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Economic Impact Analysis of Final Integrated Iron and Steel NESHAP

Final Report

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Economic Impact Analysis of
the Final Integrated Iron and Steel NESHAP

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This report contains portions of the economic impact analysis report that are related to the industry profile.

SECTION 2
INDUSTRY PROFILE

Iron is produced from iron ore, and steel is produced by progressively removing impurities from iron ore or ferrous scrap. Iron and steel manufacture is included under Standard Industrial Classification (SIC) code 3312—Blast Furnaces and Steel Mills, which also includes the production of coke, an input to the iron making process. In 2000, the United States produced 109.1 million tons of steel. Steel is primarily used as a major input to consumer products such as automobiles and appliances. Therefore, the demand for steel is a derived demand that depends on a diverse base of consumer products.

This section provides a summary profile of the integrated iron and steel industry in the United States. Technical and economic aspects of the industry are reviewed to provide background for the economic impact analysis. Section 2.1 provides an overview of the production processes and the resulting types of steel mill products. Section 2.2 summarizes the organization of the U.S. integrated iron and steel industry, including a description of the U.S. integrated iron and steel mills, the companies that own these facilities, and the markets for steel mill products. Section 2.3 describes uses and consumers. Section 2.4 presents market data on the iron and steel industry, including U.S. production, consumption, foreign trade and prices. Finally, Section 2.5 discusses recent trends in the steel industry.

2.1 Production Overview

Figure 2-1 illustrates the four-step production process for the manufacture of steel products at integrated iron and steel mills. The first step is iron making. Primary inputs to the iron making process are iron ore or other sources of iron, coke or coal, and flux. Pig iron is the primary output of iron making and the primary input to the next step in the process, steel making. Metal scrap and flux are also used in steel making. The steel making process produces molten steel that is shaped into solid forms at forming mills. Finishing mills then shape, harden, and treat the semi-finished steel to yield its final marketable condition.

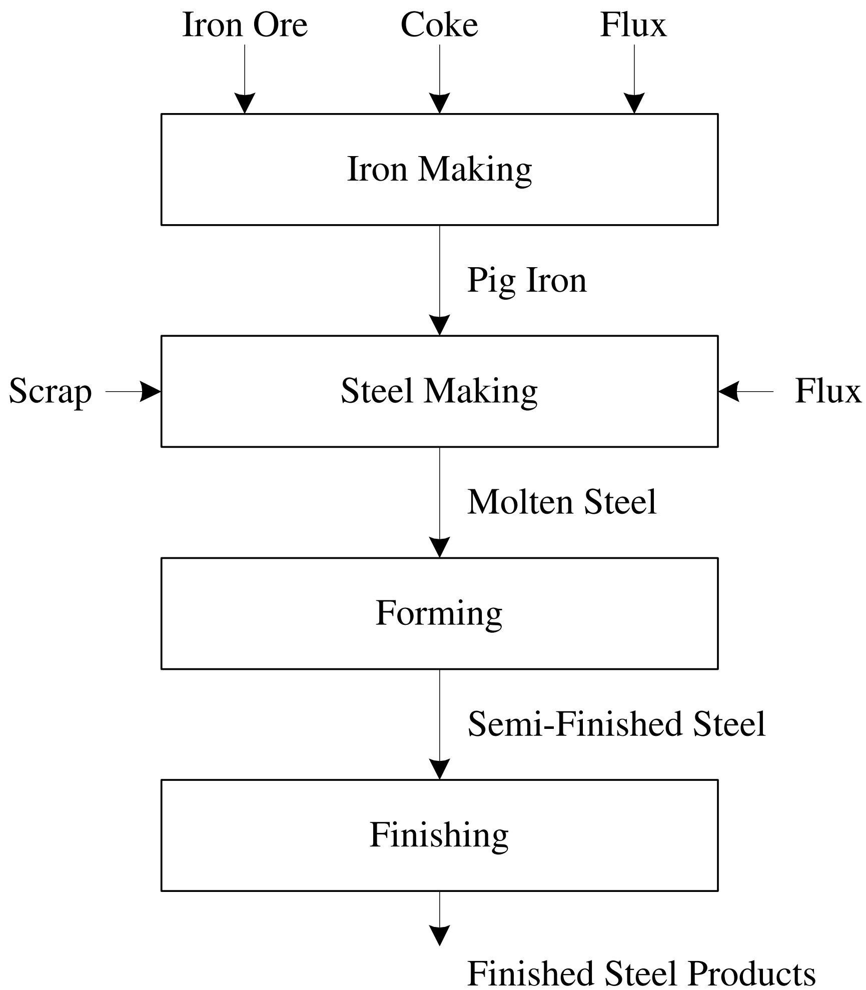

Figure 2-1. Overview of the Integrated Steel Making Process

2.1.1 Iron Making

Blast furnaces are the primary site of iron making at integrated facilities where iron ore is converted into more pure and uniform iron. Blast furnaces are tall steel vessels lined with heat-resistant brick (AISI, 1989a). They range in size from 23 to 45 feet in diameter and are over 100 feet tall (Hogan and Koelble, 1996; Lankford et al., 1985). Conveyor systems of carts and ladles carry inputs and outputs to and from the blast furnace.

Iron ore, coke, and flux are the primary inputs to the iron making process. Iron ore, which is typically 50 to 70 percent iron, is the primary source of iron for integrated iron and steel mills. Pellets are the primary source of iron ore used in iron making at integrated steel mills. Iron can also be captured by sintering from fine grains, pollution control dust, and sludge. Sintering ignites these materials and fuses them into cakes that are 52 to 60 percent iron. Other iron sources are scrap metal, mill scale, and steel making slag that is 20 to 25 percent iron (Lankford et al., 1985).

Coke is made in ovens that heat metallurgical coal to drive off gases, oil, and tar, which can be collected by a coke by-product plant to use for other purposes or to sell. Coke may be generated by an integrated iron and steel facility or purchased from a merchant coke producer. Iron makers are exploring techniques that directly use coal to make iron, thereby eliminating the need to first make coke. Coke production is responsible for 72 percent of the particulates released in the manufacture of steel products (Prabhu and Cilione, 1992).

Flux is a general name for any material used in the iron or steel making process that is used to collect impurities from molten metal. The most widely used flux is lime. Limestone is also directly used as a flux, but it reacts more slowly than lime (Fenton, 1996).

Figure 2-2 shows the iron making process at blast furnaces. Once the blast furnace is fired up, it runs continuously until the lining is worn away. Coke, iron materials, and flux are charged into the top of the furnace. Hot air is forced into the furnace from the bottom. The hot air ignites the coke, which provides the fuel to melt the iron. As the iron ore melts, chemical reactions occur. Coke releases carbon as it burns, which combines with the iron. Carbon bonds with oxygen in the iron ore to reduce the iron oxide to pure iron. The bonded carbon and oxygen leave the molten iron in the form of carbon monoxide, which is the blast furnace gas. Some of the carbon remains in the iron. Carbon is an important component of iron and steel, because it allows iron and steel to harden when they are cooled rapidly.

Flux combines with the impurities in molten iron to form slag. Slag separates from the molten iron and rises to the surface. A tap removes the slag from the iron while molten iron, called hot metal, is removed from a different tap at 2,800 to 3,000°F. Producing a metric ton of iron from a blast furnace requires 1.7 metric tons of iron ore, 450 to 650 kilograms of coke, 250 kilograms of flux, and 1.6 to 2.0 metric tons of air (Lankford et al., 1985).

