300,000
Mexico	44	44	103,000
Netherlands	1,180	1,170	3,420,000
Niger	47	46	138,000
Taiwan	22	22	31,000
United Kingdom	1,940	1,930	4,830,000
Other (12 countries)	98	97	219,000
Total	10,700	10,600	34,500,000
Other silicon:			
Canada	3,330	3,230	11,000,000
China	1,640	1,590	8,280,000
Germany	86	84	126,000

See footnotes at end of table.

TABLE 5—Continued
 U.S. EXPORTS OF FERROSILICON AND SILICON METAL IN 2011^{1,2}

(Metric tons, unless otherwise specified)

Country	Gross weight	Contained weight	Value
Metal—Continued:			
Other silicon—Continued:			
Hong Kong	1,460	1,410	\$2,180,000
Japan	4,620	4,450	17,200,000
Korea, Republic of	993	964	1,750,000
Malaysia	501	487	1,440,000
Taiwan	435	422	1,020,000
United Arab Emirates	100	97	332,000
United Kingdom	364	353	921,000
Other (24 countries)	292	283	637,000
Total	13,800	13,400	44,900,000
Total silicon metal	79,500	78,900	2,640,000,000

^cEstimated. XX Not applicable.

¹Countries listed are the leading importers in terms of year-to-date quantities (gross weight).

²Data are rounded to no more than three significant digits; may not add to totals shown.

Source: U.S. Census Bureau.

TABLE 6
U.S. IMPORTS FOR CONSUMPTION OF FERROSILICON AND SILICON METAL
IN 2011^{1,2}

(Metric tons, unless otherwise specified)

Country	Gross weight	Contained weight	Value
Ferrosilicon:			
55%–80% silicon, more than 3% Ca:			
Belgium	23	14	\$85,300
Brazil	4,830	2,920	13,300,000
China	2,600	1,900	3,970,000
France	490	305	1,300,000
India	36	27	84,700
South Africa	40	24	33,300
Spain	71	47	192,000
Vietnam	206	154	287,000
Total	8,300	5,390	19,300,000
55%–80% silicon, other:			
Brazil	845	629	1,580,000
Canada	11,800	8,610	30,500,000
China	55,600	41,800	86,600,000
France	2,450	1,750	6,400,000
Germany	707	512	3,610,000
Iceland	4,000	1,480	5,690,000
Russia	85,100	64,700	134,000,000
South Africa	1,500	1,050	2,660,000
Ukraine	1,270	974	2,040,000
Venezuela	21,100	16,100	32,500,000
Other (6 countries)	1,290	955	2,450,000
Total	186,000	139,000	308,000,000
80%–90% silicon:			
Canada	5	4	11,100
Germany	171	138	388,000
Total	176	142	399,000
More than 90% silicon, Denmark	21	19	23,100
Magnesium ferrosilicon:			
Argentina	894	402	2,160,000
Brazil	1,070	493	2,470,000
Canada	11,300	5,140	23,100,000
China	880	407	1,830,000
France	345	164	530,000
Germany	96	46	258,000
Iceland	1,030	479	2,230,000
Japan	31	14	192,000
Korea, Republic of	133	60	277,000
Norway	757	399	915,000
Other (1 country)	(3)	(3)	3,620
Total	16,500	7,610	34,000,000
Other ferrosilicon:			
Brazil	118	29	158,000
Canada	8,030	2,010	10,600,000
China	14,000	2,020	9,490,000
France	28	14	75,000
Poland	57	29	119,000
Total	22,300	4,110	20,500,000
Total ferrosilicon	233,000	156,000	383,000,000
Metal:			
More than 99.99% silicon:			
Canada	293	XX	10,600,000
China	156	XX	9,770,000
Germany	2,650	XX	192,000,000
Italy	297	XX	21,700,000
Japan	402	XX	38,900,000
Korea, Republic of	224	XX	11,900,000

See footnotes at end of table.

