Metallurgical Coke: Baseline Analysis of the U.S. Industry and Imports

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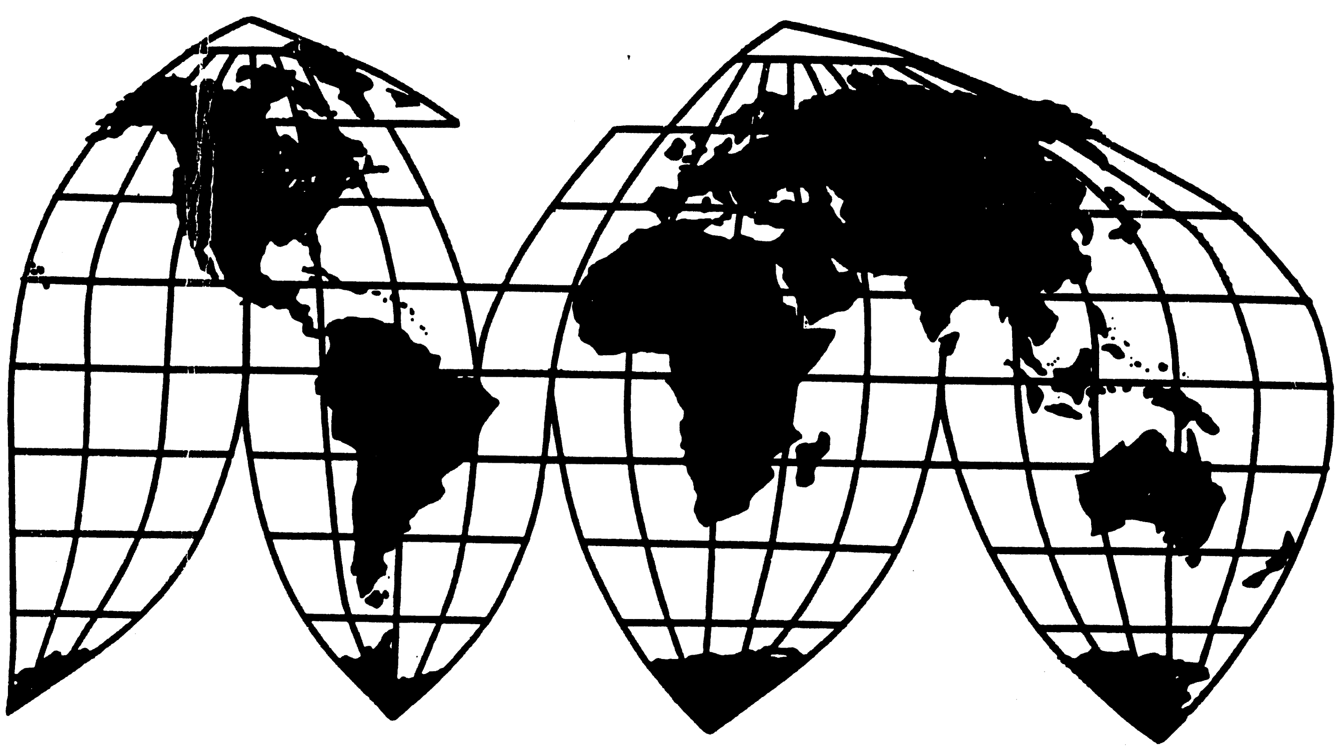

Washington, DC 20436

U.S. International Trade Commission

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NOTE

The information and analysis in this report are for the purpose of this report only. Nothing in this report should be construed to indicate how the Commission would find in an investigation conducted under other statutory authority covering the same or similar matter.

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EXECUTIVE SUMMARY

Background

- On May 6, 1993, the U.S. House of Representatives Committee on Ways and Means requested that the U.S. International Trade Commission (Commission) provide a baseline analysis of the U.S. metallurgical coke industry.[1] The Committee also requested an analysis of the effect of increasing imports from major world producers, specifically including Japan, China, and the former Eastern bloc nations. The Commission was to evaluate the impact of significant market and trade issues related to the consuming industries on the availability of coke in the United States, Japan, and the other nations. Specifically, the Commission was to study such coke market practices as pricing, quality, and byproduct valuation as well as the costs of transportation and environmental compliance. The Commission instituted its investigation on May 21, 1993.[2]
- Metallurgical coke is an industrial fuel obtained by the carbonization of coal.[3] It is used to support a variety of industrial activities, most importantly the production of iron and steel. Coke is consumed in steel industry blast furnaces to reduce iron oxides to molten iron, which is then converted into steel by further processing. A small share of total coke consumption occurs in iron foundries, ferroalloy furnaces, and nonferrous smelters; the byproduct gases of coke production are separated and used to produce certain chemicals and energy, which is typically used by the producer or sold.
- The U.S. metallurgical coke industry is composed of two segments: (1) integrated plants, which are owned by or affiliated with steelmakers, and (2) merchant plants, which produce coke for sale on the open market. Some plants owned by integrated steel firms sell excess coke on the market as well.
- The U.S. coke industry is facing several major challenges, including decreasing consumption, large portions of capacity reaching life expectancy, increasingly stringent environmental regulations, increased imports, and generally declining prices. All of these factors contribute to uncertainty about committing to capital expenditures that seem crucial if production capability is to be maintained in the long term. Most integrated producers of coke will need to decide in coming years whether to shut down coke batteries and to rely on purchased coke, whether to adopt one of the new ironmaking techniques under development that could displace coke, or whether to invest capital to build new coke ovens to replace aging ones. Merchant producers of coke similarly will need to decide whether to replace or refit old batteries or whether to shut down operations entirely.

Findings

Overview of Production and Technology

- The major world producers and consumers of coke are China, Japan, and the United States.[4] China and the United States have abundant reserves of coal for their own future needs or export; Japan relies on imports of coal, primarily from Australia, Canada, and the United States.

[1] See appendix A for the request letter.

[2] Appendix B contains a copy of the *Federal Register* notice instituting the study.

[3] Metallurgical coke is composed of several subsets, including, as primary subsets, blast furnace coke and foundry coke. Industrial coke and breeze, which are two other subsets, are classifications covering the undersized residual from the production of blast furnace and foundry coke.

[4] The former Soviet Union was for many years the largest producer and consumer of coke; however, with the Union's dissolution on December 31, 1991, China took the lead in these measures.

- Currently, excess capacity in the world market has resulted in depressed prices. However, capacity in the industrialized countries is expected to decrease throughout the rest of the decade because of the closing of aging facilities and the high cost of constructing new facilities that meet environmental regulations.

- Research is ongoing to develop new cokemaking processes that are more cost effective in meeting environmental protection standards. Research also continues on technologies to reduce or replace coke in the steelmaking process. Pulverized coal injection, a proven technology that substitutes coal for coke in blast furnaces, has been and will continue to be used to reduce coke consumption significantly. Research is also underway to develop new iron- and steelmaking processes that further reduce or eliminate the need for coke in the long term.

The Industry and Market in the United States

- Production of coke in the United States declined between 1985 and 1992, falling from 25.8 million metric tons in 1985 to 21.2 million metric tons in 1992. Production peked during the period in 1988 at 26.3 million metric tons. This decline in production is mainly attributed to (1) decreased integrated steel production, (2) improvements in blast furnace efficiency, (3) plant closings, and (4) the advancing age of coke batteries. In 1992, integrated plants accounted for 84 percent of the production of metallurgical coke while merchant plants accounted for the remaining 16 percent.

- The overwhelming majority (over 97 percent in 1992) of blast furnace and foundry coke shipments are under contracts, ranging from 1 to 6 years. Contract prices, which are typically renegotiated on a quarterly or semiannual basis, for blast furnace coke trended downwards during 1990-92 and January-June 1993, as consumption declined. Spot prices for blast furnace coke during this period declined more sharply than contract prices, although spot and contract prices for foundry coke increased slightly. Because the demand for metallurgical coke is primarily derived from the demand for steel, and coke production capacity is relatively fixed in the short term, prices are fairly sensitive to changes in the supply of, or demand for, coke.

- Most coke is consumed at facilities adjacent to the coke plant. The consumption of coke per ton of steel has generally been decreasing, chiefly because of improved operating practices at blast furnaces, modernization of integrated steelmaking facilities, and increased electric furnace production of steel. However, for open-market sales, transportation costs can have a significant impact on delivered costs to U.S. metallurgical coke purchasers, reaching as high as 20 percent of delivered cost for some domestic purchasers. The ability of imports to compete in the U.S. market seems to be currently limited to sites near ports or distant from domestic coke sellers.

- Prior to 1987, the United States maintained a positive trade balance in coke. Since 1987, imports have outpaced exports, peaking at a level of 2.4 million metric tons in 1988, when the trade deficit also reached its highest level at 1.4 million metric tons. The major import sources in 1992 were Japan, Australia, and Canada, accounting for 80.4, 15.9, and 2.5 percent of imports, respectively. Aggregate U.S. coke import unit values[5] have declined about 20 percent, to $96 per metric ton in 1993, since peaking at $120 per metric ton during 1989. Similarly, import unit values for Japanese coke have declined by 24 percent since 1989, averaging $95 per metric ton in 1993.

- New environmental regulations stemming from the 1990 Clean Air Act Amendments have begun to raise operating and capital costs for domestic coke producers. Further cost increases are expected as additional regulations take effect over the next two decades. Operating costs per metric ton of production attributed to pollution control by coke producers averaged $8.35 in 1992.

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[5] Cost, insurance, and ocean freight (c.i.f.) basis.

The Industry in Japan

- The Japanese coke industry is facing some challenges similar to those of the U.S. industry, including decreasing domestic consumption and aging capacity. With coke capacity reported at 47.4 million metric tons, Japan has one of the world's largest coke industries. Changes in blast furnace operations, including widespread application of coal injection, have enabled the iron- and steelmaking industry to reduce the ratio of coke consumed per ton of iron produced.
- Metallurgical coal for coke production in Japan is supplied solely by imports primarily from Australia (51 percent), Canada (25 percent), and the United States (13 percent) in 1992. The average $60 per metric ton import value of metallurgical coal in 1992 was approximately 10 percent higher than comparable coal costs in the United States.
- Japan's coke industry produces the same three basic byproduct chemicals as do U.S. producers: coke oven gas (COG), tar, and light oil. Individual firms in both industries further process the products to varying degrees. The average unit values calculated for light oil and COG in Japan are higher than U.S. unit values.
- Exports of coke from Japan totaled 3.1 million metric tons in 1992, approximately 7 percent of production, of which roughly half went to the United States. Over the past 10 years, coke has been exported to a wide variety of countries, although the United States, Brazil, and Romania have consistently been the largest export markets. Japanese metallurgical coke exports to the United States are transported by large bulk carrier vessels with ocean freight costs averaging $10-12 per metric ton and U.S. port costs of $2-3 per metric ton. These costs fall in the middle of the range for U.S. producers' overland transportation costs.
- The regulation of pollution in Japan is controlled at three levels—national, prefectural, and local. Japan imposes similar ambient standards as the United States for many of the same pollutants—sulfur oxides, nitrous oxides, and particulate, but currently no Japanese standards specifically regulate hazardous air emissions. Compliance with environmental standards in Japan reportedly involves a significant reliance on case-by-case negotiations between producers and governmental entities.

The Industry in Other Selected Countries

- With the break-up of the former Soviet Union, China is the world's largest coke producer. China's total output of both metallurgical and non-metallurgical coke amounted to 78 million metric tons during 1992. A further expansion of its coking capacity is expected, but projected increases in steelmaking production will likely consume most of the increase. A variety of cost advantages (e.g. coal and labor) should allow China to market a slowly growing surplus at very competitive prices. This export potential is likely to be constrained by limited harbor facilities in the near term. After being absent from the U.S. market since 1989, imports of metallurgical coke from China resumed in 1993.
- Poland and the Czech Republic are the only net exporters of coke in the former Eastern bloc. Coke ovens in these countries are relatively new, and both countries have abundant coking coal reserves to support projected levels of coke production. Although both cokemaking and steelmaking capacity are declining in both countries, cokemaking capacity is declining more slowly than steel capacity, thereby creating a surplus for export. In both countries, the imposition of environmental cleanup costs is increasing the costs of coke production and in some cases may result in the closing of facilities. There have been no recent imports of Czech coke to the U.S. market and no imports from Poland since 1989. Imports from Poland are expected in early 1994.

Comparative Assessment

- The relative competitiveness of domestic and foreign coke producers is determined by such factors as the cost of production inputs, the valuation of byproduct credit streams, the costs and constraints imposed by environmental regulation, the installed technology, support by government institutions, and costs associated with transporting coke between production and consumption sites. It should also be noted that this report bases its analysis largely on industry averages, and that the relative competitive position of any individual firm may differ from industry norms.

- Based on the information collected, no definitive conclusion can be drawn regarding the overall competitiveness of U.S. coke producers relative to the foreign industries studied. Relative to Japan, U.S. producers appear to have an advantage with respect to coal costs and certain measures of coke quality (e.g. sulfur and ash content). Differentials in basic byproduct unit values appear to favor Japanese producers, but these differentials may be diminished when the net energy balance of the coke oven/byproduct recovery facility and higher Japanese input costs are considered. Environmental regulations are not comparable and relative costs of pollution control are unknown. However, U.S. producers face deadlines for stricter compliance in the near future, while no significant new regulations are known to be forthcoming in Japan. Japanese producers, on average, operate newer and larger ovens than U.S. producers, indicating a competitive advantage based on the generally higher efficiency of larger ovens.

- China, Poland and the Czech Republic all have large metallurgical coal reserves, and the U.S. industry seems to be at a disadvantage with respect to coal costs when compared to Poland and China. Other costs are generally unknown. Governmental ownership and policy may confer some competitive advantages in these countries. Imports from China and Poland have only recently resumed. Although information is limited, Chinese coke quality apparently varies from unacceptable to competitive levels. Polish and Czech quality is reportedly good.

- Although captive consumption still dominates the U.S. coke market, coke in the United States is increasingly being traded on the open market. The increasing willingness of steelmakers to rely on non-captive sources for coke supplies should afford more opportunities for import competition as well as for merchant coke producers. Higher average production costs for the integrated sector indicate the possibility of cost savings for some integrated firms by purchasing coke from merchant producers.

- Changes in traditional domestic supply patterns resulting from coke oven and blast furnace closures in the steel industry are increasing the importance of transportation costs for many coke consumers, for whom these costs were at one time negligible. Despite the vast differences in distance traveled by imports and domestic shipments, the relatively low cost of ocean freight mitigates the disadvantage of long shipping distances from most of the countries studied to certain domestic consumers.

- While imports of coke into the U.S. market have varied widely from year-to-year, they still have several general characteristics: (1) imports are from a limited number of sources, (2) coke is imported by a limited number of importers/consumers, (3) most current import sales are the result of long-term contracts, and (4) most imports are sold to facilities that were self-sufficient in coke and then shut down their batteries, thus replacing captive production.