Hot metal may be transferred directly to steel making furnaces. Hot metal that has cooled and solidified is called pig iron. Pig iron is at least 90 percent iron and 3 to 5 percent carbon (Lankford et al., 1985). Pig iron is typically used in steel making furnaces, but it also may be cast for sale as

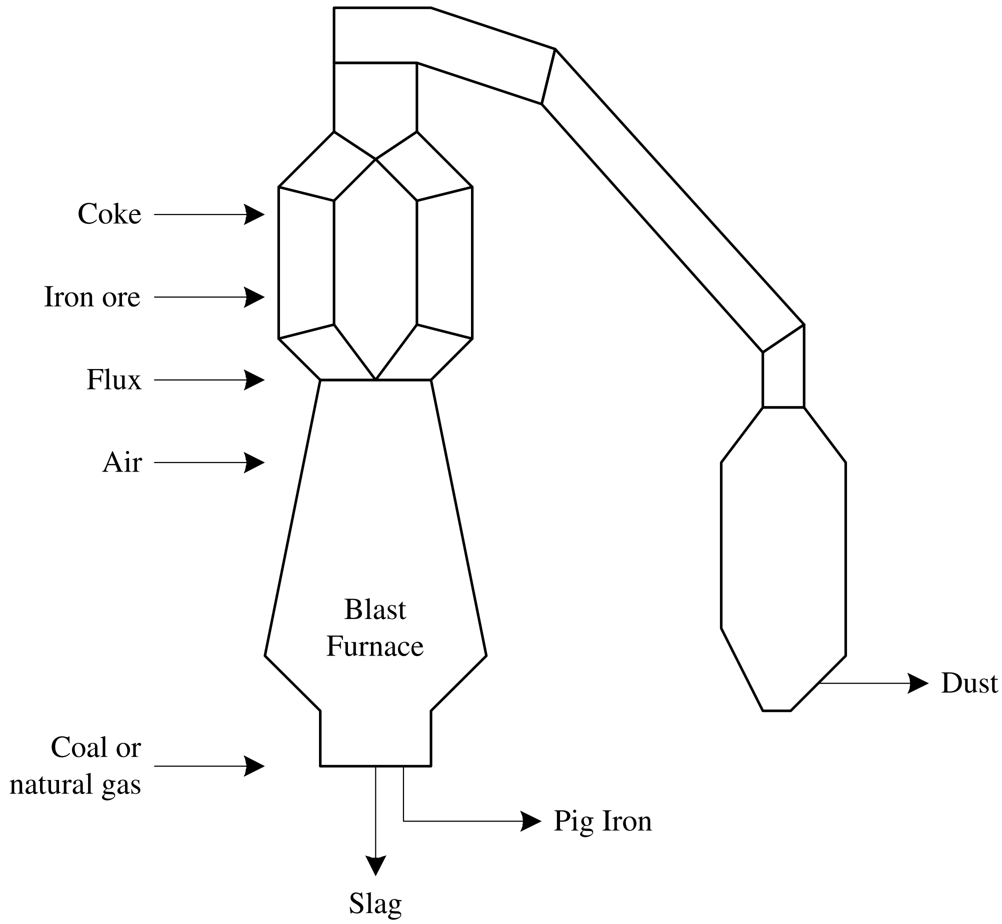

Figure 2-2. Iron Making Process: Blast Furnace

Source: U.S. Environmental Protection Agency, Office of Compliance. 1995. *EPA Office of Compliance Sector Notebook Project: Profile of the Iron and Steel Industry*. Washington, DC: Environmental Protection Agency.

merchant pig iron. Merchant pig iron may be used by foundries or electric arc furnace (EAF) facilities that do not have iron making capabilities. In 1997, blast furnaces in the United States produced 54.7 million short tons of iron, of which 1.2 percent was sold for use outside of integrated iron and steel mills. Six thousand tons of pig iron were used for purposes other than steel making (AISI, 1998).

2.1.2 Steel Making

Steel making is carried out in basic oxygen furnaces or in EAFs, while iron making is only carried out in blast furnaces. Basic oxygen furnaces are the standard steel making furnace used at integrated mills, although two facilities use EAFs. EAFs are the standard furnace at mini-mills since they use scrap metal efficiently on a small scale. Open hearth furnaces were used to produce steel prior to 1991 but have not been used in the United States since that time.

Hot metal or pig iron is the primary input to the steel making process at integrated mills. Hot metal accounts for up to 80 percent of the iron charged into a steel making furnace (AISI, 1989a). Scrap metal is also used, which either comes as wastes from other mill activities or is purchased on the scrap metal market. Scrap metal must be carefully sorted to control the alloy content of the steel. Direct-reduced iron (DRI) may also be used to increase iron content, particularly in EAFs that use mainly scrap metal for the iron source. DRI is iron that has been formed from iron ore by a chemical process, directly removing oxygen atoms from the iron oxide molecules.

Predictions for iron sources for basic oxygen furnaces in the year 2004 indicate an expected decrease in the use of pig iron and expected increases in the use of scrap and DRI. Shares for basic oxygen furnaces in 2004 are predicted to be 67 percent pig iron, 27 percent scrap, and 6 percent DRI. In contrast, shares for EAFs in 2004 are predicted to be 2 percent pig iron, 88 percent scrap, and 10 percent DRI (Dun & Bradstreet, 1998).

Figure 2-3 shows the steel making process at basic oxygen furnaces and EAFs. At basic oxygen furnaces, hot metal and other iron sources are charged into the furnace. An oxygen lance is lowered into the furnace to inject high purity oxygen—99.5 to 99.8 percent pure—to minimize the introduction of contaminants. Some basic oxygen furnaces insert the oxygen from below. Energy for the melting of scrap and cooled pig iron comes from the oxidation of silicon, carbon, manganese, and phosphorous. Flux is added to collect the oxides produced in the form of slag and to reduce the levels of sulfur and phosphorous in the metal. Approximately 365 kilograms of lime are needed to produce a metric ton of steel (AISI, 1989a). The basic oxygen process can produce approximately 300 tons in 45 minutes (AISI, 1989a). When the process is complete, the furnace is tipped and the molten steel flows out of a tap into a ladle.

EAFs have removable roofs so that they can be charged from the top. EAFs primarily use scrap metal for the iron source, but alloys may also be added before the melt. In EAFs, electric arcs are formed between two or three carbon electrodes. The EAFs require a power source to supply the charge necessary to generate the electric arc and typically use electricity purchased from an outside source. If electrodes are aligned so that the current passes above the metal, the metal is heated by radiation from the arc. If the electrodes are aligned so that the current passes through the metal, heat is generated by the resistance of the metal in addition to the arc radiation. Flux is blown or deposited on top of the metal after it