TABLE 6—Continued
U.S. IMPORTS FOR CONSUMPTION OF FERROSILICON AND SILICON METAL
IN 2011^{1,2}

(Metric tons, unless otherwise specified)

Country	Gross weight	Contained weight	Value
Metal—Continued:			
More than 99.99% silicon—Continued:			
Malaysia	13	XX	\$358,000
Norway	142	XX	6,610,000
Russia	82	XX	7,330,000
Taiwan	121	XX	6,190,000
Other (16 countries)	37	XX	5,160,000
Total	4,420	4,420^e	311,000,000
99.00%–99.99% silicon:			
Australia	9,100	9,050	30,600,000
Brazil	53,900	53,400	170,000,000
Canada	10,300	10,200	28,600,000
France	2,010	1,990	7,040,000
Japan	355	6	462,000
Laos	1,890	1,880	3,990,000
Norway	9,130	9,040	40,400,000
South Africa	36,000	35,700	114,000,000
Spain	6,330	6,300	21,700,000
Thailand	7,390	7,360	20,000,000
Other (5 countries)	482	444	1,860,000
Total	137,000	135,000	439,000,000
Other silicon:			
Australia	1,910	1,660	5,940,000
Brazil	25,800	25,200	78,000,000
Canada	13,300	13,000	31,700,000
China	673	624	1,420,000
France	3,390	3,310	9,970,000
Germany	483	466	642,000
Japan	361	219	926,000
Norway	1,800	1,720	3,490,000
South Africa	300	295	1,040,000
United Kingdom	121	118	332,000
Other (7 countries)	295	283	922,000
Total	48,400	46,900	134,000,000
Total silicon metal	190,000	187,000	884,000,000

^eEstimated. XX Not applicable.

¹Countries listed are the leading exporters in terms of year-to-date quantities.

²Data are rounded to no more than three significant digits; may not add to totals shown.

³Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 7
SILICON MATERIALS: FINAL ANTIDUMPING DUTY RATES ASSESSED IN 2011¹

(Listed in order of date assessed)

Date	Imported material	Country of origin	Period of investigation	Producer and duty rate
February 11	Silicon metal	China	6/1/08 – 5/31/09	Shanghai Jinneng International Trade Co., Ltd. (3.3%)

¹Amended final result of an antidumping duty administrative review by the International Trade Administration of the U.S. Department of Commerce.

Source: Federal Register.

TABLE 8
SILICON MATERIALS: APPEALS OF IMPORT ANTIDUMPING DUTY ADMINISTRATIVE REVIEWS IN 2011, BY DECISION DATE

Imported material	Country of origin	Period of investigation	U.S. court	Decision	Decision date	Source
Silicon metal	China	6/1/07 – 5/31/08	CIT	The CIT remanded to the ITC the issue of Indian silicon metal producer Ferro Alloys Corp. Ltd. (FACOR) Selling General and Administrative (SGA) expense ratio. FACOR was one of four nonmarket economy companies used by the ITC as surrogates to evaluate antidumping duties on the subject imports. The CIT concurred with the Chinese companies involved in the original antidumping administrative review that the ITC should include the sale of a surplus captive powerplant (a fixed asset) and miscellaneous income to calculate FACOR's SGA expense ratio. The CIT, however, upheld the ITC's determinations to 1) not reduce Chinese export prices by Chinese export or value-added taxes, 2) use the average value of Indian Grade A noncoking coal values as a surrogate for Chinese coal expenses, 3) calculate dumping margins based on all sales invoiced during the period of investigation that were provided by the Chinese companies, and 4) retain FACOR as a surrogate company because it could not confirm the company was "sick" as defined under Indian law.	June 21	Globe Metallurgical Inc. v. United States, Court No. 10-00032, CIT Slip Opinion 11-72.

CIT, Court of International Trade. ITC, International Trade Commission.