- Imports in the past 6 years averaged well above historical levels, but 1993 quantities were below 1988 levels. The vast majority of imports in the 1990s have been the result of a few multi-year contracts, most of which are up for renewal during 1994.

- Imports represented 8 percent of total U.S. consumption in 1992, a ratio that has risen from 4 percent in 1990. However, when examining open market sales alone, 1992 imports accounted for approximately 18 percent of the coke purchased by consumers, essentially the same share as in 1990.

- Since 1991, average import prices for blast furnace coke from Japan, the major source, have been below average domestic contract prices but above average domestic spot prices. Statistical modeling shows a positive correlation between domestic spot prices and coke imports. Possible explanations for this correlation include that imports are being drawn in by high prices, or that some other independent variable is affecting both prices and import levels.

Outlook

- Forecasters in the private sector agree that the U.S. industry faces continued declines in consumption and capacity, but they differ on the magnitudes. However, forecasters also generally agree that a shortfall in domestic capacity relative to domestic consumption will occur by the year 2000.

- Many coke producers will have to decide whether to make significant capital investments or to close facilities as they approach deadlines for increasingly strict environmental regulation over the next two decades. Uncertainty about future demand and prices, sources and levels of import competition, and the specifics of environmental regulations at given times in the future make such decisions difficult.

CHAPTER 1
Introduction

Metallurgical coke is an industrial fuel obtained by the carbonization of coal. It is used to support a variety of industrial activities, most importantly the production of iron and steel. Production of coke worldwide is predominately in the form of metallurgical coke, although some nonmetallurgical coke is produced as well.[1] Coke is produced by heating selected bituminous coals at high temperatures to separate the volatile gaseous content. The major end user of coke is the steel industry where it is used in blast furnaces to reduce iron oxides to molten iron, which is then converted into steel by further processing in a steelmaking furnace. A relatively small share of metallurgical coke is consumed outside of the steel industry by iron foundries, ferroalloy producers, nonferrous smelters, and other industrial consumers.

The U.S. metallurgical coke industry is composed of integrated plants and merchant plants. Integrated plants are owned by, or affiliated with, integrated steel companies that produce coke primarily for captive use in their blast furnaces, although several firms with excess capacity are active in the open market. Merchant plants produce coke for sale on the open market and are typically owned by, or affiliated with, chemical or coal companies. Currently, both segments of the industry are faced with the advanced age of many of their coke ovens and the rising costs of replacing them with environmentally clean ovens. Plants affiliated with steel companies need to decide whether, (1) to shut down their coke batteries and rely solely on merchant production and imported coke, (2) to adopt one of the new ironmaking techniques under development that could displace some if not all the required coke, or (3) to invest large amounts of capital in building new coke ovens to replace aging ones. The strategies pursued by U.S. steelmakers will determine the amount of coke that will be produced as well as imported into the United States in the near future. Merchant plants facing increased competition from imports must decide whether to shut down operations or to replace or refit batteries according to U.S. environmental regulations.

[1] Metallurgical coke is composed of several subsets, including blast furnace coke and foundry coke as the most important. Industrial coke and breeze (two other subsets) are classifications covering the undersized residual from the production of blast furnace and foundry coke. See appendix E for definitions of additional technical terms.

[2] See appendix A for the request letter.

Purpose of the Report

On May 6, 1993, the U.S. House of Representatives Committee on Ways and Means requested that the U.S. International Trade Commission (Commission) provide a baseline analysis of the U.S. metallurgical coke industry.[2] The Committee also requested an analysis of the effect of increasing imports from major world producers, specifically including Japan, China, and the former Eastern bloc nations. It requested the Commission to evaluate the impact of significant market and trade facts related to the consuming industries on the availability of coke in the United States, Japan, and the other nations studied. Specifically, the Commission was asked to study such coke market practices as pricing, quality, and byproduct valuation as well as the costs of transportation and environmental compliance. The Commission instituted its investigation on May 21, 1993.[3]

Approach of the Report

The approach for analyzing the metallurgical coke industry has been to examine the supply (production) and demand (consumption) conditions that prevailed in recent years in the domestic and selected foreign markets.[4]

Market parameters such as changes in capacity, production, and consumption, the cost of major inputs, the age and design of facilities, and governmental policies have been examined where information could be collected for each of the countries covered in the report: the United States, Japan, the Peoples Republic of China, Poland, and the Czech Republic. An attempt was also made to determine the impact of imports on the U.S. coke industry. Since the major source of U.S. imports is Japan, much of the comparative analysis focuses on the effect of Japanese imports.

Information in this report has been compiled from submissions and testimony presented at the Commission's public hearing on this investigation[5],

[3] Appendix B contains a copy of the Federal Register notice instituting the study.

[4] Data have generally been presented for the 1985-92 time period. Data collected from the domestic industry via questionnaires cover 1990, 1991, 1992, and the six month periods January-June 1992 and January-June 1993.

[5] Appendix D contains a witness list for the public hearing.

domestic and foreign fieldwork, responses to the Commission's questionnaires, literature searches, telephone interviews, and other sources. Data collected from various sources were found to not always agree, especially with respect to capacity levels. Questionnaires were sent to 32 U.S. facilities that produced coke during 1990-92 and responses were received from 31 facilities. Late responses and difficulties in reconciling data for 3 facilities precluded use of their data. Therefore, the data presented from questionnaires on the coke producing industry, except where noted, represent approximately 96 percent of domestic metallurgical coke production capacity in 1992. Purchaser questionnaires were also sent to and received from 22 domestic facilities that consume blast furnace coke. Four consumers reported no purchases, yielding data from 18 consumers, believed to represent all U.S. purchasers of blast furnace coke. Differences in questionnaire data on foreign purchases and import data published by the U.S. Department of Energy (DOE) resulted in an examination of individual shipment data of the U.S. Department of Treasury, U.S. Customs Service. This exercise has led the Commission to believe that metallurgical coke imports are significantly higher in some recent years than reported by DOE.

Domestic fieldwork was centered at producers in the Pittsburgh, PA, and Birmingham, AL, areas. Foreign field work included trips to Japan and Europe. Appendix C lists companies and government agencies contacted in the course of the investigation.

Organization

Chapter 2 provides an overview of metallurgical coke in terms of world coal reserves, technologies, production, consumption, and trade. Chapter 3 discusses the U.S. coke industry structure, production, consumption, trade, financial performance, environmental regulations, and other factors affecting production. Chapter 4 discusses similar issues for the coke industry in Japan. Chapter 5 analyzes industry conditions in the People's Republic of China, Poland, and the Czech Republic. Chapter 6 compares and analyzes industry conditions and factors affecting costs in the U.S. coke industry and the foreign industries studied above. An examination of coke imports and their effect on the U.S. market is also included in this chapter. A glossary is provided in appendix E to aid in the definition of technical terms.

CHAPTER 2
Overview of Production and Technology

World production of coke has been declining due to both supply and demand conditions. On the supply side, world coke production has been declining because of aging and closing of existing facilities, limited rebuilding of old or construction of new facilities, and increasingly stringent environmental regulations in most producing nations. During the 1980s, closures of coke ovens exceeded construction of new facilities. Major closures in the United States, Germany, and Japan offset increases in capacity in Asia and Latin America. However, the overall decline may be reversed if China continues to increase its coke capacity in the 1990s.

On the demand side, the decline in the consumption of metallurgical coke is primarily due to technological changes in the world steel industry. An increasing share of world steel production uses the electric arc furnace process, which bypasses the need for coke. In addition, those producers who use the blast-furnace-based integrated process have improved their operating procedures and applied technology to lessen the amount of coke consumed per ton of iron produced. This decline in world demand for coke, however, may be slowed or even reversed if Chinese steel capacity continues to increase at its current rate.

This chapter describes the basic processes used for the production of coke as well as some of the alternatives being developed to meet both efficiency and environmental objectives. Also examined are some of the technological changes in the iron and steel industry that have affected and will continue to affect the quantity of coke consumed. In addition, this chapter reviews environmental problems associated with emissions of hazardous materials during the production of coke and the basic control technologies that address these problems. Since coal is the primary input to the production process, this chapter also briefly discusses the coal supply situation for the major world coke producers.

Producing Nations

The major world producers and consumers of coke are the former Soviet Union countries, China, Japan, and the United States (table 2-1). From 1985 through

Table 2-1
World metallurgical coke production, 1985-92

(Million metric tons)

Country	1985	1986	1987	1988	1989	1990	1991	1992
Total	362.9	359.4	361.1	375.7	378.4	369.1	341.7	331.1
Former Soviet Union	[1]84.0	[1]84.0	[1]83.0	81.9	80.4	78.0	64.6	60.7
China	47.9	52.7	57.9	61.1	66.2	73.3	73.5	[1]75.0
Japan	51.7	48.1	46.4	50.6	49.8	47.6	46.7	43.4
United States	26.0	23.2	25.4	29.4	29.9	25.1	21.8	22.4
Poland	16.4	16.8	17.4	17.5	16.9	13.7	11.4	11.4
Czechoslovakia[2]	10.2	10.1	10.6	10.6	10.1	9.6	8.6	8.2
Germany[3]	23.2	23.1	20.2	18.8	18.8	21.9	16.5	[1]15.2
All Other	103.3	101.4	100.1	105.8	106.2	99.9	98.5	94.8
Total	362.9	359.4	361.1	375.7	378.4	369.1	341.7	331.1

[1] Estimate

[2] On January 1, 1993, Czechoslovakia disolved, forming the separate countries of the Czech Republic and Slovakia

[3] Refers to the Federal Republic of Germany.

Note.—Totals may not add due to rounding.

Source: IISI, *World Cokemaking Capacity,* (Brussels, 1993), pp. 48-49.

1992, their combined production averaged about 60 percent of the world total. World production ranged from 359.4 million metric tons to 378.4 million metric tons from 1985 through 1991, with the highest production for the period coming in 1989. From 1989 through 1992, world production declined by 47.3 million metric tons (14 percent), with 19.7 million metric tons of that decline occurring in the former Soviet Union. Of the major producers, only China has increased production since 1989, as production in both the United States and Japan has fallen. Production in Poland, Czechoslovakia, and Germany has also declined substantially, while production in the remainder of the world has remained relatively stable.

Currently there is an ample supply of coke on the world market, but, as more ovens are shut down, the supply situation may tighten, with increases in prices probable.[1] In most parts of the world, the aging coke ovens have come under close environmental scrutiny, which is resulting in the closure of some facilities. This situation, coupled with the capital costs of constructing new ovens that meet higher environmental standards, is expected to further the decline of coke-making capacity in some countries. China is expected to increase coke capacity because of Chinese industrialization policies geared toward steel production. However, coke capacity in the former Soviet Union, the United States and Japan may decline from 1992 levels (table 2-2). As will be seen in the following section on coke production technology, coke capacity is difficult to estimate because production capacity is largely a function of the types of coke that are being produced at each facility.

[1] William T. Hogan, "The Future World Crisis in Coke," *Iron and Steel Engineer,* Dec. 1992, p. 35.

Coke Production Technologies

Coke is produced by the carbonization of coal in the absence of air, at temperatures of 900-1,000°C.[2] The process vaporizes the volatile components of the coal and transforms the remaining solid as it softens. The process requires a range of 12 to 80 hours, depending upon the technology used. The three proven processes for manufacturing metallurgical coke are the byproduct process, the nonrecovery process, and the antiquated beehive process.

Byproduct Coke Operations

Byproduct cokemaking is, by far, the dominant process for coke production worldwide, and plants using this process are the focus of this investigation. In byproduct operations, coke processing is usually performed in slot ovens (a series of which is called a "battery"), which are parallel chambers separated by walls of silica brick. The coke ovens in a battery alternate with heating flues such that there is a heating chamber on each side of a coke oven.[3]

The coking process begins with the preparation of the coal. The coal is blended, crushed, and screened before being transferred to the coal storage bunker, which sits atop the battery (see figure 2-1 for a schematic of the production process). From the storage

[2] As coke ovens age, their capacity often declines as operators trade off longer coking cycles for lower temperatures. Coking at lower temperatures is easier on the ovens and extends their useful life.
[3] U.S. Steel, *The Making, Shaping and Treating of Steel,* 10th ed., 1985, p. 156.

Table 2-2
Worldwide estimated annual coke capacity, 1992

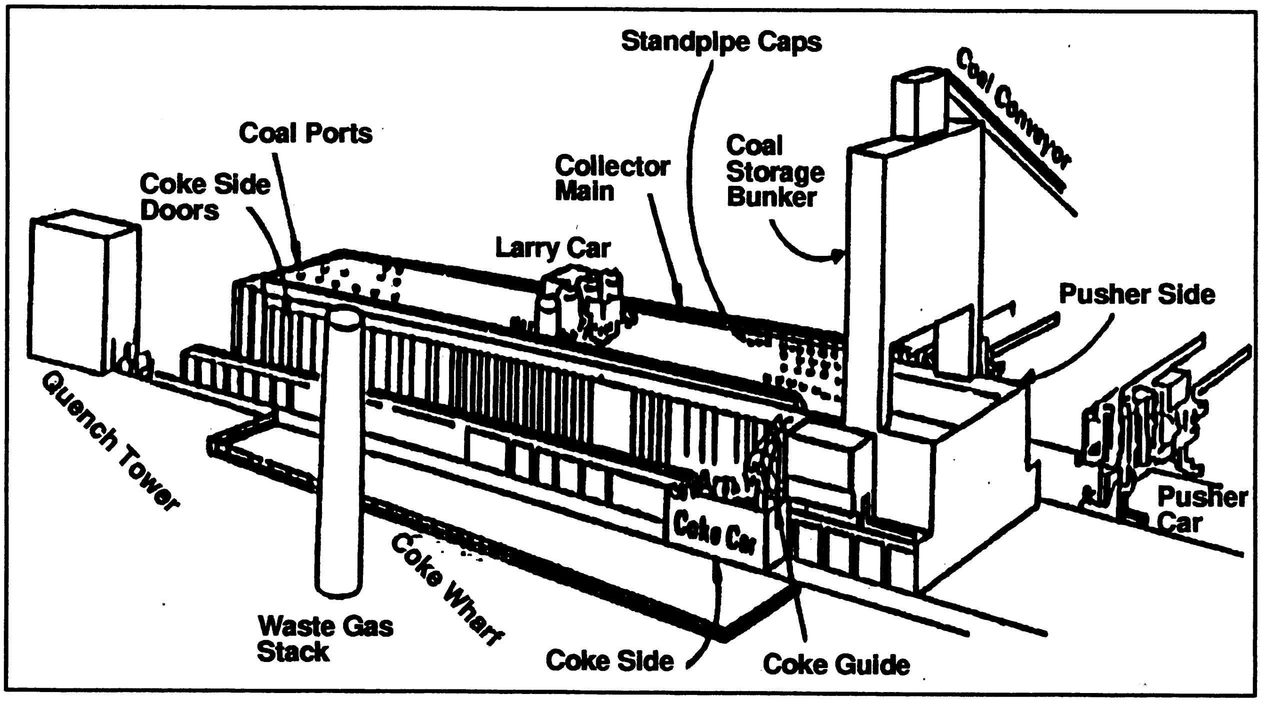
(Million metric tons)

Country	1992
Former Soviet Union	80.1
China	[1]62.0
Japan	47.2
United States	23.8
Germany	[1]14.7
Poland	10.3
Czech Republic	8.2
Australia	4.8
All Other	104.0
Total	355.1

[1] Estimated capacity for 1992 is less than estimated production for 1992 as shown on table 2-1.