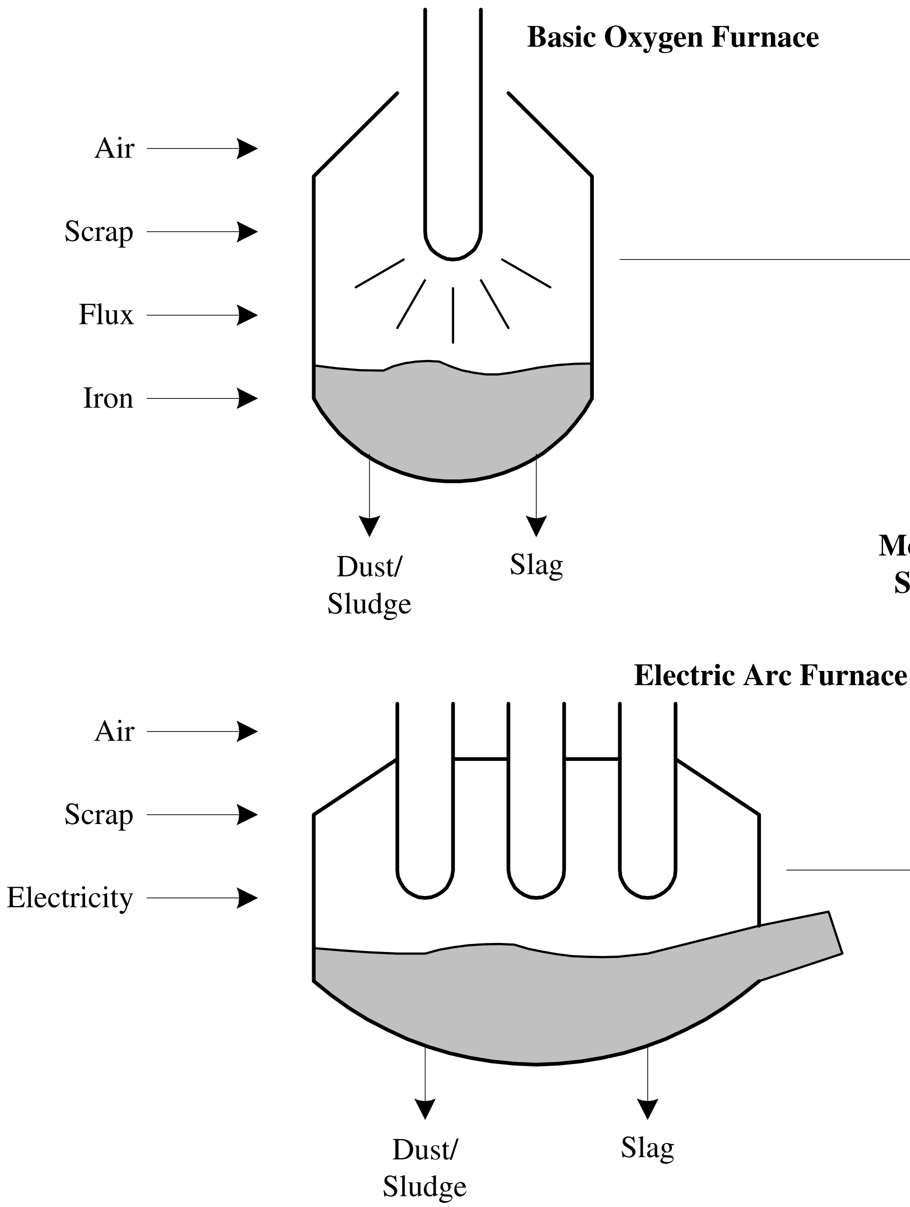

Figure 2-3. Steel Making Processes: Basic Oxygen Furnace and Electric Arc Furnace

Source: U.S. Environmental Protection Agency, Office of Compliance. 1995. *EPA Office of Compliance Sector Notebook Project: Profile of the Iron and Steel Industry*. Washington, DC: Environmental Protection Agency.

has melted. Impurities are oxidized by the air in the furnace and oxygen injections. The melted steel should have a carbon content of 0.15 to 0.25 percent greater than desired because the excess will escape as carbon monoxide as the steel boils. The boiling action stirs the steel to give it a uniform composition. When complete, the furnace is tilted so that the molten steel can be drained through a tap. The slag may be removed from a separate tap. The EAF process takes 2 to 3 hours to complete (EPA, 1995).

Steel often undergoes additional, referred to as secondary, metallurgical processes after it is removed from the steel making furnace. Secondary steel making takes place in vessels, smaller furnaces, or the ladle. These sites do not have to be as strong as the primary refining furnaces because they are not required to contain the powerful primary processes. Secondary steel making can have many purposes, such as removal of oxygen, sulfur, hydrogen, and other gases by exposing the steel to a low-pressure environment; removal of carbon monoxide through the use of deoxidizers such as aluminum, titanium, and silicon; and changing of the composition of unremovable substances such as oxides to further improve mechanical properties.

Molten steel transferred directly from the steel making furnace is the primary input to the forming process. Forming must be done quickly before the molten steel begins to cool and solidify. Two generalized methods are used to shape the molten steel into a solid form for use at finishing mills: ingot casting and continuous casting machines (Figure 2-4). Ingot casting is the traditional method of forming molten steel in which the metal is poured into ingot molds and allowed to cool and solidify. However, continuous casting currently accounts for approximately 95 percent of forming operations (AISI, 1998). Continuous casting, in which the steel is cast directly into a moving mold on a machine, reduces loss of steel in processing up to 12 percent over ingot pouring (USGS, 1998). Continuous casting is projected to account for nearly 100 percent of steel mill casting by the year 2004 (Dun & Bradstreet, 1998).

2.1.3 Types of Steel Mill Products

Carbon steel is the most common type of steel by metallurgical content (see Figure 2-5). By definition, for a metal to be steel it must contain carbon in addition to iron. Increases in carbon content increase the hardness, tensile strength, and yield strength of steel but can also make steel susceptible to cracking. Alloy steel is the general name for the wide variety of steels that manipulate alloy content for a specific group of attributes. Alloy steel does not have strict alloy limits but does have desirable

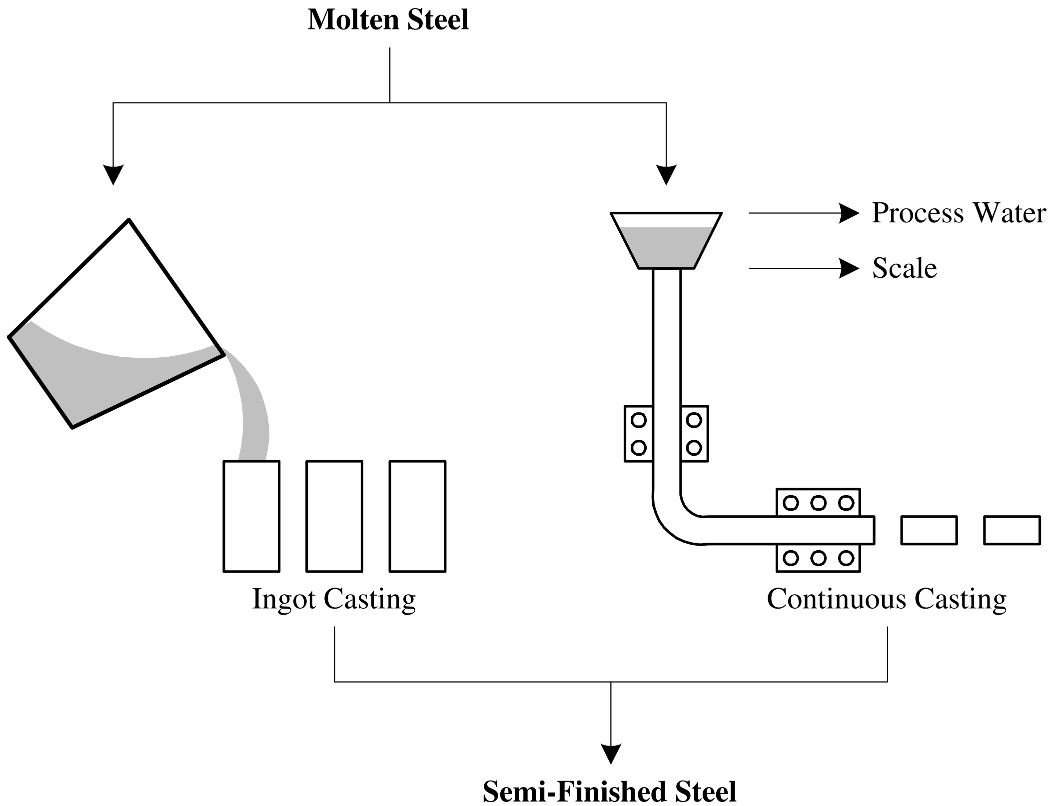

Figure 2-4. Steel Casting Processes: Ingot Casting and Continuous Casting

Source: U.S. Environmental Protection Agency, Office of Compliance. 1995. *EPA Office of Compliance Sector Notebook Project: Profile of the Iron and Steel Industry*. Washington, DC: Environmental Protection Agency.

ranges. Some of the common alloy materials are manganese, phosphorous, and copper. Stainless steel must have a specific mix of at least 10 percent chromium and 50 percent iron content (AISI, 1989b).