TABLE 9
FERROSILICON AND SILICON METAL: WORLD PRODUCTION, BY COUNTRY^{1,2,3}

(Metric tons, gross weight)

Commodity and country	2007	2008	2009	2010	2011 ^c
Argentina, ferrosilicon ^c	15,000	10,400	11,300	11,000	11,000
Australia, silicon metal ^c	35,000	35,000	30,000	30,000	30,000
Bhutan, ferrosilicon ⁴	40,313	30,824	90,798	97,528	94,000
Bosnia and Herzegovina: ^{e,5}					
Ferrosilicon	860	640	470	870	1,800
Silicon metal	11,600	12,400	11,000	17,300	17,500
Total	12,500	13,000	11,500	18,200	19,300
Brazil: ^c					
Ferrosilicon	146,000	144,832 ⁶	145,000	145,000	145,000
Silicon metal	133,000	131,940 ⁶	132,000	132,000	133,000
Total	279,000	276,772 ⁶	277,000	277,000	278,000
Bulgaria, ferrosilicon ^c	10,000	6,000	3,000	--	--
Canada: ^c					
Ferrosilicon	35,000	35,000	25,820 ⁶	36,786 ⁶	31,039 ⁶
Silicon metal	30,000	50,000	30,000	30,000	30,000
Total	65,000	85,000	55,800	66,800	61,000
China: ^c					
Ferrosilicon	4,710,000	4,900,000	5,100,000	5,300,000	5,400,000
Silicon metal	950,000	980,000	1,230,000	1,300,000	1,400,000
Total	5,660,000	5,880,000	6,330,000	6,600,000	6,800,000
Egypt, ferrosilicon ^c	48,000	59,000	78,000	78,000	78,000
France: ^c					
Ferrosilicon	31,000	30,000	18,300	27,000	59,000
Silicon metal	120,000	118,000	80,000	112,000	128,000
Total	151,000	148,000	98,300	139,000	187,000
Germany, silicon metal	35,245	29,092	27,620	30,105	30,134 ⁶
Iceland, ferrosilicon	110,000 ^c	100,000 ^c	112,993	114,231	120,076 ⁶
India, ferrosilicon ^c	80,000	92,000	101,337 ⁶	101,000	105,000
Iran, ferrosilicon ^c	45,000	45,000	45,000	45,000	45,000
Kazakhstan:					
Ferrosilicon	59,886	54,964	33,100	4,813	10,000
Silicon metal	--	--	--	1,500 ^e	8,000
Total	59,886	54,964	33,100	6,313	18,000
Laos, silicon metal ^{e,5}	--	3,020	7,350	7,770	3,000
Macedonia, ferrosilicon	34,215	42,674	7,657	30,044	56,167 ⁶
Norway:					
Ferrosilicon	217,000 ^e	250,575	207,337	210,000 ^e	200,000
Silicon metal	145,782	180,135	169,643	170,000 ^e	170,000
Total	363,000 ^e	430,710	376,980	380,000 ^e	370,000
Peru, ferrosilicon ^c	600	600	600	600	600
Poland, ferrosilicon	58,538	56,031	9,685	53,206	53,000
Russia: ^c					
Ferrosilicon	896,100 ⁶	850,000	745,000	916,000	920,000
Silicon metal	54,000	54,000	23,900	48,700	50,000
Total	950,000	904,000	769,000	965,000	970,000
Slovakia, ferrosilicon	8,583	10,844	8,622	37,034	38,771 ⁶
Slovenia, ferrosilicon	6,000 ^e	--	--	--	--
South Africa:					
Ferrosilicon	140,000	135,000	110,000	118,000	112,000
Silicon metal	50,000	52,000	39,000	56,400	70,600
Total	190,000	187,000	149,000	174,400	183,000
Spain: ^c					
Ferrosilicon	71,000	74,000	44,000	64,400	57,000
Silicon metal	32,000	33,000	23,000	32,500	43,000
Total	103,000	107,000	67,000	96,900	100,000
Sweden, ferrosilicon ^c	5,000	5,000	5,000	5,000	5,000
Thailand, silicon metal	--	--	NA	22,500 ^e	20,000

See footnotes at end of table.