Source: IISI, *World Cokemaking Capacity,* (Brussels, 1993), pp. 64-123.

Figure 2-1
A schematic of a by-product coke battery



Source: U.S. Environmental Protection Agency.

bunker, a weighed amount of prepared coal is discharged into a "larry" car, which is powered by electric motors and which travels the length of the battery top on a track. Before the hot oven is filled, the doors are closed and sealed. The larry car is then positioned over the empty, hot oven, and the oven is charged with coal through the coal ports.[4] After the oven is filled, the lids are placed over the coal ports and sealed. Ovens in a battery are individually charged at approximately equal time intervals. Ovens are situated side-by-side and the product mix can be altered within a battery with differences only in coking time, temperature, and the coal mixture.[5]

The coking process, called thermal distillation, separates the volatile and nonvolatile components of coal. Heating for the ovens comes from regenerative[6] combustion systems below the ovens, which are fired by cleaned coke oven gas. The distillation process creates pressure in the oven; this pressure prevents ignition of the coal by keeping oxygen out of the ovens and drives off the gases and hydrocarbons. These gases and hydrocarbons pass through stand pipes, or offtakes, at the top of the ovens, pass into the collector mains, and are then sent to the byproduct plant for recovery. The coking process proceeds for 15 to 24 hours to produce blast furnace coke and from 25 to 40 hours to produce foundry coke.[7]

At the end of the coking cycle, doors at both ends of the ovens are opened and the coke is pushed out the coke side by a ram or "pusher." The coke is usually pushed into a quench car, which carries it to the end of the battery, where it is quenched, usually by directly deluging it with water. Some producers use the alternative dry quenching process. In this process, the coke is put into an enclosed container, and the coke is then cooled by recirculating inert gases. Dry quenching produces stronger coke but requires more capital outlays than wet quenching.[8]

The quenched coke is discharged onto a "coke wharf" to drain excess water and to allow the coke to cool to handling temperature. The coke is then crushed and screened for particular size requirements. The undersized coke or "breeze" created by the crushing and screening is used in other plant processes, stockpiled, or sold. The yield of a byproduct coke oven can vary, depending on the coals charged, but

[4] At some byproduct plants outside the United States, the ovens are side-charged with coal through the oven doors.
[5] Mark Engle, president, American Coke and Coal Chemicals Institute, testimony before the U.S. International Trade Commission, Oct. 5, 1993.
[6] Flue gas produced from combustion contains a significant amount of heat, and some of this waste gas is collected and blended with rich gas to produce the needed heat.
[7] USITC staff interviews with U.S. industry officials, Nov. 1993.
[8] Ibid.

typically 75 percent of the output (by weight) is coke, 20 percent coke oven gas and light oils, and 5 percent is miscellaneous products, which include crude coal tars.[9]

Once brought into service, typical byproduct coke oven batteries run continuously. Although individual ovens may be taken out of service for maintenance, batteries are only shut down as a last resort. Allowing a battery to cool results in significant damage to the ovens upon reheating. Batteries are occasionally placed on "hot idle," where the temperature is maintained but no coal is charged nor coke produced. Maintaining a battery on hot idle is expensive and occurs usually only briefly because an outside source of gas is often needed to maintain the temperature in the ovens.

Gases produced during the coking cycle are cooled and byproducts are separated. These byproducts include crude coal tar, light oils, and ammonia. Coal tar can be burned for fuel, refined into tar-based products, or further distilled to produce pyridine, naphthalene, creosote oil, road tar, and other products. Light oil is composed of a mixture of aromatic hydrocarbons, which can be further separated to yield intermediate chemical products such as benzene, toluene, and xylenes. The ammonia is precipitated using sulfuric acid, producing ammonia sulfate, which is an input to fertilizer production.

Once these products are removed, the residual is clean coke oven gas, which has approximately half the BTU value of natural gas. Approximately 50 percent of the gas produced is used to fire the coke ovens. The excess gas can be used in a variety of ways. At integrated steel facilities, the gas is often used in blast or reheat furnaces. At merchant facilities, the gas is either sold to outside utilities, used to generate electrical power, or flared.

Nonrecovery Ovens

In nonrecovery ovens, the volatile materials produced during the coking process are oxidized in the oven chamber rather than recovered in a byproduct plant. The oxidation of the gases above the coal bed provides the heat for the process, thus eliminating the need for external heat sources. The ovens are conveyor charged, and the coke is conventionally pushed and quenched. However, waste gases from the batteries are recycled to steam generators for the production of electricity. In the United States, Sun Coal Co. operates 150 nonrecovery ovens at the Jewell Coal and Coke Co. in Virginia, producing about 600,000 metric tons of coke per year.[10]

Beehive Ovens

Beehive ovens are refractory-lined kilns, dome-like in structure and appearance, which are frequently built into the side of a hill or embankment. Air is admitted to the coking chamber in controlled amounts for the purpose of burning the volatile products distilled from coal to generate heat for further distillation. No byproducts are recovered. This process is no longer used in the United States or most other industrialized nations because the excess gases are vented to the atmosphere, resulting in the emissions of hazardous materials.

Alternative Cokemaking Technologies

The United States, Japan, Germany, and the former Soviet Union countries are researching and developing alternatives to the byproduct process, aiming at producing coke more efficiently and with more regard for the environment. Except for the United States, which has no centralized cokemaking research organization, these nations have organized their efforts through various research and development institutes.[11]

Formcoke

Formcoke technology offers lower raw material costs, because some subbituminous coal can be used, and lower dust releases that reduce environmental concerns; however, it also has the problems of less-than-optimum productivity, fuel rates, and stability.[12] In a formcoke process, finely pulverized coking or other coal is dried and partially oxidized with steam or air in fluidized-bed reactors to prevent the coal from agglomerating. The product is carbonized in two stages at successively higher temperatures to obtain a char. Using a binder produced from tar, the char is made into briquettes in roll presses. The green briquettes are then cured at low temperatures, carbonized at high temperatures, and finally cooled in the atmosphere to produce a low-volatile metallurgical coke.[13]

Several processes have been developed to produce formcoke, only 2 of which, termed FMC and Peabody, are commercially available and produce formcoke. At least two other processes are currently under development and testing but have not yet been commercially adopted.

The Coal Technology Corporation (CTC), with funding from the U.S. Department of Energy, has developed the CTC formcoke process, which is designed to produce blast furnace formcoke and various liquid hydrocarbon fuels. Crushed coal is

[9] American Coke and Coal Chemicals Institute, testimony before the U.S. International Trade Commission, Oct. 5, 1993.

[10] USITC staff conversations with representatives of Sun Coal Co., Sept. 1993.

[11] Hogan, various pages.

[12] Ibid.

[13] Alternative Cokemaking Technology Survey Task Group, "Alternative Cokemaking Technologies: A Report to the AISI Committee on Technology," Aug. 1991, p. 7.

conveyed through a mild gasifier, producing char containing 7 to 8 percent volatile materials. The offgases are refined into liquid fuels.[14]

In Japan, the industry and the Ministry of International Trade and Industry (MITI) fund coke technology research. The Japan Iron and Steel Federation (JISF) formcoke process uses continuous carbonization, which offers environmental benefits by eliminating hazardous emissions.[15] A formcoke pilot plant was established at Nippon Steel's Yawata Works and tested during the late 1980s. The formcoke technology, however, caused a decline in productivity and an increase in fuel consumption.[16]

Jumbo Ovens

The jumbo coker was originally designed by Ruhrkohle AG, Bergbau Forschung GmbH (now Deutsche Montan Technologie) and various German coke plant construction firms. In many ways, the jumbo coker is similar to traditional coke ovens in that both coke and various byproducts are produced. However, instead of using a multi-chamber system, coke is produced in individually controlled single reactors that can be operated as independent coking units. The ovens are larger than the traditional 6.2-meter byproduct ovens, and the design makes it possible to substantially lessen the number and length of doors and lids per ton of coke produced which lessens the length of the closures that can emit pollutants. Ruhrkohle reports projections of about 25 percent lower operating costs compared with traditional slot-ovens.[17] However, capital costs that are 10 percent higher than those for byproduct ovens have been reported.[18]

Technologies Affecting Coke Consumption

The world demand for metallurgical coke has fallen as the efficiency of traditional iron- and steelmaking technologies has improved, as scrap-based steel production has increased, and as proven new technologies that were designed to reduce coke use are utilized. Considerable effort has been expended to develop new ironmaking technologies that use coal directly, but widespread adoption of these technologies may take decades. Hence, coke is expected to remain an important raw material for steel production even though its consumption may decline in the foreseeable future.

These changes in iron- and steelmaking technologies have resulted in less coke being needed by the integrated steel producers by decreasing the coke rate in the blast furnace or by improving the steel yields. The primary technologies affecting the coke rate in blast furnaces are the injection of alternative fuels, the increasing of hot-blast temperatures, and the use of prefluxed iron ore pellets.

Fuel injections cannot completely replace coke as the principal fuel and reductant in the blast furnace because excessive use of injections negatively affects blast furnace productivity. The most common fuels used for injection in the United States have been fuel oil and natural gas because of their simplicity of use, abundance, and relatively low price. Tar and pitch are also used, though in smaller quantities. Japan and Western Europe currently use coal injections in the majority of their blast furnaces, and coal injection is gaining increasing acceptance in the United States.

Pulverized coal injection (PCI) into the blast furnace was developed in the United States by Armco in 1963 in an attempt to discover ways to reduce fuel expenditures.[19] Worldwide interest in the PCI process grew quickly, and the process was adopted by many companies in Europe, Japan, and the Republic of Korea. Part of the attraction to PCI is that cheaper, more abundant, lower grades of coal can be used instead of the high-grade coals needed for coke production. Pound for pound, PCI can replace up to 40 percent of the coke currently required in the blast furnace. Recent research shows that natural gas injection can be substituted for about 25 percent, although most steel makers inject much lower levels of natural gas.[20] Moreover, the use of coal as an injected fuel results in a less severe reduction in blast furnace flame temperature than that of other injected materials. In 1992, PCI alone was estimated to have displaced approximately 10 million metric tons of coke worldwide, or about 3 percent of world consumption. Some analysts project a fourfold increase in this figure by 2000.

Coke-free ironmaking methods such as direct reduced iron, iron carbide, and the Corex process have gained commercial acceptance, but still account for only a fraction of worldwide pig iron production. Other technologies for cokefree ironmaking, such as the Direct Iron Ore Smelting (DIOS) process in Japan, the Hi-smelt process in Australia, and the American Iron and Steel Institute (AISI) direct ironmaking process in the United States are under research and development but are not yet ready for commercial adoption.

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[14] Ibid., 13.
[15] Ibid., pp. 8, 15-17.
[16] Jennifer Bennett, *PCI and Coke: Market Impacts of Changing Steel Technologies,* McCloskey Coal Information Services Ltd., 1993, p. 45.
[17] Ibid., p. 19-20.
[18] Hogan, p. 34.

[19] George E. Kuebler, "Coke Concerns Fuel Interest in PCI", *33 Metal Producing,* Apr. 1993, p. 18.
[20] The Gas Research Institute sponsored a gas injection study that showed that natural gas injection could replace 25 percent or more of the coke used in the blast furnace with an injection rate of 193 lb/net tons of hot metal (NTHM). Norman L. Samways, "Developments in the North American Iron and Steel Industry—1992," *Iron and Steel Engineer,* Feb. 1993, p. D-16.

Cokemaking and the Environment

Air-Pollutant Emissions

Historically, air pollution concerns about cokemaking focused on the emissions of sulfur oxides (SO_x) and nitrogen oxides (NO_x), both of which are associated with atmospheric problems such as acid rain. SO_x and NO_x are produced by the combustion of the coke oven gas used to fire the ovens and by the coking process itself. These pollutants are also emitted by other stationary sources when fuels are burned in other types of production processes or by mobile sources such as automobiles. To control SO_x, coke producers have increased their use of low-sulfur coal, improved the desulfurization of coke oven gas, and increased sulfur removal from stack gases. NO_x levels have been reduced through improved combustion technology and as a result of the desulfurization of coke oven gas.

Recently, increased attention is being paid to the hazardous pollutants emitted from byproduct coke ovens that are not collected by the byproduct recovery process. Since there is relatively high positive pressure within byproduct coke ovens during the coking process, the doors, lids, and offtakes tend to leak. Coke oven emissions consist of an oily yellowish-brown gas that contains over 10,000 compounds as gases, vapors, and particulates. The primary health concern relates to benzene and other known or suspected carcinogens. Owing to the difficulty in sampling fugitive emissions and the variation in the size and configuration of coke batteries, the measurement of emissions in quantitative terms is imprecise. Temperature, type of coal, time into the coking cycle, pressure fluctuations, or other differences between batteries cause variations in the levels and concentrations of pollutants emitted.[21] Other factors that affect emissions include the age of the battery and its maintenance program.

Given the difficulties in measuring the quantity of these emissions, pollution from coke ovens is generally expressed in the United States in qualitative terms, or occurrences, and not in quantitative terms. Emissions are measured by observing the percentage of doors, lids, and offtakes on a coke battery that are leaking. Charging emissions are determined by the total time that visible emissions occur during the charging of an oven with coal. A specific procedure has been developed to determine compliance with qualitative emission limits for each of the points where leaks occur.[22]

[21] EPA, *Coke Oven Emissions from Wet-Coal Charged By-Product Coke Oven Batteries—Background Information For Proposed Standards*, 1987, P. 3-19.

[22] See chapter 3 for a discussion of these emission limits.

Control Technologies

There are four basic technological options for controlling or reducing coke oven emissions: (1) sealing doors and lids with sodium silicate luting compounds; (2) retrofitting existing ovens, which includes replacing doors and lids, and adding sheds[23] and new larry cars; (3) totally rebuilding coke ovens from the pad up; and (4) adopting new technologies. The technical efficacy and the costs and benefits of each option vary for each coke battery and may largely depend upon the remaining economic life of the battery. A fifth option, used in conjunction with one or more of the technological options, is to improve operation, maintenance, and repair procedures. A sixth, and final, option is shutting down the coke battery.