Semi-finished steel forms from the casting process are passed through processing lines at finishing mills to give the steel its final shape (Figure 2-6). At rolling mills, steel slabs are flattened or rolled into pipes. At hot strip mills, slabs pass between rollers until they have reached the desired thickness. The slabs may then be cold rolled in cold reduction mills. Cold reduction, which applies greater pressure than the hot rolling process, improves mechanical properties, machinability, and size accuracy, and produces thinner gauges than

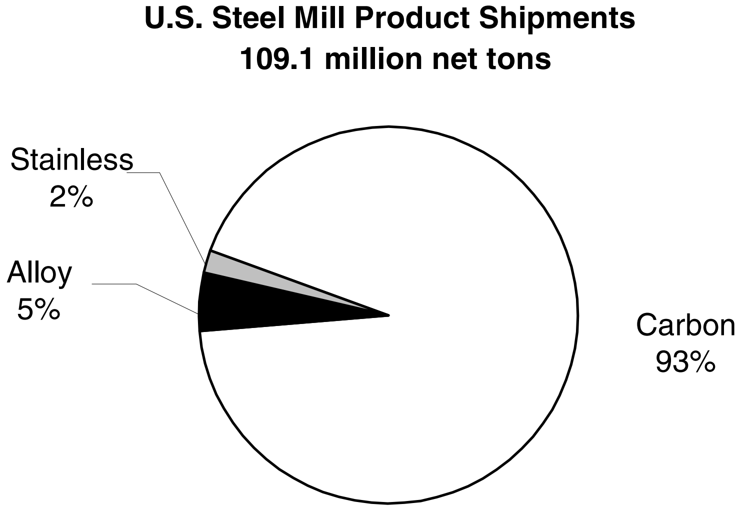

Figure 2-5. U.S. Steel Mill Product Shipments by Type of Steel: 2000

Source: American Iron and Steel Institute (AISI). 2002. AISI Statistics. <http://www.steel.org/stats/>. As obtained August 2002.

possible with hot rolling alone. Cold reduction is often used to produce wires, tubes, sheet and strip steel products.

After the shape and surface quality of steel have been refined at finishing mills, the metal often undergoes further processes for cleansing. Pressurized air or water and cleaning agents are the first step in cleansing. Acid baths during the pickling process remove rust, scales from processing, and other materials. The cleaning and pickling processes help coatings to adhere to the steel. Metallic coatings are frequently applied to sheet and strip to inhibit corrosion and oxidation, and to improve visual appearance. The most common coating is galvanizing, which is a zinc coating. Other coatings include aluminum, tin, chromium, and lead. Semi-finished products are also finished into pipes and tubes. Pipes are produced by piercing a rod of steel to create a pipe with no seam or by rolling and welding sheet metal.

Slag is generated by iron and steel making. Slag contains the impurities of the molten metal, but it can be sintered to capture the iron content. Slag can also be sold for use by the cement industry, for railroad ballast, and by the construction industry, although steel making slag is not used for these purposes as often as iron making slag (EPA, 1995).

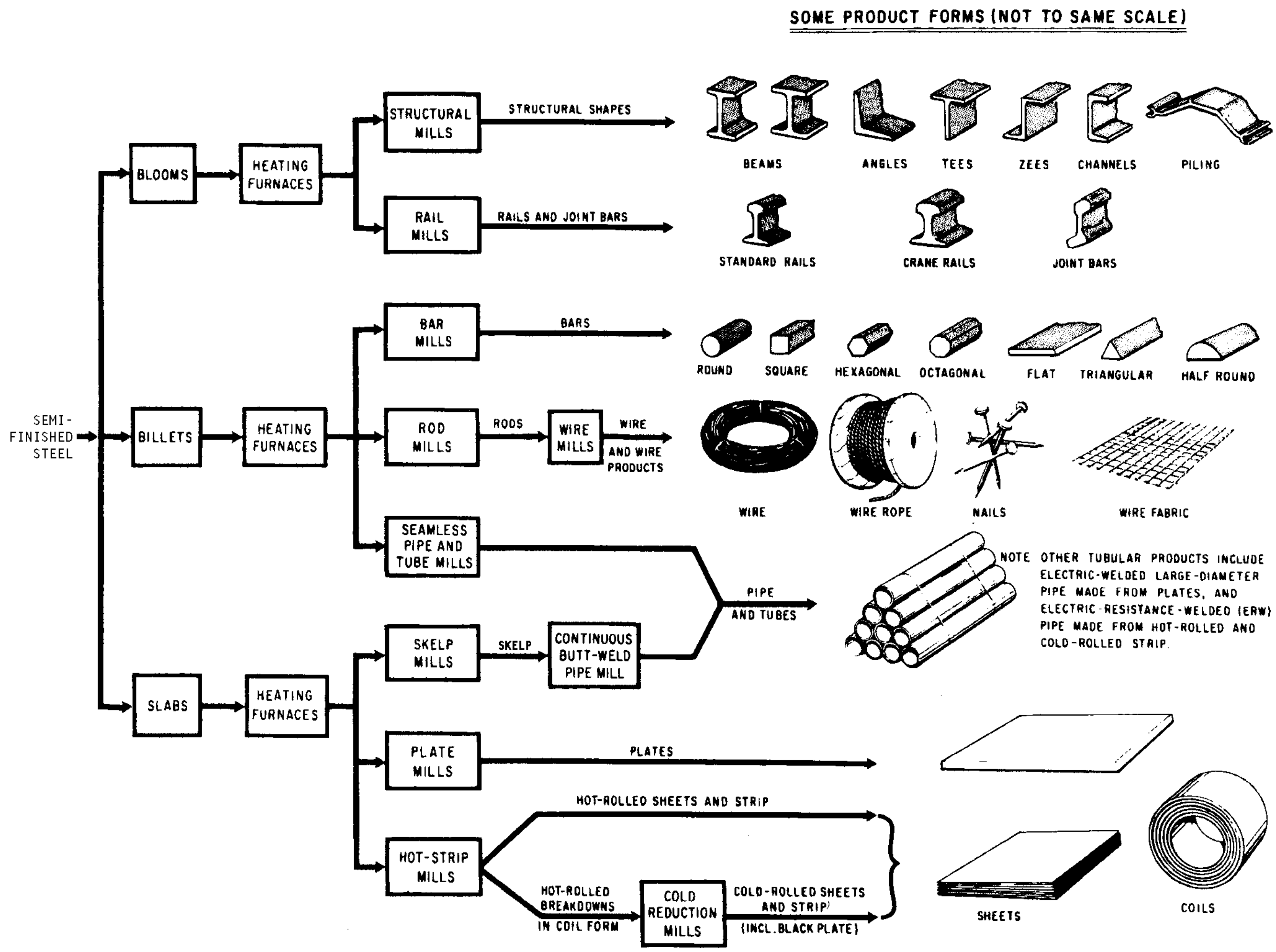

Figure 2-6. Steel Finishing Processes by Mill Type

Source: Lankford, William T., Norman L. Samways, Robert F. Craven, and Harold E. McGannon, eds. 1985. *The Making, Shaping and Treating of Steel*. Pittsburgh: United States Steel, Herbick & Held.

2.1.4 Emissions

Emissions are generated from numerous points throughout the integrated steel mill production processes. Blast furnace gas, such as carbon monoxide, is often used to heat the air incoming to the blast furnace and can also be used as fuel if it is first cleaned. The iron making process often generates other gases from impurities such as sulfur dioxide or hydrogen sulfide.

Particulates may be included in the blast furnace gas. The steel making process also generates gases that typically contain metallic dust such as iron particulates, zinc, and lead. In addition, when the steel is poured, fumes are released that contain iron oxide and graphite. Air filters and wet scrubbers of emissions generate dust and sludge.

About a thousand gallons of water are used per ton of steel to cleanse emissions (EPA, 1995). The water used to cool and rinse the steel picks up lubricants, cleansers, mill scale, and acids. A sludge may form that contains metals such as cadmium, chromium, and lead.