TABLE 9—Continued
 FERROSILICON AND SILICON METAL: WORLD PRODUCTION, BY COUNTRY^{1,2,3}

(Metric tons, gross weight)

Commodity and country	2007	2008	2009	2010	2011 ^c
Turkey, ferrosilicon ^c	5,000	4,500	4,000	4,000	4,000
Ukraine, ferrosilicon	218,000	152,800	150,300	195,500	150,900 ⁶
United States, net production:					
Ferrosilicon	220,000	248,000	194,000	370,000	(7)
Silicon metal	W	W	W	W	(7)
Total	220,000	248,000	194,000	370,000	437,000 ^{6,8,9}
Uruguay, ferrosilicon ^c	200	200	200	200	200
Venezuela, ferrosilicon ^c	94,000	88,000	52,100	76,800	70,000
Grand total	8,900,000	9,110,000	9,110,000	10,000,000	10,300,000 ¹⁰
Of which:					
Ferrosilicon	7,310,000	7,430,000	7,300,000	8,040,000	7,770,000 ¹¹
Silicon metal ¹²	1,600,000	1,680,000	1,800,000	1,990,000	2,130,000
U.S. total silicon materials	W	W	W	W	437,000

^cEstimated. NA Not available. W Withheld to avoid disclosing company proprietary data; not included in "Total." -- Zero.

¹World totals, U.S. data, and estimated data are rounded to no more than three significant digits; may not add to totals shown.

²Table includes data available through August 23, 2012.

³Excludes semiconductor and solar grades of silicon metal.

⁴Exports.

⁵Net exports.

⁶Reported figure.

⁷Withheld to avoid disclosing company proprietary data; included in "Total."

⁸Includes total ferrosilicon and silicon metal to avoid disclosing company proprietary data.

⁹For January 2011, data include ferrosilicon and silicon alloys only.

¹⁰Includes total U.S. net production of ferrosilicon and silicon metal.

¹¹Excludes U.S. net production of ferrosilicon.

¹²Excludes U.S. net production of silicon metal.

TABLE 10
SILICON MATERIALS: PROJECTS SCHEDULED FOR COMPLETION, BY YEAREND 2015^{1, 2, 3}

(Metric tons, gross weight, unless otherwise specified)