To control leaks from gaps between the door and the door jamb, one of two types of seals is used. The first type of seal is a luting mixture that is troweled by hand into a V-shaped opening between the door and the door frame. The second type, known as self-sealing, generally uses a rigid knife edge or a flexible S-shaped band around the rim of the door.[24] The gaps are then sealed by the condensation of tars as coke oven gas escapes. Given that the seals around the doors are the largest source of leaks, the design and operation of door-handling equipment is an important factor in controlling leaks and in controlling repair and maintenance costs for doors. Damaged or worn doors, caused by warping, buckling, or handling, and shifting of brick are more likely on older ovens, and increase the likelihood of higher emissions. Maintenance (cleaning and repair of doors and jambs) and operation (control of door-handling equipment and latching and the sealing and adjustment processes) are also key variables.[25]

The control of leaks from lids and offtakes appears to be more a function of operation (cleaning, sealing, and maintaining proper pressure) than technology, although luting mixtures are used for sealing lids. Emissions from leaking lids or offtake are similar to those from leaking doors and are generally caused by poorly seated or damaged lids. Emissions can also occur from cracks in the standpipes themselves.[26]

Emissions from the ovens during charging are a combination of gases and particulates forced from the oven as a result of the expanding gas volume that occurs as coal is loaded into the oven from above. The quantity of emissions is affected by variables such as the moisture content or volatile content of the coal, the amount of oil added to the coal before charging, and the size of the coal particles[27]. The primary

[23] Sheds are structures built alongside and over the doors to catch emissions.

[24] U.S. Steel, p. 160.

[25] EPA, 1987, p. 3-55.

[26] EPA, 1987, p. 3-57.

[27] EPA, 1987, p. 3-36.

methods of improving the emissions record of the ovens during charging have been better design and operation of the lid-handling equipment and larry cars and the use of stage charging.[28]

Water-Pollutant Emissions

Most coke operations produce a wastewater stream that has relatively high concentrations of chemical oxygen demand, ammonia, phenols, cyanide, and some organic materials. This wastewater stream now generally undergoes a biological treatment process to lower the incidence of various contaminants to acceptable levels before being released into the receiving waters. The specific emission standards or permit requirements for each coke operation depend upon the nature of the receiving waters. The relatively recent installation of biological treatment plants and certain improvements in the ammonia removal process at the various coke operations have added to the cost of producing coke, but they have improved the quality of the effluent flows from these facilities. The activated sludge process in the treatment plant provides an effective means of eliminating biochemical oxygen demand and other contaminants. Various facultative bacteria are used to treat for ammonia, phenols, benzene, and cyanide.[29]

Coal Supply

Metallurgical coke is produced from certain bituminous coals, and approximately 1.45 metric tons of these coals are required to produce 1 metric ton of coke.[30] The nations of the world possessing the largest recoverable reserves of coal are also among the major world producers of coke. Except for Japan, the United States and the other major world producers have abundant coal reserves to feed their ovens. The nations of the former Soviet Union, primarily the Russian Federation (Russia), together possess the largest recoverable coal reserves, followed closely by the United States (table 2-3).

United States

U.S. coals are generally considered by world markets as the best coking coals because of their low sulfur, high volatility, and low ash. U.S. coal reserves are estimated at 264.7 billion short tons, of which bituminous reserves account for nearly 50 percent (table 2-3). Reserves are nearly equally distributed in terms of being low, medium, or high sulfur content coals, a significant quality factor for the production of coke. Many coke producers, both domestic and foreign, blend different coals to achieve the desired characteristics and to lower their raw material input costs. For example, coals from Alabama, West Virginia, and Pennsylvania with different characteristics might be blended to produce a particular specification of coke.

The United States is the leading world exporter of metallurgical coal, accounting for 32 percent of total world exports.[31] The major markets for U.S. exports of metallurgical coals are Western Europe, Japan, Canada, and Latin America.

Japan

Japan, with less than one-tenth of 1 percent of the world's recoverable reserves of coal, relies solely on

[28] U.S. Steel, p. 163.
[29] USITC, staff fieldwork, Nov. 1993.
[30] Testimony before the U.S. International Trade Commission by Mr. Michael Locker, Locker Associates, Inc., statement on behalf of the United Steelworkers of America, AFL-CIO-CLC., Oct. 5, 1993.

[31] Derived from official statistics of the U.S. Department of Energy and the International Energy Agency.
[32] *Japan Exports and Imports, Commodity by Country,* (Tokyo, Japan Tariff Association, Dec. 1992).

Table 2-3
World estimated recoverable reserves of coal, 1992

(Billion short tons)

Country	Anthracite/ bituminous	Lignite/ subituminous	Combined
Former Soviet Union	114.6	151.0	265.6
United States	117.4	147.3	264.7
China	68.5	57.6	126.1
Australia	50.0	50.3	100.3
Germany	26.4	61.9	88.3
South Africa	61.0	(1)	61.0
Poland	32.6	12.8	45.4
Other	97.4	96.2	193.6

[1] Not applicable.

Source: U.S. Department of Energy, Energy Information Administration, *International Energy Annual 1992,* Jan. 1994.

imports of coal to feed its coke ovens. Japan's imports of metallurgical coal in 1992 were primarily from Australia (which accounts for 51 percent of Japan's total imports), Canada (25 percent), and the United States (13 percent).[32] Other sources for Japan's imports of metallurgical coal include Russia, China, and South Africa. Japan's coke producers blend lower quality Australian coal with the higher quality U.S. and Canadian coal to increase the quality of the coke.

China

China is third in the world in terms of recoverable coal reserves. These abundant reserves support the rising production of coke. However, only about 20 percent of the coal reserves are near coking facilities. Therefore, a considerable amount of transportation is involved. Coking coal is railed from the northern mines to the ports for shipment along the coasts to the coking facilities.[33] Despite the large reserve base, China accounts for only 2 percent of world exports of metallurgical coals.[34]

[33] McCloskey Coal Information Service, *PCI and Coke: Market Impacts of Changing Steel Technologies*, Aug. 1993, p. 86.

[34] Derived from official statistics of the U.S. Department of Energy and the International Energy Agency.

Poland

Poland is seventh in terms of world coal recoverable reserves and coal accounts for 70 percent of the country's energy needs.[35] Poland's main bituminous coal reserves are in an area that stretches into the Czech Republic. Coking coal supplies are large enough to meet domestic demand over the long term and are well connected by rail to serve local coke and steel producers.[36] Poland accounts for approximately 4 percent of world exports of metallurgical coals.[37]

Czech Republic

The Czech Republic is self-sufficient in coking coal, with the bulk of the nation's recoverable reserves in an area that borders Poland's reserves. The mines are well connected by rail to supply domestic coke and steel producers with metallurgical coal. The Czech Republic accounts for less than 1 percent of world exports of metallurgical coals.[38]

[35] U.S. Department of Energy, Energy Information Administration, *Annual Prospects for World Coal Trade*, June 1991, pp. 67-68.

[36] International Energy Agency Coal Research, *Major Coalfields of the World*, IEAACR/51, Jan. 1993, pp. 88-89.

[37] Derived from official statistics of the U.S. Department of Energy and the International Energy Agency.

[38] Ibid.

CHAPTER 3
Industry and Market in the United States

Introduction

The U.S. coke industry faces several major challenges: lessening consumption, falling prices for U.S. coke, increasing imports of low-priced foreign coke, much capacity nearing the end of its life expectancy, and rising capital and operating costs because of stricter environmental regulation. Declining revenues and cost fluctuations have adversely affected profitability, especially for producers of blast furnace coke. Coke imports are increasingly purchased on a long-term contract, rather than on a spot basis, increasing their permanency in the market. As consumption has declined, domestic capacity has also declined.

This chapter is a baseline analysis of the domestic industry, lending perspective on size and competitive position. The first part takes up the basic parameters of the industry in terms of capacity, production, consumption, and trade. The second part analyzes production costs, financial performance, market dynamics, and prices that help determine the competitive position of the U.S. coke industry. The third part takes up the major environmental regulations and the pollution abatement costs that may affect the performance of the industry.

Industry Structure

The U.S. coke industry has two sectors: the integrated producers and the merchant producers. Integrated plants are owned and operated by, or affiliated with, integrated iron and steel producers. These plants produce blast furnace coke for captive use as well as for some intercompany sales among steel firms. Integrated plants accounted for about 80 percent of U.S. coke capacity in 1992 (table 3-1). Merchant plants account for the remaining 20 percent of total U.S. coke capacity, producing coke for sale on the open market. They are typically owned by, or affiliated with, chemical or coal companies. Some merchant plants produce both blast furnace coke and foundry coke, while others tend to concentrate on only one. Merchant plants sell their coke production primarily to firms with blast furnace, foundry, and nonferrous smelting operations. At the end of 1993, the industry was operating 26 byproduct recovery plants around the country with 71 batteries and approximately 4,100 byproduct ovens.[1] The integrated sector was operating 16 of these plants with 49 batteries and about 3,100 ovens. The merchant sector was operating the other 10 plants with 22 batteries and about 1,000 ovens. The merchant sector also includes 1 plant with 3 batteries and 150 nonrecovery ovens.

The number of active byproduct batteries has declined significantly since the end of 1989, falling from 91 to 71 (table 3-2). The integrated sector idled 18 batteries from 1990 through 1993, while the merchant sector idled 3 batteries over the same period. Much of the decline occurred in 1992 in the integrated sector with the shutdown of plants by Bethlehem Steel, LTV Steel, and Sharon Steel, and the idling of 1 battery by Inland Steel. National Steel brought a battery that had been previously idled back into production in 1992 after a rebuilding of the facility. In the merchant sector, Detroit Coke and Indiana Gas each closed a battery in 1990, and Shenango idled 1 battery in 1991.

The geographic distribution of U.S. coke oven facilities generally reflects the location of coal deposits or steelmaking facilities (figure 3-1). Coke production is concentrated near Pittsburgh, PA, Chicago, IL, and Birmingham, AL. Geography also affects the strength of competition that domestic coke facilities face from imported material. Coke producers near the Great Lakes or close to ocean ports are more likely to face competition from imported material than inland producers, owing to transportation costs associated with transferring coke to inland consumers.

Capacity

Cokemaking capacity in the United States has been declining for almost two decades. Approximately 50 percent of U.S. capacity has reached or is nearing the average accepted lifespan for coke oven batteries, which is 20 to 30 years.[2] For the industry to maintain capacity, these aging batteries must either be replaced or repaired, depending upon their condition, to comply with pending environmental standards. Recent data in table 3-3 show that capacity decreased significantly

[1] The number of ovens was estimated from data reported in EPA, Office of Air Quality, Planning and Standards, "Cost Analysis For the Coke Oven NESHAP," Research Triangle Park, North Carolina, Apr. 1992, pp. 25-26.

[2] William T. Hogan, "The Future World Crisis in Coke," *Iron and Steel Engineer*, Dec. 1992.

Table 3-1
U.S. coke producers and capacities (active, hot idle, and cold idle), 1992

(1,000 metric tons)

Integrated Company	Capacity	Merchant Company	Capacity
U.S. Steel	6,024	Koppers	740
Bethlehem Steel	3,165	Jewell Smokeless	680
Armco	2,175	ABC Coke	629
LTV Steel	2,414	Citizens Gas and Coke	576
National Steel	1,385	Sloss	410
Wheeling-Pittsburgh	1,156	New Boston Coke	314
Inland Steel	1,073	Empire Coke	307
Geneva Steel	726	Shenango[1]	467
Acme Steel	512	Tonawanda Coke	244
Gulf States Steel	466	Erie Coke	188
Sharon Steel[2]	338	Toledo Coke	163
Total	19,434	Total	4,718
Grand total			24,152

[1] Shenango is currently under the provisions of chapter 11 bankruptcy.

[2] Sharon Steel cold idled its capacity in 1993.

Source: IISI, *World Cokemaking Capacity,* pp. 120-123.

during 1990-92 and the first half of 1993. This decline in capacity is reflected in battery shutdowns noted above and is primarily the result of battery shutdowns by the integrated sector. During the period, several integrated producers cold idled their ovens with the intention of purchasing all of their coke requirements from a combination of domestic and imported sources.[3]

Production

Coke

U.S. production of coke has declined sharply since the early 1970s, when production averaged about 60 million metric tons. Production has continued to decline in recent years, falling to a low of 21.2 million metric tons in 1992 (table 3-4).

Based on USITC questionnaire data, integrated producers accounted for about 84 percent of total U.S. metallurgical coke production in 1992 (table 3-5 and 3-6); merchant plants accounted for the remaining 16 percent. Blast furnace coke accounted for approximately 96 percent of shipments (including captive shipments) in recent years (table 3-5). Foundry coke, which is produced exclusively by the merchant sector, accounts for the remaining 4 percent of coke production and shipments (table 3-6).[4]

The decline in production during this period is attributed to decreased U.S. steel demand, improvements in the efficiencies of blast furnaces, operating limitations, plant closings, and capital improvements associated with environmental standards. The decline in production occurred entirely in blast furnace coke production by the integrated sector. The merchant sector actually increased production of blast furnace coke slightly from 1990 to 1992. Production of foundry coke remained stable over the period.

[3] USITC staff conversations with industry representatives, November, 1993.

[4] Questionnaire data on foundry coke understates totals as responses from certain facilities were either too late to be included or not received.

Coke Byproducts

Many coke byproducts are sold to the chemical industry as feedstocks for further processing. Over time, the production of feedstocks from crude petroleum has become more efficient and less expensive. As a result, demand for as well as production of some of the primary coke byproducts has declined, as reflected by trends in the following byproducts.