2.2 Industry Organization

2.2.1 Iron and Steel Making Facilities

As of 2000, twenty integrated steel plants operated in the United States (see Figure 2-7). Five facilities are located in Ohio, four are in Indiana, two each are in Illinois, Alabama, and Michigan, and one each is in Kentucky, Maryland, Utah, Pennsylvania, and West Virginia. However, four of these plants ceased operations in late 2000 and early 2001. Recently, International Steel Group (ISG) purchased LTV assets and these two plants reportedly plan to re-open their operations in 2002.

EPA developed a baseline data set for the economic model that characterized baseline coke, iron and steel making operations in the year 2000 (see Table 2-1). The sources of these data include information the 1997 ICR and updates (EPA, 1998a and 1998b), recent 10-K and annual reports for parent companies, and publicly available USITC publications. As shown, twenty steel making facilities have basic oxygen furnaces, while only two facilities have EAFs: Inland Steel and Rouge Steel. Total basic oxygen capacity at integrated mills is approximately 61 million tons per year, while the EAF capacity is only 1.5 million tons per year.

Since 1995, total domestic steel making capacity (basic oxygen process and electric) has consistently increased (see Table 2-2). However, total capacity fell in 2001 with utilization rates reaching a ten year low of 79.2 percent. Declining economic conditions in the United States coupled with strong import competition contributed to this decline.

2.2.2 Companies

Companies that own integrated iron and steel plants are legal business entities that have the capacity to conduct business transactions and make business decisions that affect the facility. As shown in Table 2-3, 14 parent companies own the 20 U.S. integrated iron and steel plants operating in 2000. Total revenues for these companies range from

Figure 2-7. Location of U.S. Integrated Iron and Steel Manufacturing Plants: 2000

Source: Association of Iron and Steel Engineers (AISE). 1998. *1998 Directory Iron and Steel Plants*. Pittsburgh, PA: AISE.

$100 million to $40 billion, with an average of $5.7 billion (see Table 2-4). According to the Small Business Administration's (SBA's) criterion (e.g., fewer than 1,000 employees), none of the companies owning integrated iron and steel plants are classified as small businesses.

Many of the companies that own integrated mills own multiple facilities, indicating horizontal integration. Some companies also have additional vertical integration. Companies may own service centers to distribute their steel products, or coal and iron ore mines and transportation operations to capture the early stages of steel production. For example, Bethlehem Steel owns BethForge, which manufactures forged steel and cast iron products, and BethShip, which services ships and fabricates some industrial products.

Table 2-1. Baseline Data for Integrated Iron and Steel Mills: 2000

		Iron Making	Steel Making			Coke Making			
			1997 Capacity		2000 Steel				
Facility Name	Location	1997 Capacity	Basic Oxygen Process	Electric	Mill Products[a]	1997 Capacity	2000 Production[a]	2000 Total Demand[a]	Current Status
Acme Steel Company	Riverdale, IL[b]	1,000,000	1,200,000	—	864,860	493,552	484,725	270,762	Closed 2001
AK Steel	Ashland, KY	2,000,000	2,100,000	—	1,999,472	942,986	703,982	723,240	
AK Steel	Middletown, OH	2,300,000	2,640,000	—	2,513,622	410,000	306,084	831,726	
Bethlehem Steel[c]	Burns Harbor, IN	4,960,000	5,600,000	—	5,168,702	1,672,701	1,248,747	1,884,800	Chapter 11 bankruptcy—2001
Bethlehem Steel	Sparrows Pt., MD	3,100,000	3,375,000	—	2,918,325	—	—	1,103,600	Chapter 11 bankruptcy—2001
Geneva Steel	Orem, UT	2,628,000	2,700,000	—	1,912,000	700,002	522,583	914,820	Chapter 11 bankruptcy—2002
Gulf States Steel	Gadsden, AL	1,100,000	1,400,000	—	750,000	521,000	513,546	297,202	Closed late 2000
Inland Steel	East Chicago, IN	NA	NA	600,000	5,615,620	—	—	1,771,593	
LTV Steel	Cleveland, OH[d]	4,270,000	6,400,000	—	4,970,733	543,156	—	1,402,944	LTV ceased ops in late 2000; however, ISG purchased and operates in 2002
LTV Steel	East Chicago, IN[b]	3,320,000	3,800,000	—	2,951,372	590,250	440,648	1,090,813	LTV ceased ops in late 2000; however, ISG purchased and operates in 2002
National Steel	Granite City, IL	2,495,000	3,300,000	—	2,852,079	570,654	426,019	936,614	Chapter 11 bankruptcy—2002
National Steel	Ecorse, MI	3,440,000	3,600,000	—	3,111,359	908,733	678,411	1,291,364	Chapter 11 bankruptcy—2002
Rouge Steel	Dearborn, MI	2,934,600	3,300,000	850,000	2,817,526	—	—	783,361	
USX	Braddock, PA[e]	2,300,000	2,957,000	—	2,606,697	4,854,111	4,731,105	782,579	
USX	Fairfield, AL	2,190,000	2,240,000	—	2,010,159	—	—	758,556	
USX	Gary, IN	7,240,000	8,730,000	—	6,422,015	1,813,483	1,353,848	2,055,687	
USS/Kobe Steel	Lorain, OH	2,236,500	NA	—	1,874,000	—	—	685,044	Chapter 11 bankruptcy—2001
WCI Steel	Warren, OH	1,460,000	2,040,000	—	1,265,895	—	—	438,276	
Weirton Steel	Weirton, WV	2,700,000	3,000,000	—	2,428,901	—	—	922,500	
Wheeling-Pittsburgh	Mingo Junction, OH[f]	2,152,800	2,400,000	—	2,100,000	1,249,501	1,234,752	775,535	Chapter 11 bankruptcy—2000
Total		53,826,900	60,782,000	1,450,000	57,153,338	15,270,129	12,644,450	19,721,019	

[a] EPA estimates using selected 10K, 10K405, 10Q, and Annual Reports. The data were supplemented with market data from AISI (2002) and USITC (2001)

[b] Includes coke facilities at Chicago, IL.

[c] Bethlehem facility at Lackwanna, NY, not included. It has two coke batteries with coke-making capacity and production of 747,686 tons per year and a cold reduction mill.

[d] Includes coke facilities at Warren, OH.

[e] Includes coke facilities at Clairton, PA.

[f] Includes coke facilities at Follansbee, WV.

NA = not available.

Sources: Association of Iron and Steel Engineers (AISE). 1998. *1998 Directory Iron and Steel Plants*. Pittsburgh, PA: AISE.

U.S. Environmental Protection Agency (EPA). 1998b. *Update of Integrated Iron and Steel Industry Responses to Information Collection Request (ICR) Survey*. Database prepared for EPA's Office of Air Quality Planning and Standards. Research Triangle Park, NC: Environmental Protection Agency.

Table 2-2. U.S. Steel Making Capacity and Utilization: 1981-2001

	Total Capacity(10^6) (net short tons)	Capacity Utilization (%)
1990	116.7	84.7
1991	117.6	74.7
1992	113.1	82.2
1993	109.9	89.1
1994	108.2	93.0
1995	112.4	93.3
1996	116.1	90.7
1997	121.4	89.4
1998	125.3	86.8
1999	128.2	83.8
2000	130.4	86.1
2001	125.4	79.2

Source: American Iron and Steel Institute (AISI). 1991. *Annual Statistical Report.* Washington, DC: American Iron and Steel Institute.
American Iron and Steel Institute (AISI). 1998. *Annual Statistical Report.* Washington, DC: American Iron and Steel Institute.
American Iron and Steel Institute (AISI). 2002. AISI Statistics. <http://www.steel.org/stats/>. As obtained August 2002.