Projected year of first production	Country	Project and company	Project type	Incremental annual production capacity	Total annual production capacity	Silicon product ⁴
2011	Australia	Simcoa Silicon Plant Simcoa Operations Pty., Ltd.	silicon plant expansion	16,000	49,000 ^r	Si.
2011	China	Qinghai Wutong Plant Qinghai Wutong (Group) Industry Co., Ltd.	ferroalloys plant expansion	25,000	450,000	FeSi.
2011	Russia	Yurga Plant JSC ⁵ Kuznetsk Ferroalloys	do.	41,400	80,000	Do.
2011	South Africa	Rand Carbide Plant Silicon Smelters, (Pty) Ltd.	ferroalloys plant conversion	12,000 ^c	12,000 ^c	Si.
2011	Thailand	Ratchaburi Silicon Plant G.S. Energy Co., Ltd.	ferroalloys plant expansion	20,000	45,000	Do.
2012 ^r	China	ERDOS Qipanjing Plant ERDOS Group	do.	50,000 ^r	650,000 ^r	FeSi.
2012 ^r	Do.	Ferroatlántica Sichuan Silicon Plant Ganzi Ferroatlántica Silicon Industry Co., Ltd. ⁶	new silicon smelter	XX	42,000 ^r	Si.
2012	India	Amit Ferroalloys Plant ⁷ Amit Ferro-Alloys & Steel Pvt. Ltd.	new ferroalloys plant	XX	19,800	FeSi.
2012	Malaysia	Banting Silicon Plant Elpion Co., Ltd.	new silicon plant	XX	50,000	Si.
2012	Sweden	Vargön Alloys Ferroalloys Plant ⁸ Vargön Alloys AB	ferroalloys plant conversion	XX	25,000	FeSi.
2012	Uzbekistan	Navoi Silicon Plant Uz-Kor-Silicon	new silicon plant	XX	12,000	Si.
2013 ^r	Australia	Simcoa Silicon Plant Simcoa Operations Pty., Ltd.	silicon plant expansion	16,000	64,000	Do.
2013	China	Ferroatlántica Sichuan Silicon Plant Ganzi Ferroatlántica Silicon Industry Co., Ltd. ⁶	do.	42,000 ^{r, c}	84,000 ^{r, c}	Do.
2013	Malaysia	Pertama Ferroalloys Plant ⁹ Pertama Ferroalloy SDN BHD	new ferroalloys plant	XX	67,000	FeSi.
2013	Russia	Bratsk Ferroalloy Plant Mechel OAO	ferroalloys plant expansion	34,800	122,000	Do.
2013	Do.	Chelyabinsk Electrometallurgical Integrated Plant Chelyabinsk Group	do.	300,000	600,000 ^{r, c}	Do.
2013	Do.	Yurga Plant JSC ⁵ Kuznetsk Ferroalloys	do.	70,000	150,000	Do.
2014	China	Ferroatlántica Sichuan Silicon Plant Ganzi Ferroatlántica Silicon Industry Co., Ltd. ⁶	silicon plant expansion	44,000 ^c	128,000 ^{r, c}	Si.
2014 ^c	Malaysia	Asia Cement Silicon Plant Asia Cement Co.	new silicon plant	XX	33,000	Do.
2014	Do.	Banting Silicon Plant Elpion Co., Ltd.	silicon plant expansion	50,000	100,000	Do.
2014	Do.	Pertama Ferroalloys Plant ⁹ Pertama Ferroalloy SDN BHD	ferroalloys plant expansion	45,000	112,000	FeSi.
2014	Do.	Sarawak Ferroalloys Plant ¹⁰ OM Materials (S) Pte Ltd. (80%) and Cahya Mata Sarawak Berhard (20%)	new ferroalloys plant	XX	150,000 ^c	Do.
2015	Iceland	PCC ¹¹ Silicon Plant PCC ¹¹ BakkiSilicon	new silicon plant	XX	32,000	Si.
2015	Do.	Thorsil Silicon Plant Thorsil ehf	do.	XX	53,000	Do.
2015	Malaysia	Sarawak Ferroalloys Plant ¹⁰ OM Materials (S) Pte Ltd. (80%) and Cahya Mata Sarawak Berhard (20%)	new ferroalloys plant	150,000 ^c	300,000	FeSi.

^cEstimated. ^rRevised. Do., do. Ditto. XX Not applicable.

¹Estimated data are rounded to no more than three significant digits.

TABLE 10—Continued
SILICON MATERIALS: PROJECTS SCHEDULED FOR COMPLETION, BY YEAREND 2015^{1,2,3}

²Excludes silicon metal containing more than 99.99% silicon.

³Projects in feasibility or later stages of development in 2011. Actual startup dates may be postponed, owing to economic or other factors. Additional projects might produce silicon materials by 2015, but not enough information was available to include them.

⁴FeSi Ferrosilicon and Si Silicon metal (containing 99.99% or less Si).

⁵JSC joint-stock company.

⁶A joint-venture between Grupo Ferroatlántica, S.L. (75%) and Ganzhi Perfecture Kangding Sunday Silicon Co., Ltd. (25%).

⁷The Amit ferroalloys plant will also have a ferromanganese production capacity of 55,400 metric tons per year (t/yr) and a silicomanganese production capacity of 39,600 t/yr.

⁸One 30,000-metric-ton-per-year ferrochromium furnace will be converted to ferrosilicon production.

⁹The Pertama ferroalloys plant will have a 175,000-metric-ton-per-year capacity to produce medium- and low-carbon ferromanganese and silicomanganese, as well as a 50,000-metric-ton-per-year capacity to produce electrolytic manganese metal.

¹⁰The Sarawak ferroalloys plant will also have a silicomanganese production capacity of 300,000 t/yr.

¹¹Petro Carbo Chem.

Sources: Company annual reports, presentations, and press releases; unpublished personal communications; and trade publications.