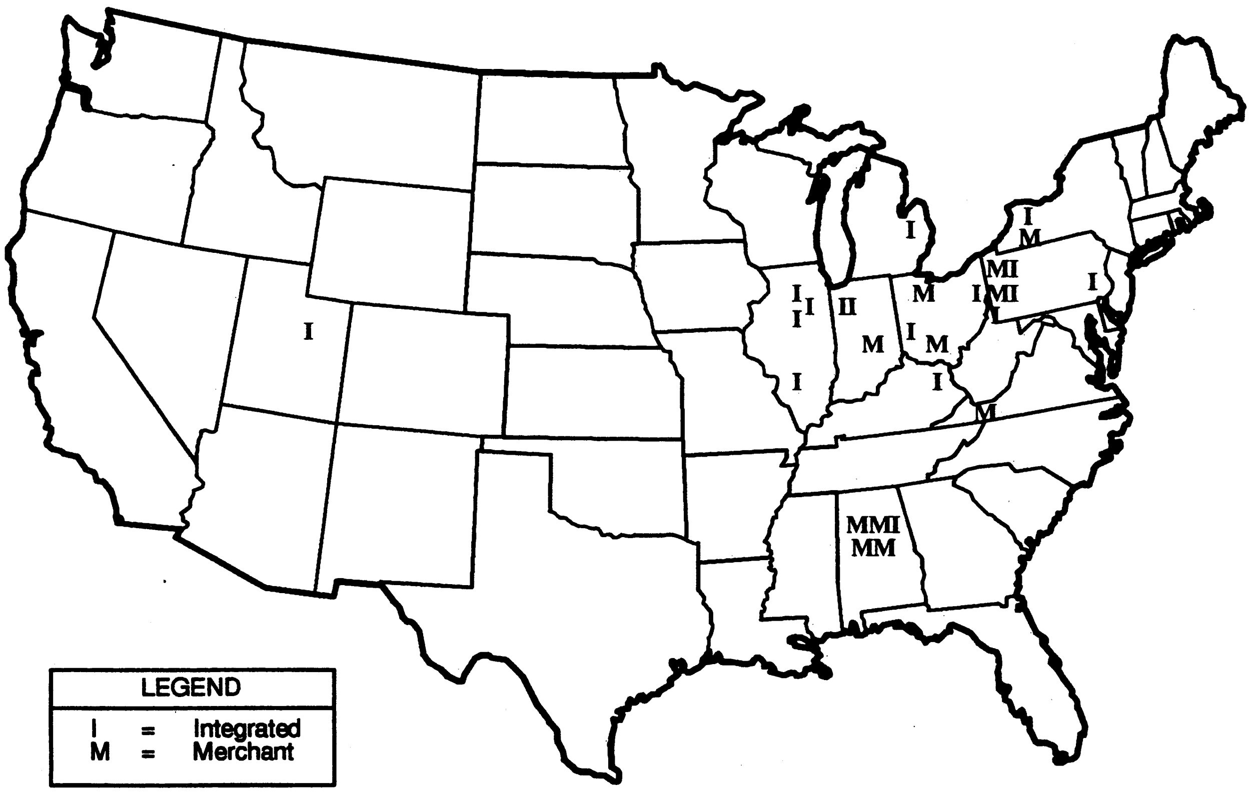
Coke producers can burn crude coal tar or further refine it into tar products. Approximately 80 percent of the crude coal tar is refined into tar acid oils, soft pitch, creosote oil, road tar, and other products. U.S. production of crude coal tar decreased from 596.8 million liters in 1990 to 586.2 million liters in 1992 (table 3-7). Sales increased from 481.8 million liters in 1988 to 525.2 million liters in 1992. Crude light oil is a mixture of aromatic hydrocarbons (benzene, toluene, and xylenes), as well as thiophene, mercaptans, hydrogen sulfide, and hydrogen disulfide. Additional refining separates the higher valued aromatic hydrocarbons from these other chemicals. U.S. production of crude light oil decreased from 254.9 million liters in 1990 to 193 million liters in 1992 (table 3-8). Sales also decreased during the period, from 255.5 million liters to 195 million liters.

Table 3-2
Active U.S. metallurgical coke batteries, as of December 31, 1989-1993

Company	Plant	1989	1990	1991	1992	1993
Integrated:						
U.S. Steel	Clairton, PA	12	12	12	12	12
	Gary, IN	4	4	4	4	4
Bethlehem Steel	Bethlehem, PA	2	2	2	2	2
	Burns Harbor, IN	2	2	2	2	2
	Lackawanna, NY	3	2	2	2	2
	Sparrows Point, MD	3	3	3	0	0
Armco	Middletown, OH	3	3	3	3	3
	Ashland, KY	2	2	2	2	2
LTV Steel	Cleveland, OH	5	5	5	0	0
	Pittsburgh, PA	5	5	5	5	5
	Chicago, IL	1	1	1	1	1
	Warren, OH	1	1	1	1	1
National Steel						
	Ecorse, MI	1	1	0	1	1
	Granite City, IL	2	2	2	2	2
Wheeling-Pittsburgh	E. Steubenville, WV	4	4	4	4	4
Inland Steel	East Chicago, IN	6	6	5	4	0
Geneva Steel	Provo, UT	4	4	4	4	4
Acme Steel	Chicago, IL	2	2	2	2	2
Gulf States Steel	Gadsden, AL	2	2	2	2	2
Sharon Steel	Monessen, PA	2	2	2	0	0
Total		66	65	63	53	49
Merchant:						
Koppers	Woodward, AL	5	5	5	5	5
Jewell Smokeless	Van Sandt, VA	3	3	3	3	3
ABC Coke	Tarrant, AL	3	3	3	3	3
Citizens Gas and Coke	Indianapolis, IN	3	3	3	3	3
Sloss	Birmingham, AL	3	3	3	3	3
New Boston	Portsmouth, OH	1	1	1	1	1
Empire Coke	Holt, AL	2	2	2	2	2
Shenango	Pittsburgh, PA	2	2	2	1	1
Tonawanda Coke	Buffalo, NY	1	1	1	1	1
Erie Coke	Erie, PA	2	2	2	2	2
Toledo Coke	Toledo, OH	1	1	1	1	1
Detroit Coke	Detroit, MI	1	1	0	0	0
Indiana Gas	Terra Haute, IN	1	1	0	0	0
Total		28	28	26	25	25
Grand Total		94	93	89	78	74

Source: IISI, *World Cokemaking Capacity*, 1993, and discussions with industry officials, February, 1994.

Figure 3-1
Geographic distribution of U.S. coke producers



Source: American Coke and Coal Chemicals Institute, and IISI, *World Cokemaking Capacity.*

Table 3-3
Metallurgical Coke: Active and hot idle capacity, by sector and type of coke, 1990-92, Jan.-June 1992, and Jan.-June 1993

(1,000 metric tons)

				Jan.-June—	
Producer type	**1990**	**1991**	**1992**	**1992**	**1993**
Integrated:					
Blast furnace	23,550	21,594	20,004	12,969	9,925
Merchant:					
Blast furnace	2,418	2,458	2,491	1,244	1,136
Foundry	1,160	1,154	1,155	577	580
Total blast furnace	25,968	24,052	22,495	14,213	11,061
Total	27,128	25,206	23,650	14,790	11,641

Note.—Actual foundry capacities are estimated to be approximately 30 to 35 percent higher as data was not received from all foundry coke production facilities.

Source: Data compiled from responses to the U.S. International Trade Commission questionnaires.

Table 3-4
Metallurgical Coke: U.S. production, imports, exports, stocks, and consumption, 1985-92
(1,000 metric tons)

Year	Production	Imports	Exports	Stocks[1]	Consumption[2]
1985	25,794	525	1,018	(1,055)	26,356
1986	22,600	298	911	(442)	22,429
1987	23,859	837	521	(909)	25,084
1988	26,254	2,439	992	471	27,231
1989	25,438	2,092	984	305	26,241
1990	25,049	1,026	519	(1)	25,557
1991	21,810	1,069	671	171	22,037
1992	21,234	1,902	582	(203)	22,757

[1] Stocks refer to the inventories on the ground; data presented are the average annual change in stocks. The numbers with parentheses are withdrawals from inventories and those without parentheses are additions to inventories.

[2] Consumption is equal to production plus imports, minus exports, and changes in stocks.

Note.—Production totals for 1990-1992 based on official responses to the Commission's questionnaire (see tables 3-4 and 3-5) averaged approximately 1 to 2 percent higher than official statistics of the U.S. Department of Energy. Therefore, to provide a more consistent comparison over the 1985-1992 period, U.S. Department of Energy data are presented in this table.

Source: Derived from official statistics of the U.S. Department of Energy, Energy Information Administration, *Quarterly Coal Report April-June 1993*, Nov. 1993 and the U.S. Department of Commerce.

Table 3-5
Coke: Blast furnace production, stocks, and shipments,[1] by sector, 1990-92, Jan.-June 1992, and Jan.-June 1993

				Jan.-June—	
Producer type	1990	1991	1992	1992	1993
	Quantity *(1,000 metric tons)*				
Beginning stocks	1,194	1,209	1,384	1,385	1,249
Integrated:					
Production	22,053	18,616	18,064	9,125	8,993
Shipments	22,031	18,529	18,277	9,219	9,240
Merchant:					
Production	2,477	2,509	2,558	1,284	1,160
Shipments	2,498	2,428	2,506	1,290	1,193
Ending stocks	1,194	1,377	1,222	1,284	968
	Value *(million dollars)*				
Integrated:					
Shipments	2,246	2,022	1,912	971	951
Merchant:					
Shipments	248	241	245	129	111

[1] Includes toll operations.

Note.—Production data include purchases; shipments data include domestic transfers and exports.

Source: Data compiled from responses to the U.S. International Trade Commission questionnaires.

Table 3-6
Coke: Foundry production, stocks, and shipments[1] 1990-92, Jan.-June 1992, and Jan.-June 1993

(1,000 metric tons)

Item	1990	1991	1992	Jan.-June— 1992	Jan.-June— 1993
Beginning stocks	49	55	59	59	56
Production	954	857	927	467	506
Shipments	948	853	930	472	510
Ending stocks	55	59	56	54	52

[1] Includes toll operations.

Note.—Production data include purchases; shipments data include domestic transfers and exports. Actual totals are estimated to be 30 to 35 percent higher as data was not received from all foundry coke production facilities.

Source: Data compiled from responses to the U.S. International Trade Commission questionnaires.

Table 3-7
Crude coal tar: U.S. production and sales, 1990-92

Year	Production	Sales: Quantity	Sales: Value	Average unit value[1]
	1,000 liters	1,000 liters	*1,000 dollars*	*Dollars*
1990	596,762	481,843	49,252	.10
1991	535,885	430,307	48,048	.11
1992	586,226	525,169	61,221	.12

[1] Unit value per liter.

Source: Derived from responses to USITC questionnaires and from USITC, *Synthetic Organic Chemicals, United States Production and Sales,* various years.

Table 3-8
Crude light oil: U.S. production and sales, 1990-92

Year	Production	Sales: Quantity	Sales: Value	Average unit value[1]
	1,000 liters	1,000 liters	*1,000 dollars*	*Dollars*
1990	254,902	255,494	45,440	.18
1991	203,741	200,836	27,351	.14
1992	193,008	194,951	23,591	.12

[1] Unit value per liter.

Source: Derived from responses to USITC questionnaires and from USITC, *Synthetic Organic Chemicals, United States Production and Sales,* various years.

Coke oven gas, which in the United States is generally more important in operating the coke facility or a related steel plant than as a product for sale, contains several components, with methane and hydrogen in the greatest proportion. These gases have approximately 50 percent of the heating value of natural gas and must be further processed before being used as a fuel. According to industry sources, coke producers consume about 80 to 90 percent of the coke oven gas produced either to heat the coke ovens or to use as boiler fuel for the generation of electricity. Electricity is required to operate the coke batteries and the byproduct recovery plant. Steel producers and other metallurgical operations also use oven gas to heat furnaces. In terms of quantity, the industry internally consumed an average of 58 percent of its coke oven gas, transferred about 25 percent to related facilities (which in some cases is an onsite power plant), and commercially sold the remaining 17 percent (table 3-9).[5]

Breeze is the fine screenings that result from the crushing of coke. Usually breeze will pass through a 1/2-inch or 3/4-inch screen opening. Breeze is reused in the byproduct ovens by foundry coke producers and is also used as a fuel source in the agglomeration of iron ore. U.S. production of breeze decreased from 2 million metric tons in 1990 to 1.8 million metric tons in 1992 (table 3-10). Sales also decreased slightly.

Consumption

As shown previously on table 3-4, consumption of coke declined from 27.2 million metric tons in 1988 to 22 million metric tons in 1991, before rebounding slightly in 1992. Integrated steelmakers account for most coke consumption in the United States (table 3-11). A small percentage of coke is used by the iron and steel foundries to melt iron or steel scrap for casting purposes. An even smaller percentage of coke is used in nonferrous smelters and chemical plants.

Consumption by Integrated Steelmakers

Coke consumption in the U.S. steel industry has been declining for several reasons, including the development of alternative iron- and steelmaking techniques and the restructuring of the steel industry during the 1980s. Over the long term, the decline in coke consumption in the United States has reflected the downward trend in U.S. steel production. Raw steel production reached its peak (151 million short tons) in the United States in 1973 and then dropped to a low of 75 million short tons in 1982. At that point the U.S. industry entered a period of restructuring. Measures were taken to reduce capacity,[6] production, and employment to lower operating costs and to consolidate operations for more effective use of new investments in technology and management techniques.[7] For example, the share of total U.S. steel produced in electric furnaces, a process that does not require coke, increased from 31 percent in 1982 to 38 percent in 1992.

During 1982-88, U.S. raw steel production generally increased, peaking at 90.6 million metric tons in 1988. Coke consumption by the steel industry generally tracked steel production, reaching 27.2 million metric tons in 1988, before falling to 22.7 million metric tons in 1992 as steel production fell to 84.3 million metric tons. However, integrated steelmakers have taken steps to decrease coke rates, which include increasing the hot blast temperature, improving the burden quality and distribution, and increasing fuel injections. As a result, U.S. average coke rates decreased by about 24 percent during 1971-92, from 1,261 pounds of coke per ton of hot metal to 957 pounds of coke per ton of hot metal. Coke rates have been relatively stable for the past few years.[8]

Consumption by Foundries

Foundry coke accounted for about 5 percent of the total coke consumed in the United States during 1991-92.[9] As with blast furnaces, improved operating techniques have led to a decrease in the amount of coke required to produce 1 ton of hot metal.

In addition, the economy-wide recession experienced in the U.S. in the early 1980s lead to the downsizing of the auto industry which in turn reduced the demand for steel castings. This, plus competition from alternative materials and manufacturing processes, led to declines in the consumption of foundry coke. During the 1980s, 33 percent of the U.S. foundries closed, leaving fewer than 1,500 in operation.[10] Despite these closings, capacity to produce foundry products remains greater than demand.

Trade

Trade in coke has historically been limited because of the cost of transportation and amount of breakage associated with transportation. Prior to 1987, the United States maintained a positive trade balance in coke. In 1987, imports began to outpace exports; as a result, the trade deficit in coke reached 1.4 million

[5] Testimony before the U.S. International Trade Commission by Mr. Donald Sweet, Vice President and General Manager, Koppers Industries Inc., Oct. 5, 1993.

[6] Capacity closures included a wide variety of facilities, including coke ovens.

[7] For additional information, see "Steel Industry Annual Report", USITC publication 2436, September 1991.

[8] Calculated from data of the American Iron and Steel Institute.

[9] Based on data compiled in the *Quarterly Coal Report* issued by the Energy Information Agency.

[10] Tom Stundza, "Too Much Reliance on Automotive," *Purchasing*, July 18, 1991, pp. 48A3-48A5.

Table 3-9
Coke oven gas: Internal consumption, company transfers, and commercial shipments, 1990-92, Jan.-June 1992, and Jan.-June 1993

Producer type	1990	1991	1992	Jan.-June— 1992	Jan.-June— 1993
	Quantity *(1,000 metric tons)*				
Internal consumption	227,645	201,091	198,509	103,576	104,976
Company transfers	101,673	83,239	82,452	49,372	41,774
Commercial shipments	60,154	62,984	65,568	29,847	21,493
	Value *(thousand dollars)*				
Internal consumption	261,938	220,257	199,480	103,689	111,866
Company transfers	126,822	99,384	82,399	46,902	44,327
Commercial shipments	66,669	59,056	57,918	28,481	17,804
	Unit value *(dollars per 1,000 cubic feet)*				
Internal consumption	1.15	1.10	1.00	1.00	1.07
Company transfers	1.25	1.19	1.00	.94	1.06
Commercial shipments	1.11	.94	.88	.95	.83

Source: Data compiled from responses to the U.S. International Trade Commission questionnaires.