2.2.2.1 Profitability

The Agency collected additional 2000 financial data for affected domestic companies from publicly available financial statements. Although three of these firms (National Steel, U.S. Steel Group, and Ispat Inland, Inc.) are owned by another parent company, we used 10-K data for these subsidiaries to examine the profitability of domestic operations. We found that in the baseline year of the analysis, only five of these companies reported positive operating income. Of the remaining firms nine firms with negative operating income data, three have subsequently closed (Acme Steel, Gulf States Steel, and LTV Corporation[1]). Five (Bethlehem Steel, Geneva Steel, National Steel Group, Republic Technologies, and WHX Corporation) companies have filed voluntary petitions for relief under Chapter 11 of the U.S.

[1]International Steel Group (ISG) announced plans to open LTV's plants in 2002.

Table 2-3. Baseline Data for U.S. Integrated Iron and Steel Mills By Parent Company: 2000

	Iron Making	Steel Making			Coke Making		
		1997 Capacity					
Parent Company Name	1997 Capacity	Basic Oxygen Process	Electric	2000 Steel Mill Products[a]	1997 Capacity	2000 Production[a]	2000 Total Demand[a]
Acme Metals Inc.	1,000,000	1,200,000	—	864,860	493,552	484,725	270,762
AK Steel Corporation	4,300,000	4,740,000	—	4,513,093	1,352,986	1,010,066	1,554,966
Bethlehem Steel Corporation	8,060,000	8,975,000	—	8,087,027	1,672,701	1,248,747	2,988,400
Geneva Steel Company	2,628,000	2,700,000	—	1,912,000	700,002	522,583	914,820
HMK Enterprises Inc.	1,100,000	1,400,000	—	750,000	521,000	513,546	297,202
Inland Steel Industries Inc.	NA	NA	600,000	5,615,620	—	—	1,771,593
LTV Corporation	7,590,000	10,200,000	—	7,922,105	1,133,406	440,648	2,493,757
National Steel Corporation	5,935,000	6,900,000	—	5,963,439	1,479,387	1,104,430	2,227,978
Renco Group Inc.	2,934,600	3,300,000	850,000	2,817,526	—	—	783,361
Rouge Industries Inc.	2,236,500	NA	—	1,874,000	—	—	685,044
USS/KOBE Steel Company	11,730,000	13,927,000	—	11,038,871	6,667,594	6,084,953	3,596,823
USX Corporation	1,460,000	2,040,000	—	1,265,895	—	—	438,276
Weirton Steel Corporation	2,700,000	3,000,000	—	2,428,901	—	—	922,500
WHX Corporation	2,152,800	2,400,000	—	2,100,000	1,249,501	1,234,752	775,535
Total	53,826,900	60,782,000	1,450,000	57,153,338	15,270,129	12,644,450	19,721,019

[a] EPA estimates using selected 10K, 10K405, 10Q, and Annual Reports. The data were supplemented with market data from AISI (2002) and USITC (2001)

[b] Includes coke facilities at Chicago, IL.

[c] Bethlehem facility at Lackwanna, NY, not included. It has two coke batteries with coke-making capacity and production of 747,686 tons per year and a cold reduction mill.

[d] Includes coke facilities at Warren, OH.

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NA = not available.

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Sources: Association of Iron and Steel Engineers (AISE). 1998. *1998 Directory Iron and Steel Plants*. Pittsburgh, PA: AISE.
U.S. Environmental Protection Agency (EPA). 1998b. *Update of Integrated Iron and Steel Industry Responses to Information Collection Request (ICR) Survey*. Database prepared for EPA's Office of Air Quality Planning and Standards. Research Triangle Park, NC: Environmental Protection Agency.

Table 2-4. Sales, Operating Income, and Profit Rate for Integrated Producers: 2000

	Total Revenue ($$10^6$)	Operating Income ($$10^6$)	Operating Margin ($$10^6$)	Net Income ($$10^6$)	Return on Sales ($$10^6$)	Status
Acme Metals Inc.	$501	–$13	–2.6%	–$43	–8.6%	Closed 2001
AK Steel Holding Corporation	$4,611	$338	7.3%	$132	2.9%	Operating
Bethlehem Steel Corporation	$4,197	–$95	–2.3%	–$118	–2.8%	Chapter 11 Bankruptcy—2001
Geneva Steel Company	$564	–$10	–1.8%	–$9	–1.6%	Chapter 11 Bankruptcy—2002
Gulf States Steel[a]	$101	–$2	–1.5%	–$4	–4.2%	Closed late 2000
Ispat International N.V.	$5,097	$315	6.2%	$99	1.9%	Operating
Ispat Inland Inc.	$2,305	$51	2.2%	–$33	–1.4%	Operating
LTV Corporation	$4,934	–$177	–3.6%	–$868	–17.6%	LTV ceased ops in late 2000; however, ISG prchased and operates in 2002
NKK Corporation	$14,148	$638	4.5%	$768	5.4%	Operating
National Steel Group	$2,979	–$117	–3.9%	–$130	–4.4%	Chapter 11 Bankruptcy—2002
Rouge Industries, Inc.	$1,100	–$167	–15.2%	–$117	–10.7%	Operating
Republic Technologies	$1,265	–$152	–12.0%	–$287	–22.7%	Chapter 11 Bankruptcy—2001
USX-Corporation	$39,914	$8,456	21.2%	$411	1.0%	Operating
USX-U.S. Steel Group	$6,132	$339	5.5%	–$21	–0.3%	Operating
WCI Steel Inc.	$561	$34	6.1%	$10	1.8%	Operating
Weirton Steel Corporation	$1,117	–$42	–3.8%	–$85	–7.6%	Operating
WHX Corporation	$1,745	$5	0.3%	–$181	–10.4%	Chapter 11 Bankruptcy—2000

[a] January through April 30, 2000.

Source: Hoover's Online.
Selected 10-K, 10-K405, 10-Q and Annual Reports.

Bankruptcy Code since December 2000. Although these filings do not necessarily imply closure, they provide an indicator of financial stress that currently exists among integrated iron and steel producers.

Based on industry financial statistics published by AISI, the average operating margin for the domestic steel segment between 1998 and 2001 is 2.5 percent. As shown in Table 2-5, profit margins for the industry fell to there lowest levels in 2000 (0.9 percent). This is coincided with a 6.2 percent increase in foreign steel imports that occurred between 1999 and 2000. However, preliminary data for 2001 show operating margins increasing to 7.8 percent in 2001 (AISI, 2002).

Table 2-5. Operating Margins for the Domestic Steel Industry: 1998–2000 ($$10^6$)

	Total Sales	Operating Income	Operating Margin
1998	$35,310	$353	1.0%
1999	$36,408	$367	1.0%
2000	$38,677	$366	0.9%
2001	$31,295	$2,440	7.8%
Totals	$141,690	$3,526	2.5%

Source: American Iron and Steel Institute (AISI). 2002. AISI Statistics. <http://www.steel.org/stats/>. As obtained August 2002.

2.3 Uses and Consumers

Automotive and construction industries are the two largest demanders of finished steel products, consuming 15 percent and 19 percent, respectively, of total net shipments in 2000 (see Figure 2-8). Although service centers are the single largest market group represented in Figure 2-8, they are not a single end user group because they represent businesses that buy steel mill products at wholesale and then resell them. We provide additional historical data on shipments by end use in Table 2-6.

Steel mill products are used for large automobile parts, such as body panels. One technique by steel makers is the use of high strength steel to address the automobile industry's need for lighter vehicles to achieve fuel efficiency gains. High strength steels are harder than the alloy steels traditionally used in the industry, meaning that less mass is necessary to build the same size vehicle. An UltraLight Steel Auto Body has recently been designed that has a 36 percent decrease in mass from a standard frame (*Steel Alliance*, 1998).