Table 3-10
Breeze: Production, shipments 1990-92, Jan.-June 1992, and Jan.-June 1993

Item	1990	1991	1992	Jan.-June— 1992	Jan.-June— 1993
Beginning stocks	95	159	139	129	160
Production	1,961	1,774	1,837	915	774
Shipments	1,899	1,803	1,813	902	892
Ending stocks	157	131	161	151	130

Note.—Production data include purchases; shipments data include domestic transfers and exports, beginning stocks include inventory adjustments.

Source: Data compiled from responses to the U.S. International Trade Commission questionnaires.

Table 3-11
Coke shipments including transfers, by type of customer, 1992

(Percent)

Customer	Share of total
Integrated steel mills	91.2
Foundries	3.4
Industrial coke users	1.9
Other (including merchant producers)	3.5
Total	100.0

Source: Data compiled from responses to the U.S. International Trade Commission questionnaires.

Table 3-12
Metallurgical coke:[1] U.S. import quantities, customs values, and unit values, customs and c.i.f., 1985-93

Source	1985	1986	1987	1988	1989	1990	1991	1992	1993
				Quantity *(1,000 metric tons)*					
Australia	0	(2)	113.3	550.7	459.5	201.5	171.7	302.0	214.5
Canada	46.9	31.4	170.0	439.4	129.4	131.1	44.1	47.7	17.5
China	0	0	0	20.0	39.7	0	0	0	11.9
Japan	421.2	266.8	490.6	950.1	659.7	612.7	834.3	1,528.3	1,595.7
All other	56.6	(2)	62.8	477.5	803.8	80.5	19.1	23.8	39.7
Total	524.6	298.3	836.7	2,438.6	2,092.1	1,025.7	1,069.1	1,901.8	1,879.2
				Customs value *(million dollars)*					
Australia	0	(3)	6.6	41.1	46.1	20.6	18.5	28.0	19.6
Canada	3.2	2.3	9.4	28.3	7.0	15.2	3.3	3.6	1.5
China	0	0	0	1.5	3.5	0	0	0	0.7
Japan	36.0	23.0	34.5	73.6	73.1	61.0	75.9	141.3	136.2
All other	3.6	(3)	4.5	49.1	94.6	8.0	0.8	0.9	2.4
Total	42.9	25.4	54.9	193.5	224.3	104.8	98.5	173.8	160.3
				Customs unit value *(dollars per metric ton)*					
Australia	(4)	109.40	58.40	74.60	100.41	102.09	107.80	92.78	91.35
Canada	67.93	74.80	55.04	64.34	53.95	116.01	75.87	74.68	86.31
China	(4)	(4)	(4)	75.00	87.77	(4)	(4)	(4)	56.92
Japan	85.57	86.27	70.27	77.36	110.84	99.61	90.98	92.44	85.34
All other	64.82	119.07	71.19	102.79	117.66	98.92	40.93	38.54	59.88
Average	81.76	85.08	65.64	79.35	107.21	102.14	92.16	91.37	85.32
				C.I.F. unit value *(dollars per metric ton)*					
Australia	(4)	118.15	71.18	85.40	112.80	115.35	129.50	113.00	111.47
Canada	67.93	74.80	67.77	71.97	57.93	120.76	81.82	81.38	101.47
China	(4)	(4)	(4)	101.70	105.74	(4)	(4)	(4)	75.25
Japan	93.56	93.55	80.12	90.79	124.40	111.22	102.08	102.76	94.68
All other	82.74	168.51	82.63	112.91	131.22	113.39	45.19	39.50	75.75
Average[5]	90.11	91.59	76.59	90.60	120.01	113.42	104.64	103.05	96.13

[1] Metallurgical coke as provided for under TSUSA subheading 521.3140 and HTS subheadings 2704.00.00.05(pt.), 2704.00.00.10, 2704.00.00.15, 2704.00.00.20(pt.), and 2704.00.00.50(pt.). Discrepancies between the foreign purchases reported on USITC questionnaires and U.S. Department of Energy import data led to an examination of individual shipment import data maintained by the U.S. Department of Treasury, Bureau of Customs. This examination revealed the apparent classification of metallurgical coke under Harmonized Tariff Schedule (HTS) subheadings not expected to contain metallurgical coke. Discussions with the importers of record confirmed these suspicions. These individual shipments have been added to imports classified under 2704.00.00.15. These discussions also indicated that there seem to be some errors in the Customs/Census import data regarding the country of origin and value of certain shipments, although these errors could not be confirmed.

[2] Less than 500 metric tons.

Table 3-12—Footnotes Continued
Metallurgical coke:[1] U.S. import quantities, customs values, and unit values, customs and c.i.f., 1985-93

[3] Less $500,000 dollars.
[4] Not applicable.
[5] Average unit value for all U.S. coke imports.

Note.—1985-88 unit values are revised unit values based on metric tons (comparable to 1989-93 data as presented). In 1989 TSUSA classification was converted to HTS, and during 1990 metallurgical coke provided for under HTS subheading 2704.00.00.10 was converted into HTS subheadings 2704.00.00.05 and 2704.00.00.15. Therefore, shifts in unit values may be partially the result of changes in official import product classifications.

Source: Compiled from official statistics of the U.S. Department of Commerce.

Table 3-13
Metallurgical coke:[1] U.S. export quantities, values, and unit values, f.a.s., 1985-93

Source	1985	1986	1987	1988	1989	1990	1991	1992	1993
					Quantity *(1,000 metric tons)*				
Canada	369.5	432.7	215.1	315.5	584.4	340.9	217.2	281.2	378.5
Japan	0	9.4	27.4	105.6	65.1	(2)	59.5	41.1	0
All other	648.7	649.2	283.9	570.6	335.2	178.1	394.8	260.3	379.1
Total	1,018.2	911.2	526.4	991.8	984.7	519.0	671.5	582.6	757.7
					Value *(million dollars)*				
Canada	28.0	26.1	22.2	32.8	44.8	30.0	17.0	22.2	24.4
Japan	0	0.7	4.1	6.5	2.4	(3)	2.9	1.9	0
All other	48.8	38.7	23.1	37.8	33.0	20.1	30.3	20.3	35.3
Total	76.8	65.5	49.3	77.1	80.2	50.1	50.2	44.3	59.7
					Unit value per metric ton				
Canada	75.70	60.35	103.01	104.00	76.67	87.99	78.10	79.09	64.50
Japan	(4)	76.25	148.09	61.80	37.00	91.73	49.57	47.01	(2)
All other	75.23	82.46	81.46	66.20	98.39	112.84	76.77	77.51	93.17
Average[5]	75.40	71.90	93.74	77.79	81.44	96.52	74.79	76.13	78.85

[1] Metallurgical coke as provided for under schedule B subheading 521.3148 and HS-based Schedule B subheading 2704.00.00.10.
[2] Less than 500 metric tons.
[3] Less than $500,000.
[4] Not applicable.
[5] Average unit value for all U.S. coke exports.

Note.—1985-88 unit values were calculated based on short tons (as reported in Census statistics); these are revised unit values based on metric tons (comparable to 1989-93 data as presented). In 1989 TSUSA classification was converted to HTS, and during 1990 metallurgical coke provided for under HTS subheading 2704.00.00.10 was converted into HTS subheadings 2704.00.00.05 and 2704.00.00.15. Therefore, shifts in unit values may be the result of concordance changes in official import product classification.

Source: Compiled from official statistics of the U.S. Department of Commerce. Columns may not sum due to rounding.

metric tons in 1988 (tables 3-12 and 3-13). This change coincided with the increase in steel production, which also peaked in 1988.

However, since 1990 imports have risen by about 0.9 million metric tons despite declining demand for coke by steel producers. U.S. exports of coke remained relatively stable during the 1990-92 period, with Canada being the major market because of its proximity. Most of the trade deficit was the result of increased U.S. imports from Japan, the primary source of U.S. imports.

Imports

Major sources for U.S. metallurgical coke imports during the period from 1985-93 were Japan, Australia, and Canada, with small shipments from China in 1989 and 1993. Import quantity peaked in 1988 at 2.4 million metric tons ($194 million), although the value of imports peaked in 1989 at $224 million (2.1 million metric tons. Imports then fell to 1.0 million metric tons in 1990 before beginning to increase in 1991. From 1988-93, imports from Australia and Canada declined significantly (60 percent and 96 percent, respectively), while imports from Japan rose by more than 68 percent. Imports as a share of consumption[11] ranged between 1.3 and 9.0 percent for the period 1985-92 with the highest share in 1988. The import-to-consumption ratio declined to 4.0 percent in 1990, before rising to 4.9 percent and 8.4 percent in 1991 and 1992, respectively.

The unit values of imports ranged from $76.59 per metric ton to $120.01 per metric ton. The unit values of imported coke generally declined over the 4-year period 1990-1993. Unit values for imported Canadian coke were lower, relative to other major suppliers during 1991-92 (table 3-12). U.S. imports from China were valued at $75.25 per metric ton in 1993.[12] Unit values for U.S. imported coke from Japan declined from $111.22 to $102.76 per metric ton during 1990-92 and then to $94.68 per metric ton during 1993.

Exports

The major export market for U.S. metallurgical coke during the period 1985-1993 was Canada, with some shipments to other smaller markets, including Japan (table 3-13). Exports ranged between 2.2 and 4.0 percent of U.S. production over the period.

Unit values of exported metallurgical coke to Japan were highest during 1987, while the average unit value for all U.S. metallurgical coke exports was highest in 1989 (table 3-13).[13] Unit values for exports to Canada ranged from $60.35 to $104.00 per metric ton during 1986 and 1988, respectively, but have since fallen, and were $64.50 in 1993. Unit values of exports to Japan ranged from $37.00 to $148.09 per metric ton during 1989 and 1987, respectively.

[11] See table 3-4 for the data on consumption.

[12] USITC questionnaire data indicates that the value of Chinese imports may be understated in Department of Commerce data.

[13] Export unit values were based on f.a.s. value and quantity of metallurgical coke exports compiled from official statistics of the U.S. Department of Commerce.

Production Costs[14]

U.S. merchant and integrated steel producers' cost of production for their blast furnace coke operations are presented in table 3-14, based on total costs per metric ton of blast furnace coke produced.[15] Metallurgical coal costs ranged from $67.76 to $71.17 per metric ton of coke produced during 1990-92. Direct labor costs increased 15.4 percent, from $15.01 to $17.32 per metric ton of production. Credits for sales of associated byproducts, coke breeze and/or industrial coke ranged between $16.34 and $17.05 per metric ton of coke produced during 1990-92. Total cost of production ranged from $106.52 to $118.85 per metric ton of blast furnace coke produced, and was highest during 1991.

Differences in metallurgical coke production costs between integrated and merchant producers were most evident for coal, energy, and other costs, and for credits during 1990-92. Integrated producers' metallurgical coal cost ranged from $68.54 to $71.95 per metric ton of coke produced, while merchant producers reported a cost of $61.61 to $65.29 per metric ton of coke produced (table 3-15). Average energy costs for integrated producers were about twice those of merchant plants.[16] Depreciation, amortization and other production costs were also higher for integrated producers.[17] However, integrated producers' credits for sales of byproducts, coke breeze, and industrial coke were nearly twice the level of that reported by merchant producers, narrowing the total cost differential. Overall, total costs of production were between 10.7 and 22.3 percent higher for integrated plants than for merchant plants during 1990-92.

Transportation Costs

The vast majority of coke is still consumed at facilities adjacent to the coke plants, and therefore travels only a matter of yards. However, open market sales often involve significantly greater distances, and transportation costs and reliable delivery are key purchase factors for U.S. coke consumers.[18]

[14] Data presented in this section reflect blast furnace coke production costs, excluding tolling operations, for merchant and integrated producers.

[15] Production cost per metric ton of coke produced may not reflect actual costs of the specified production factors. (Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission)

[16] The large difference in energy costs between integrated and merchant plants may partly the reflect the difficulty in allocating energy costs for metallurgical coke production from steel production.

[17] Higher "other production costs" for integrated producers may partly shut-down costs associated battery closings during 1990-92.

[18] Fourteen out of 17 producers indicated in their questionnaire response that inland transportation costs were an important factor in their customers' sourcing decision for metallurgical coke.

Table 3-14
Blast furnace coke: U.S. producers' production costs per ton of coke for selected items, 1990-92, Jan.-June 1992, and Jan.-June 1993[1]

(Dollars per metric ton)

Item	1990	1991	1992	Jan.-June— 1992	Jan.-June— 1993
Metallurgical coal	69.96	71.17	67.76	67.93	68.91
Other raw materials	4.75	7.21	8.20	7.41	8.05
Direct labor	15.01	16.79	17.32	16.74	16.44
Energy costs	7.07	8.13	7.68	7.39	7.74
Other costs[3]	26.77	31.89	29.13	30.27	30.29
Credits[2]	(17.05)	(16.34)	(16.45)	(15.83)	(16.17)
Total	106.52	118.85	113.64	113.91	115.26

[1] Production costs were calculated as the cost per ton of actual production and may not reflect actual costs.

[2] Includes credits for sales of by products, coke breeze and/or industrial coke.

[3] Includes depreciation, amortization, and other factory costs associated with metallurgical coke production not previously reported.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table 3-15
Blast furnace coke: U.S. producers' production costs for selected items, by producer types, 1990-92, Jan.-June 1992, and Jan.-June 1993[1]

(Dollars per metric ton)

Item	1990	1991	1992	Jan.-June 1992	Jan.-June 1993
Integrated producers:					
Raw materials:					
Metallurgical coal	$70.43	$71.95	$68.54	$68.35	$69.82
Other	4.95	7.83	9.09	8.11	8.59
Costs of good sold					
Direct labor	15.06	17.15	17.34	16.95	16.53
Energy costs	7.46	8.63	8.26	7.92	8.16
Other costs[3]	27.41	32.97	30.06	31.25	30.85
Credits[2]	(17.85)	(17.33)	(17.46)	(16.75)	(16.96)
Total	107.45	121.19	115.84	115.83	116.98
Merchant producers:					
Raw materials:					
Metallurgical coal	65.29	64.64	61.61	64.47	61.00
Other	2.76	1.91	1.14	1.79	3.35
Costs of good sold					
Direct labo	14.55	13.77	17.15	15.07	15.62
Energy costs	3.10	3.92	3.02	3.14	4.13
Other costs[3]	20.30	22.77	21.70	22.39	25.34
Credits[2]	(8.89)	(7.93)	(8.43)	(8.42)	(9.27)
Total	97.10	99.08	96.19	98.44	100.17

[1] Production costs were calculated as the cost per ton of actual production and may not reflect actual costs.

[2] Includes credits for sales of byproducts, coke breeze and/or industrial coke.

[3] Includes depreciation, amortization, and other factory costs associated with metallurgical coke production not previously reported.

Note.—Totals may not add due to rounding.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Transportation costs can account for 10 to 20 percent of the total delivered cost of coke.[19] However, these costs vary widely, depending on a number of factors, including distance, mode of transport, and quantity shipped.

According to questionnaire data, 62 percent of reported metallurgical coke sales, by quantity, were transported between 100 and 500 miles, while 20 and 18 percent were transported less than 100 or more than 500 miles, respectively, during 1993. Questionnaire data indicate that about 88 percent of the producers' reported metallurgical coke sales are transported by rail, while 11 percent are transported by truck, and 1 percent by barge.

The preferred mode of metallurgical coke transport in the three major blast furnace coke-producing areas,[20] is rail, despite generally less expensive barge rates. Although metallurgical coke producers in the Northeast and Great Lakes regions are equipped to transport metallurgical coke by barge,[21] the vast majority of their customers are not equipped to receive shipments in this manner and additional handling from barge unloading results in increased breakage. Moreover, the railroad infrastructure is well developed and transit times are considerably shorter than for barges. Shorter metallurgical coke movements may be trucked, but these movements are limited in frequency and tonnage.

Rail transport costs over the last 3 to 5 years have remained relatively stable and in some instances declined. Prices have not risen much in the face of greater competition along major lines as metallurgical coke movement patterns have changed, or because of the greater presence of imported metallurgical coke, modal competition by both barge and truck, and inter-railroad competition. Industry sources stated that the vast majority of metallurgical coke transport in the United States occurs under transportation contracts and that tariff rates (published rates) are seldom used and no longer represent current market prices for metallurgical coke transport. Transportation contracts may range from multiyear contracts to spot agreements for as few as 2 to 3 months.

Estimated rail and barge rates for blast furnace coke shipments between specified points are in tables 3-16 and 3-17.[22] Barge transport costs, where available, are considerably lower than for comparable rail shipments.[23] Estimated rail transport costs from the three major producing areas to specified locations ranged from $14 to $25 per metric ton, while barge rates ranged from $3 to $13 per metric ton. Similarly, comparable rates adjusted for distance were higher for rail, between $0.02 and $0.07 per mile per metric ton, than barge rates that were $0.01 per mile per metric ton. Actual rates, particularly for rail transport, vary by company, depending on contract provisions and competitive factors present in each transportation market segment. Lower rail rates may be obtained through the use of larger capacity cars (60, 70, and 80 ton) and increased shipment size through unit trains (50 or more cars).[24] According to railroad industry sources, foundry coke transport costs by rail are generally 10 to 20 percent higher than for blast furnace coke, due to lower volume and intermittent traffic patterns.

[19] USITC staff interviews with U.S. industry officials.

[20] Pittsburgh, PA, Chicago, IL, and Birmingham, AL.

[21] Nearly all integrated and merchant coke producers in the Great Lakes and Northeast regions receive their metallurgical coal shipments by barge.

[22] Transportation costs by rail and barge were estimated based on staff fieldwork, and from interviews and data submitted by transportation industry officials.

[23] Rail rates were based on 50 ton standard coal cars of fewer than 50 cars per train. Barge rates were based on standard rake or box barges of 1,300-1,400 ton minimum shipments.

Financial Performance

Net sales of coke by the U.S. industry decreased 12 percent from $2.7 billion in 1990 to $2.3 billion in 1992 (table 3-18). This downward trend continued into the first 6 months of 1993, with sales declining 3 percent from their level for the first half of 1992. Declining sales were driven by a fall in both the quantities sold and the average price per ton.

Integrated producers employ different accounting methodologies then merchant producers in valuing their coke transfers. Some coke is simply transferred at cost, some is transferred at an estimated market price. Treatment of nonoperating costs and credits varies as well, with some firms allocating overhead and interest expenses to coke operations and others choosing not to do so. For these reasons, this report does not discuss profitability for the integrated sector.

In the merchant sector, financial data contain a far greater ratio of open market sales to material transferred to associated operations, making a discussion of profitability more appropriate. Profits in the merchant sector for both blast furnace coke and foundry coke have followed similar patterns over recent years (table 3-18). However, profits fell from 1990 to 1991, rebounded somewhat in 1992, before showing a decline over the first half of 1993. These fluctuations were associated with increases in coal, energy, labor, and other costs in 1991, when profits for several merchant producers declined by about 50 percent from those of the previous year. Profits increased in 1992 as coal, energy, and other costs declined. Profits showed an overall decline across the whole period, consistently tracking declining revenues and coke prices. Profitability, as measured both by return on sales and by profits per ton of production, followed trends similar to net profits. Profitability on sales of foundry coke was consistently and significantly higher than that for blast furnace coke by both measures.

[24] Staff fieldwork with LTV officials, August 24, 1993.

Table 3-16
Blast furnace coke: Estimated railroad rates and distances, by shipping and receiving points, 1993

Shipping point	Receiving point	Rate[1]	Miles	Adjusted rate[1]
		Dollars per metric ton		*Dollars per ton per mile*
Pittsburgh, PA	Ashland, KY	18	447	0.04
	Baltimore, MD	21	314	0.07
	Birmingham, AL	23	937	0.02
	Cleveland, OH	15	297	0.05
	Chicago, IL	20	466	0.04
	Warren, OH	14	320	0.04
Birmingham, AL	Ashland, KY	25	648	0.04
	Baltimore, MD	23	997	0.02
	Chicago, IL	25	632	0.04
	Cleveland, OH	23	816	0.03
	Indianapolis, IN	21	618	0.03
Chicago, IL	Ashland, KY	21	511	0.04
	Cleveland, OH	19	359	0.05
Mobile, AL	Birmingham, AL	15	278	0.05

[1] All rates assume shipment in standard size coal cars (50 ton or 3,400 cu. ft.)

Source: Based on fieldwork, staff interviews, and data submitted by railroad industry officials.

Table 3-17
Blast furnace coke: Estimated barge rates and distances, by source and destination, 1993

Shipping point	Receiving point	Rate[1]	Miles	Adjusted rate[1]
		Dollars per metric ton		*Dollars per ton per mile*
Pittsburgh, PA	Ashland, KY	3	325	0.01
	Birmingham, AL	13	1500	0.01
	Chicago, IL	7	1500	0.01
Birmingham, AL	Ashland, KY	9	1100	0.01
	Chicago, IL	10	1100	0.01
Chicago, IL	Ashland, KY	5	1150	0.01
Mobile, AL	Birmingham, AL	5	400	0.01

[1] All rates assume minimum 1,300-1,400 net ton shipments.

Source: Based on fieldwork, staff interviews, and data submitted by barge industry officials.

Total capital expenditures increased from $208.5 million in 1990 to $420.8 million in 1991; capital expenditures decreased to $337.7 million in 1992 (table 3-19). Most of the increase between 1990 and 1991 was due to the focus on environmental requirements and facility maintenance (table 3-20). Capital expenditures in 1993 are expected to decrease, based on January-June data. Research and development expenditures increased from $3.7 million in 1990 to $4.6 million in 1991 and $4.3 million in 1992 (table 3-19).

Significant capital investment is required either to rebuild an existing battery or to construct a new battery. A rebuild with the capacity to produce 1 million metric tons of coke per year would cost up to $250 million. A new battery with the same capacity would cost up to $380 million.[25] As a result of the

[25] Industrial Economics, Inc., "Impacts on Integrated Steel Producers Resulting from Regulation of Emissions from Wet-Coal Charged By-Product Coke Oven Batteries," prepared for the U.S. Environmental Protection Agency, Aug. 1989.

Table 3-18
U.S. coke industry: Sales, profits, and profitability, 1990-92, Jan.-June 1992 and Jan.-June 1993

				Jan.-June—	
Item	1990	1991	1992	1992	1993
Net sales *(1,000 dollars)*:					
By product type:					
Blast furnace:					
Integrated	2,244,266	2,017,740	1,910,213	969,017	942,536
Merchant	247,996	240,551	245,004	128,105	110,968
Foundry	143,397	130,247	142,606	72,295	78,722
Industrial	41,860	42,723	42,642	19,969	20,245
Total	2,677,519	2,431,261	2,340,465	1,189,386	1,152,471
Blast furnace sales by customer type:					
Unrelated	550,305	512,241	624,782	307,939	309,678
Transfers	1,941,958	1,746,050	1,530,435	789,183	743,826
Total	2,492,262	2,258,291	2,155,217	1,097,122	1,053,504
Net profit of merchant plants *(1,000 dollars)*:					
Blast furnace	20,179	5,001	10,442	([1])	([1])
Foundry	26,587	16,842	23,395	([1])	([1])
Total	46,766	21,843	33,837	21,799	13,036
Profitability of merchant plants:					
Return on sales *(percent)*:					
Blast furnace	8.14	2.08	4.26	([1])	([1])
Foundry	14.35	9.74	12.63	([1])	([1])
Total	10.79	5.28	7.86	9.89	6.21
Per ton of production *(dollars/metric ton)*:					
Blast furnace	8.23	2.00	4.10	([1])	([1])
Foundry	27.88	19.75	25.24	([1])	([1])
Total	13.73	6.52	9.74	12.51	7.91

[1] Data cannot be presented for each type of coke separately owing to business confidentiality

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table 3-19
Capital and research and development expenditures, 1990-92, Jan.-June 1992 and Jan.-June 1993
(1,000 dollars)

				Jan.-June—	
Item	1990	1991	1992	1992	1993
Capital	208,530	420,803	337,736	161,792	79,095
Research & development	3,688	4,610	4,262	2,043	2,190

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table 3-20
Reasons for capital expenditures, 1990-1993

Reason	1990	1991	1992	1993
Facility maintenance and replacement	32	30	24	22
Improve operation efficiency	12	13	11	8
Environment control	27	27	26	25
Other	5	4	4	5

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

significant costs of constructing new ovens, many firms both in the United States and abroad are turning toward increased maintenance and rehabilitation of older facilities to lengthen their life expectancy. However, maintenance and rehabilitation also require significant capital investment. For example, retrofitting oven doors costs approximately $10,000 per door.[26] Substantial capital costs are also associated with the installation of ancillary equipment such as automatic door cleaners, jamb cleaners, and door machines, to improve both the operation and environmental performance of coke batteries. The cost for new door and jamb cleaners on both sides of a tall battery may reach $1.8 million, while two new door machines may cost $2.8 million.[27]

Market Dynamics

Patterns of metallurgical coke trade in the U.S. market are shaped by market consolidation, elasticity of both domestic supply and substitution, prices for both imported and domestic coke, desire for reliable supply and uniform quality, and transportation costs. Changes in domestic consumer supply patterns and the presence of new, competitively priced imports, particularly in the blast furnace market, have prompted changes in traditional supply patterns. Industry buyers have indicated a desire to source from only one or two suppliers, to limit variations in the feed to their blast furnaces, whereas previously they had used several sources to feed their blast furnace coke needs. In the case of large-volume purchasers, such purchasing patterns may preclude smaller suppliers or those with pre-existing supply agreements as potential sources.

The closing of many metallurgical coke producing and consuming facilities has also altered coke supply patterns, particularly among some integrated producers that have selectively closed metallurgical coke, ironmaking, and steelmaking facilities, leaving some ironmaking plants without adjacent coke facilities. Such previously self-sufficient producers have been transformed into net buyers, sourcing their needs from either merchant, affiliated, or foreign sources, often entailing considerable shipping distances and costs.[28] Consequently, as certain U.S. coke-producing facilities are closed, shifts in traffic patterns and transport distances of metallurgical coke will continue. Inland Steel, for example, shuttered its remaining batteries (1.5 metric tons of capacity) in December, 1993, 1 year earlier than previously announced. As a result, the firm's blast furnace coke requirements are now met solely by outside sources.

Domestic steel mills that have closed their metallurgical coke facilities and turned in large part to purchasing foreign blast furnace coke include US Steel's Fairfield AL plant, and Bethlehem Steel's Sparrows Point, MD plant. Despite the availability of blast furnace coke from its Clairton, PA, plant and the closeness of merchant metallurgical coke producers Sloss Industries Corp. (Sloss) and Koppers Industries Inc. (Koppers), US Steel's Fairfield, AL, mill purchases Japanese blast furnace coke imported through Mobile, AL.[29] Estimated 1993 transport costs for delivery of Japanese blast furnace coke were $19-22 per metric ton,[30] including ocean freight and inland transportation to Fairfield.[31] Rail transport costs from Pittsburgh to Fairfield are estimated to average $23 per metric ton.[32] Transportation costs from either of the nearby merchant facilities are significantly lower.

Bethlehem Steel's Sparrows Point mill, which closed the last of its metallurgical coke plants in 1992, currently meets its blast furnace coke needs in part through a toll arrangement with NKK of Japan. In this arrangement, Bethlehem Steel purchases metallurgical coal from sources in Australia, which is then processed in Japan and shipped to Sparrow's Point.[33]

Finally, Geneva Steel Co., another importer of Japanese metallurgical coke, receives shipments through port facilities in San Francisco, which are then transported by rail to the firm's facilities near Provo, UT. Ocean freight costs for shipments from Japan by

[26] Testimony before the U.S. International Trade Commission by Mr. John M. Pearson, Senior Vice President and General Manager of ABC Coke, Oct. 15, 1993.

[27] U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, "Cost Analysis for the Coke Oven NESHAP," Research Triangle Park, North Carolina, April, 1992.

[28] LTV, previously self-sufficient, became a net buyer of blast furnace coke shortly after shuttering coke operations at its Cleveland, OH, facility.

[29] Staff interviews with U.S. and Japanese industry officials.

[30] Based on ocean freight of $10 mt, barge transport of $5 mt, port terminal fees of $2-3 mt, and rail transport costs of $2-4 mt.

[31] USITC staff interview with U.S. and Japanese industry officials.

[32] USITC staff interviews with U.S. industry officials.

[33] Staff fieldwork with industry officials.

Panamax vessels to West coast ports are approximately $9 per metric ton.[34] Although rail costs were not publicly available for coke movements between these two points, the approximate rail distance is 820 miles, as compared to 1,690, 2,160, and 1,350 miles for shipments from suppliers in Chicago, IL, Pittsburgh, PA, and Birmingham, AL regions respectively, making total transport costs for Japanese coke competitive.

Coke Pricing

Contracts

According to questionnaire responses,[35] the vast majority of blast furnace and foundry coke shipments are sold under long-term contracts. U.S. coke purchase contracts, which range from 1 to 6 years (most frequently 3 to 5 years), stipulate quantity, price, and material specifications.[36] Nearly all multiyear contracts provide for semiannual or annual negotiations for one or more provisions. The majority of domestic coke contracts further specify penalties for material not meeting contracted specifications.[37] These specifications of quality and size vary by contract, but commonly prescribe price reductions for substandard shipments.