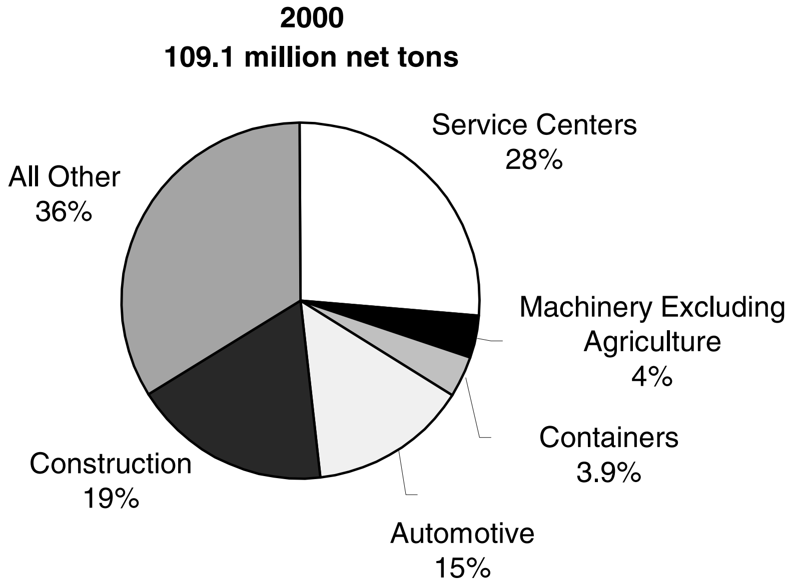

Figure 2-8. 2000 U.S. Steel Shipments: Selected Markets

Source: American Iron and Steel Institute (AISI). 1998. *Annual Statistical Report.* Washington, DC: American Iron and Steel Institute.
American Iron and Steel Institute (AISI). 2002. AISI Statistics. <http://www.steel.org/stats/>. As obtained August 2002.

Drawbacks are that the harder steels require additional processing to achieve a thin gauge, and manufacturing with high strength steels demands more care and effort due to the low levels of ductility (*Autosteel*, 1998a).

Steel makes up 95 percent of all metal used for structural purposes (Furukawa, 1998). High-strength low-alloy steels are increasingly used to construct bridges and towers because they are lighter than standard carbon. As a result, builders can use smaller sections, thus reducing wind resistance and allowing for easier construction. Steel use by construction has traditionally been limited to commercial construction, but as wood prices rise and wood quality drops with decreased available timber, steel mill products are gaining an increasing share of the residential housing market.

Because steel is used for such diverse products, there are numerous possible substitutes for it. In Table 2-7, alloy and carbon steel are compared to some possible substitutes. The density of both steels is greater than any of the substitutes, leading to greater weight. The cost per ton of all substitute materials is much higher than steel, except for wood and reinforced concrete. In addition, total annual production of the top three possible

Table 2-6. Net Shipments of Steel Mill Products by Consumer Type: 1981-1997 (10^3 short tons)

Year	Automotive	Construction	Appliances	Containers	Oil and Gas	Machinery and Electricity	Service Centers	Converting	Exports	All Other[a]	Total
1981	13,154	11,676	1,775	5,292	6,238	7,224	17,637	5,058	1,845	18,551	88,450
1982	9,288	8,570	1,337	4,470	2,745	4,587	13,067	3,222	832	13,449	61,567
1983	12,320	9,974	1,618	4,532	1,296	4,821	16,710	4,403	544	11,366	67,584
1984	12,882	10,153	1,635	4,352	2,003	5,251	18,364	5,136	428	13,535	73,739
1985	12,950	11,230	1,466	4,089	2,044	4,140	18,439	5,484	494	12,707	73,043
1986	11,889	10,614	1,648	4,113	1,023	4,189	17,478	5,635	495	13,179	70,263
1987	11,343	11,018	1,633	4,372	1,489	4,650	19,840	7,195	515	14,599	76,654
1988	12,555	12,102	1,638	4,421	1,477	5,257	21,037	8,792	1,233	15,328	83,840
1989	11,763	11,500	1,721	4,459	1,203	4,858	20,769	8,235	3,183	16,409	84,100
1990	11,100	12,115	1,540	4,474	1,892	4,841	21,111	9,441	2,487	15,980	84,981
1991	10,015	11,467	1,388	4,278	1,425	4,084	19,464	8,265	4,476	13,984	78,846
1992	11,092	12,230	1,503	3,974	1,454	4,087	21,328	9,226	2,650	14,697	82,241
1993	12,719	13,429	1,592	4,355	1,526	4,404	23,714	9,451	2,110	15,722	89,022
1994	14,753	14,283	1,736	4,495	1,703	4,726	24,153	10,502	1,710	17,023	95,084
1995	14,622	14,892	1,589	4,139	2,643	4,707	23,751	10,440	4,442	16,269	97,494
1996	14,665	15,561	1,713	4,101	3,254	4,811	27,124	10,245	2,328	17,076	100,878
1997	15,251	15,885	1,635	4,163	3,811	4,789	27,800	11,263	2,610	18,651	105,858
Average Annual Growth Rates											
1981-1997	1.0%	2.3%	–0.5%	–1.3%	–2.4%	–2.1%	3.6%	7.7%	2.6%	0.0%	1.2%
1981-1989	–1.3%	–0.2%	–0.4%	–2.0%	–10.1%	–4.1%	2.2%	7.9%	9.1%	–1.4%	–0.6%
1989-1997	3.7%	4.8%	–0.6%	–0.8%	27.1%	–0.2%	4.2%	4.6%	–2.3%	1.7%	3.2%

[a] "All Other" includes rail transportation, aircraft and aerospace, shipbuilding, mining, agriculture, and nonclassified shipments.

Sources: American Iron and Steel Institute (AISI). 1991. *Annual Statistical Report.* Washington, DC: American Iron and Steel Institute.
American Iron and Steel Institute (AISI). 1993. *Annual Statistical Report.* Washington, DC: American Iron and Steel Institute.
American Iron and Steel Institute (AISI). 1998. *Annual Statistical Report.* Washington, DC: American Iron and Steel Institute.

Table 2-7. Comparison of Steel and Substitutes by Cost, Strength, and Availability

	Yield Strength MN/m^2	Density Mg/m^3	Cost $/metric ton	Absolute Production Weight (10^6 tons/yr)	Absolute Production Volume (10^6 m^3/yr)
Reinforced concrete	50	2.5	40	500	200
Wood	70	0.55	400	69	125
Alloy steel	1,000	7.87	826	86.2 (all steel)	11 (all steel)
Carbon steel	220	7.87	385 to 600	–[a]	–[a]
Aluminum alloy	1,300	2.7	3,500	3.8	1.4
Magnesium alloy	140	1.74	3,200	0.13	0.07
Titanium alloy	800	4.5	18,750	0.06	0.01
Glass-fiber reinforced plastic	200	1.8	3,900	NA	NA
Carbon-fiber reinforced plastic	600	1.5	113,000	NA	NA

[a] Production of carbon steel included with alloy steel.
NA = not available

Source: Paxton, H.W., and A.J. DeArdo. January 1997. "Steel vs. Aluminum, Plastic, and the Rest." *New Steel*.

replacements (aluminum, magnesium, and titanium) is only 4 million tons, less than 5 percent of steel's annual production. Thus, the threat of major replacement by substitutes is low (Paxton and DeArdo, 1997).

2.4 Market Data

The average annual production growth rate for steel mill products for the period 1990 and 2001 is approximately 1.5 percent (see Table 2-8). However, production declined sharply in 2001 (9.3 percent) as a result of declining economic conditions in the United States and import competition. In 2000, domestic steel producers supplied 105 million net tons of steel mill products. EPA estimates just over half of this output was produced by integrated steel mills. AISI also reports steel mill product shipments by type of product. Using 1997 data, sheet and strip is the largest single product category followed by bars and structural shapes (see Table 2-9).

Exports and imports grew at roughly 7.0 percent during this period and domestic consumption grew at an annual rate of 2.4 percent. Export ratios show that 6-8 percent of

Table 2-8. U.S. Production, Foreign Trade, and Apparent Consumption of Steel Mill Products: 1981-2001 (10^3 short tons)

	Production[a]	Exports	Imports	Apparent Consumption[b]
1990	84,981	4,303	17,169	97,847
1991	78,846	6,346	15,845	88,345
1992	82,241	4,288	17,075	95,028
1993	89,022	3,968	19,501	104,555
1994	95,084	3,826	30,066	121,324
1995	97,494	7,080	24,409	114,823
1996	100,878	5,031	29,164	125,011
1997	105,858	6,036	31,157	130,979
1998	102,420	5,520	41,520	138,420
1999	106,021	5,426	35,731	136,326
2000	109,050	6,529	37,957	140,478
2001	98,940	6,144	30,080	122,876
Average Annual Growth Rates				
1990-2001	1.5%	7.7%	7.3%	2.4%

[a] Measured as net shipments, which are total production minus intracompany transfers.
[b] Equals U.S. production minus exports plus imports.

Sources: American Iron and Steel Institute (AISI). 1993. *Annual Statistical Report.* Washington, DC: American Iron and Steel Institute.
American Iron and Steel Institute (AISI). 1998. *Annual Statistical Report.* Washington, DC: American Iron and Steel Institute.
American Iron and Steel Institute (AISI). 2002. AISI Statistics. <http://www.steel.org/stats/>. As obtained August 2002.

domestic production is sold overseas (see Table 2-10). This ratio has remained relatively flat over the past 10 years. In contrast, import ratios have consistently been increasing over the past decade as imports represent a significant share of U.S. consumption. Since 1994, imports have accounted for approximately one-quarter of U.S. apparent consumption.

EPA estimated the average price for steel mill products using value of shipment data and output quantities reported in the U.S. Census Bureau's Current Industrial Report for Steel Mill products. In 2000, the CIR reports approximately 125,500 short tons of steel mill products were shipped at a value of $61.4 billion (U.S. Bureau of Census, 2001). This

Table 2-9. U.S. Production, Foreign Trade, and Apparent Consumption of Steel Mill Products: 1997 (tons)

Product	Production[a]	Exports	Imports	Apparent Consumption[b]
Semi-finished	7,927,145	295,325	8,595,964	16,227,784
Structural Shapes and Plate	14,883,805	1,260,197	4,079,451	17,703,059
Rail and Track	874,648	92,095	238,190	1,020,743
Bars	18,708,680	820,523	2,495,817	20,383,974
Tool Steel	63,465	14,745	131,363	180,083
Pipe and Tube	6,547,953	1,352,006	3,030,239	8,226,186
Wire-drawn	619,070	136,697	655,000	1,137,373
Tin Mill	4,058,054	410,011	637,000	4,285,043
Sheet and Strip	52,175,194	1,653,990	11,293,000	61,814,204

[a] Reflects net shipments, which are total shipments minus intracompany transfers.
[b] Reflects U.S. production minus exports, plus imports.

Source: American Iron and Steel Institute (AISI). 1998. *Annual Statistical Report.* Washington, DC: American Iron and Steel Institute.

Table 2-10. Foreign Trade Concentration Ratios for U.S. Steel Mill Products: 1981-2001

	Export Concentration (%) Ratio[a]	Import Concentration (%) Ratio[b]
1990	5.1	17.5
1991	8.0	17.9
1992	5.2	18.0
1993	4.5	18.7
1994	4.0	24.8
1995	7.3	21.3
1996	5.0	23.3
1997	5.7	23.8
1998	5.4	30.0
1999	5.1	26.2
2000	6.0	27.0
2001	6.2	24.5

[a] Measured as export share of U.S. production.
[b] Measured as import share of U.S. apparent consumption.

Source: American Iron and Steel Institute (AISI). 1993. *Annual Statistical Report.* Washington, DC: American Iron and Steel Institute.
American Iron and Steel Institute (AISI). 1998. *Annual Statistical Report.* Washington, DC: American Iron and Steel Institute.
American Iron and Steel Institute (AISI). 2002. AISI Statistics. <http://www.steel.org/stats/>. As obtained August 2002.

implies an average price of $489 per short ton. According to U.S. Bureau of Labor statistics, the price of steel mill products has declined in recent years, falling nearly 20 percent since 1995 (U.S. BLS, 2002a) (see Figure 2-9.)

2.5 Industry Trends

Domestic integrated steelmakers have faced growing competition from minimills' whose share of the steel market has increased steadily, rising from 15 percent in 1970 to about 50 percent in 2000. This trend is expected to continue over the next decade (McGraw-Hill, 2000).

Significant increases in the level of steel imports into the United States have also occurred over the past 3 years. In 1997, the U.S. imported 31.2 million tons of steel products in 1997 compared 38 million tons in 2000, and increase of 22 percent. The increase in imports coupled with declining economic conditions led industry capacity utilization rates to fall from 89 to 79 percent in 2001. Consequently, a variety of trade actions have been initiated by U.S. steel industry, Congress, and the Executive branch. We provide a brief overview of selected measures below.

The U.S. steel industry and unions have filed several petitions resulting in several antidumping (AD) or countervailing duties (CD) measures. Members of the U.S. Congress have also attempted to address the current trade situation through legislation, particularly the Steel Revitalization Act of 2001 (H.R. 808 and S. 957).[2] The Act has a number of features:

- imposes quotas over the next five years that restrict imports to average monthly levels between July 1994 and June 1997

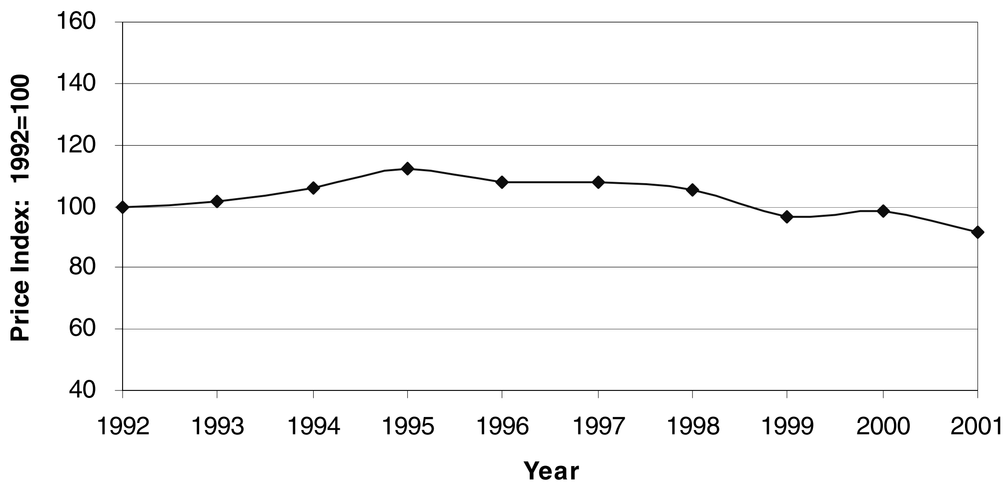

Figure 2-9. Price Trends for Steel Mill Products: 1992 to 2001

Source: U.S. Department of Labor Statistics. Producer Price Index for Blast Furnaces and Steel Mills: PCU3312#. As obtained August 2, 2002a.

- institutes a steel import notification and monitoring program, which among other things, requires foreign steel exporters to report estimated pollution emissions and wages and benefits paid to the workers producing the goods.
- expands the emergency loan guarantee program
- imposes and excise tax up to 1.5 percent on steel products to create a health care cost assistance program for unemployed and retired steel employees of bankrupt firms.
- provides a grant program for steel firms that merge to subsidize cost of compliance associated with environmental regulation.

[2]To date these measures have not been passed.

In June 2001, the Administration requested a Section 201 investigation to determine if the steel industry has been injured from imports. After the investigation, the U.S. International Trade Commission found the imports were a substantial cause of serious injury or threat of injury and recommended a program of tariffs and tariff-rate quotas to the President. As a result, President Bush announced tariffs and tariff rate quotas for selected steel mill products ranging from 8 to 30 percent.

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