A significant quantity of contracts for blast furnace coke purchases will become renewable over the next 3 years. In 1994, 2.1 million metric tons of contracts expire, 1.3 million metric tons of which is currently sourced from Japanese suppliers. During 1996, contracts covering 1.3 million metric tons are due to expire. Renewable quantities of contracted blast furnace coke during 1994-96 account for between 18 and 29 percent of the estimated 1992 open market consumption of 7.2 million metric tons.

Domestic Prices

Prices for domestic contract sales of blast furnace and industrial coke trended downward, while prices for foundry and breeze coke were relatively stable, during 1990-92 and January-June 1993 (table 3-21).[38] Quantities sold for blast furnace coke, foundry coke, and breeze increased, while industrial coke quantities decreased. Quantities shown on table 3-21 for blast furnace coke, foundry coke, and breeze account for approximately 28 percent, 85 percent, and 41 percent, respectively, of domestic shipments for these products in 1992. Spot sales of domestic coke products were more variable than contract prices.

Spot prices for blast furnace coke declined during 1990-92 and, as would be expected, led the decline in contract prices. Blast furnace coke spot prices appear to have declined sharply during the last half of 1992 as the average for the year was considerably below the average for the first half of 1992, and the downward trend continued during the first half of 1993. Industry officials reported that one or two merchant producers have drastically lowered their spot market blast furnace coke prices since 1992.[39]

Foundry coke contract prices rose slightly during 1990-92. Spot prices were generally higher than contract prices, and changes in spot prices led changes in contract prices. Production and shipments of foundry coke were relatively stable compared to the downward trends for blast furnace coke (see tables 3-5 and 3-6).

Contract prices for breeze were stable during 1990-92, while spot prices for breeze varied widely. Industrial coke contract prices trended downward, while spot prices were varied. Breeze and industrial coke are the undersized residuals from the production of blast furnace and foundry coke. Therefore the supply of these products is determined by the production of blast furnace and foundry coke and is generally unresponsive to changes in price. Nearly all breeze sales are under contract. According to industry officials, 1993 prices for sinter breeze are in the range of $20-40 per metric ton, lower than 1992 prices due to current excess supply.

Quality

The quality of domestically produced coke varies, depending on the customer's specifications. Blast furnace operators specify various quality parameters distinctive to the blast furnace and its operations. Some quality parameters employed by domestic purchasers include— stability, size, moisture, and ash, sulfur, and phosphorus content.[40] These quality factors are individually important with no one dominant factor. Their relative importance fluctuates depending on the requirements of each blast furnace and is site-specific. In addition, consistency of the specified physical and chemical properties across shipments is critical to blast furnace operators.[41]

Depending on requirements of the blast furnace, certain quality factors can be offset (within a given range) by modifications in blast furnace operating practices, while other quality factors have absolute technical limits.[42] Most U.S. supply contracts

[34] Staff interviews with U.S. and Japanese maritime industry officials.

[35] Sixteen U.S. coke producers reported the contract and spot sales data for their coke sales. Nearly 98 and 75 percent of their blast furnace and foundry domestic coke shipments, respectively, are currently under contract.

[36] Compiled from data submitted in response to U.S. International Trade Commission's questionnaires.

[37] Moisture content, percent of ash and sulfur, size, and breakage are generally specified under domestic purchase contracts.

[38] Prices represent average unit values per mt compiled from sales data submitted in response to questionnaires of the U.S. International Trade Commission.

[39] Staff interviews with U.S. industry officials.

[40] Responses to USITC Purchaser Questionnaire.

[41] USITC staff domestic fieldwork, August 23-24, 1993.

[42] Responses to USITC questionnaires.

Table 3-21
Coke: Prices, net f.o.b., for contract and spot sales reported by U.S. producers, 1990-92 and Jan.-June 1992, and Jan.-June 1993

Type	Contract sales		Spot sales	
	Price	Quantity	Price	Quantity
	Per metric ton	*Metric tons*	*Per Metric ton*	*Metric tons*
Blast furnace coke:				
1990	$106.62	4,413,490	$113.87	286,740
1991	103.99	4,193,965	111.26	674,515
1992	103.05	5,636,140	81.55	148,977
Jan.-June 1992	103.82	2,756,121	103.41	63,670
Jan.-June 1993	101.18	2,830,269	71.12	46,539
Foundry coke:				
1990	149.06	568,825	151.86	212,366
1991	153.55	500,429	147.60	204,305
1992	152.26	601,772	153.60	187,634
Jan.-June 1992	152.16	303,615	153.40	95,635
Jan.-June 1993	152.90	332,593	156.35	106,579
Coke breeze:				
1990	42.83	641,136	69.01	12,100
1991	44.42	638,120	70.67	13,230
1992	45.42	721,831	59.78	24,173
Jan.-June 1992	44.51	368,340	87.80	7,437
Jan.-June 1993	43.35	328,386	70.38	6,763
Industrial coke:				
1990	119.98	26,011	117.53	11,990
1991	117.07	23,149	118.06	12,368
1992	115.13	22,582	117.46	12,014
Jan.-June 1992	115.89	9,995	119.31	6,216
Jan.-June 1993	112.08	10,329	115.89	6,189

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

specify penalties for not satisfying the required quality parameters to offset the operating inefficiencies resulting from substandard product. Purchasers establish benchmark standards of quality reflective of their operating requirements and suppliers' ability to achieve these quality standards. The quality parameters are also somewhat dependent on a supplier's coal sources and metallurgical coke operations.[43] Common specifications reported by purchasers of U.S.-produced metallurgical coke are as follows: ash, 6.0-9.0 percent; sulfur, 0.6-0.8 percent; moisture, 4.0-6.0 percent; and stability, 57-60 CSR (coke strength after reactivity).[44]

According to U.S. industry representatives, domestic coke is often of higher quality than that of imports because of the availability of low-sulfur and ash coals and of available process technology.[45] U.S. producers' coal blends commonly are composed of 60-85 percent high-volatile coal, with 15 to 40 percent low- or medium-volatile coals or both.[46]

[43] For example, metallurgical coke supplied by producers that do not have access to low-sulfur or low-ash metallurgical coal will have a higher sulfur or ash content.
[44] USITC staff interview with domestic industry officials, Jan. 1994.
[45] Hearing transcript, pp. 52-56.
[46] USITC staff interviews with U.S. industry officials.

Implications of Environmental Regulations

Although the coke industry has been subject to environmental regulations over many years, the regulations are now becoming more stringent. The coke industry is currently approaching the implementation deadlines for new Federal limitations on coke oven emissions of hazardous air pollutants. In addition, the industry is also subject to regulations covering the discharge of various pollutants into the Nation's waters and to the handling and disposal of solid wastes. The estimated costs of complying with new regulations is being raised as a significant threat to the future competitiveness of the coke industry. Industry sources contend that environmental policy will become an even more important factor in determining the competitiveness of the U.S. industry if compliance costs in this country rise significantly, relative to those of competing producers.

The Clean Air Act

As noted in chapter 2, heating coal to make coke in byproduct recovery ovens causes such environmental problems as air pollution. Burning fuels (including coke oven gas) produces sulfur oxides (SO_x) and nitrogen oxides (NO_x), for which the coke industry is subject to Federal environmental protection regulations. This section, however, is focused on recent programs that try to limit hazardous emissions from the coke ovens themselves. In the area of these hazardous emissions, the implementation of the Federal requirements developed under the Clean Air Act Amendments of 1990 (CAAA) may affect the relative cost of U.S. coke production vis-a-vis that of its foreign competitors, and thus affect U.S. competitiveness in both domestic and export markets.

The Environmental Protection Agency (EPA) began studying coke oven emissions in the late 1970s,[47] and added coke oven emissions to the list of hazardous air pollutants in 1984[48]. The year 1987 saw national emissions standards proposed for limiting coke oven emissions from new and existing byproduct coke oven batteries[49] as part of the National Emissions Standards for Hazardous Air Pollutants (NESHAP). This process culminated in the CAAA of 1990, which imposed the first Federal emission control requirements on coke oven emissions as hazardous air pollutants.[50] [51] As a result of CAAA, EPA withdrew the standards proposed in 1987, on December 4, 1992,[52] and at the same time proposed a new two-track set of national emission standards.[53] The final regulations were promulgated on October 27, 1993.[54]

According to EPA, the existing batteries have limits set either by State regulations or consent decrees, causing the limits to vary widely.[55] Coke operations that are now under the most stringent limits generally are expected to have the smallest improvements to make, thus incurring the least costs.

[47] Graham, John D. and David Holtgrave, *Coke Oven Emissions: A Case Study of "Technology-Based" Regulation*, Congressional Research Service, (89-533 ENR), Library of Congress, Washington, D.C., September 20, 1989.

[48] 49 FR 36560.

[49] 53 FR 13586.

[50] Work practices for the control of employee exposure to coke emission limits are also subject to regulation by the U.S. Occupational Safety and Health Administration (OSHA), 29 CFR 1910.1029.

[51] Unregulated releases exceeding one pound are also subject to release notification requirements under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund), 40 CFR 302.6.

[52] 57 FR 57403.

[53] 57 FR 57404.

[54] 58 FR 57898.

[55] Considine, Timothy J., Graham A. Davis, and Donita Marakovits, "Costs and Benefits of Coke Oven Emission Controls," Final Report Under Research Grant #R819587-01 from the Office of Policy, Planning, and Evaluation of the U.S. Environmental Protection Agency, Department of Mineral Economics, The Pennsylvania State University, University Park, PA, December 17, 1992.

Mact and Laer

Under the CAAA, EPA was required to first promulgate technology-based standards and then later to promulgate standards based on risk to human health. As noted above, EPA has issued final emission standards for hazardous air pollutants (NESHAP) based upon a Maximum Achievable Control Technology (MACT) for all batteries (table 3-22).[56] Six emission points are subject to the NESHAP: the charging operation, coke oven doors, topside lids and offtakes, collecting mains, and bypass/bleeder stacks. These standards are scheduled for implementation by December 31, 1995. A second set of standards based upon a Lowest Achievable Emission Rate (LAER) are scheduled for implementation on January 1, 1998, for plants that seek more time to meet possibly even tougher standards based upon risks to human health. Like the MACT limits, the LAER standards involve limits placed on charging time and the allowable percentage of leaking doors, lids, and offtakes at coke batteries. Table 3-22 shows the baseline emission limits and those to be met under the two new standards.

The regulations offer some elements of choice to the firms that own and operate coke oven batteries. Under the first option, existing batteries had to meet work practice standards[57] by November 15, 1993, and then must meet the MACT standard by December 31, 1995, and then must meet emissions limits based upon a residual risk-based standard by January 1, 2003.[58] Under the second option, termed the extension track, existing batteries had to meet interim standards (table 3-22), and comply with work practice standards by November 15, 1993, and then must meet the LAER standard by January 1, 1998. The second option enables the batteries to defer compliance with the residual risk-based standard until 2020. Some coke plants may elect a third alternative. They may choose to defer deciding on one of the two tracks and "straddle" the options by meeting the requirements of both the MACT and the LAER. The advantage of this alternative is that the plants can defer the decision about track until such time as the risk-based standards are known.[59] A fourth option available for plants scheduled to close between 1995 and 2003 is to meet the MACT option until their closing.[60]

[56] 58 FR 57898.

[57] 58 FR 57917. These work practices are to include a written plan covering such items as training and procedures for inspection, documentation, operation, maintenance, and certification.

[58] EPA is to issue the risk-based standards within 8 years of promulgation of the MACT standards which were issued October 27, 1993.

[59] A plant, or battery, that is "straddling" the two tracks may wait until EPA has promulgated the risk-based standards for those batteries on the MACT track and then indicate their choice of either MACT or LAER.

[60] Ailor, David C., P.E. "Environmental Issues Facing the Coke Industry In The 1990s," Paper presented to the 1992 AISE Annual Convention, Chicago, IL, September 22, 1992.

Table 3-22
Emission limits for existing byproduct batteries

Emission point	Base line—[1]		MACT track limits—		LAER extension track limits—		
	Range	Average	12/31/95	01/01/2003[2]	11/15/93	01/01/98	01/01/2010
Tall doors, PLD[3]	[4]5-16	[4]10.7	6.0	5.5	7.0	4.3	4.0
Foundry doors, PLD[3]			5.5	5.0	7.0	4.3	4.0
All other doors, PLD[3]			5.5	5.0	7.0	3.8	3.3
Lids, PLL[5]	1-5	3.2	0.6	0.6	0.83	0.4	0.4
Offtake,PLO[6]	4-10	8.0	3.0	3.0	4.2	2.5	2.5
Seconds/charge[7]	[8]11-60	[9]21.2	12	12	12	12	12

[1] The base line limits reflect the range and average of the limits under state and local regulation.
[2] These 2003 standards are applicable to the MACT track unless more strigent risk-based standards are promulgated.
[3] PLD means percent leaking doors.
[4] Applies to all doors.
[5] PLL means percent leaking lids.
[6] PLO means percent leaking offtakes.
[7] Time of visible emissions during charging of on oven.
[8] Based on a simple observation.
[9] Based on four to seven observations.

Source: 58 FR 57899 and Considine, 1992.

Given the various options described above, the operators of coke plants have not yet had to make final decisions as to which track they will follow to comply with the regulations. However, according to the responses to the Commission's questionnaires, 5 batteries at 4 plants are planning to follow the MACT track, 19 batteries at 7 plants are planning to follow the LAER track, and 39 batteries at 11 plants are going to straddle the tracks.[61] These figures account for 63 of the 71 byproduct batteries in operation as of December 31, 1993 that are subject to the regulations.

The apparent choices of the plants in the integrated sector are decidedly different than those of the plants in the merchant sector. In the integrated sector, 4 batteries at 3 plants are going to follow the MACT track, 3 batteries at 2 plants are going on the LAER track, and 38 batteries at 10 plants will straddle the tracks. By contrast, it appears that in the merchant sector only 1 battery will follow the MACT track, while 1 battery will straddle the tracks, and 16 batteries at the other 5 plants reporting will follow the LAER track. Thus, it appears that the merchant sector has decided to commit to the LAER track, while the integrated sector has a significantly higher proportion of its batteries deferring the decision.

In most cases, new batteries will have to meet stricter standards than existing batteries,[62] which adds complexity to the industry's decision-making on this issue. Currently, three batteries scheduled for rebuilding at plants where such construction will not result in an increase in plant capacity are eligible for grandfathering before these stricter limits have to be met.[63] New batteries that add capacity at an existing plant would have to meet the standard for nonrecovery ovens.[64] Construction of byproduct recovery ovens using a new technology would have to meet limits more stringent than the LAER limits.[65]

The CAAA authorized the U.S. Department of Energy (Energy) and the administrator of the EPA to "assist in the development and commercialization of technically practicable and economically viable control technologies which have the potential to significantly reduce emissions of hazardous air pollutants from coke oven production facilities." The act authorizes the Secretary of Energy and the EPA administrator to provide financial support for the development of such technologies, "provided that Federal funds shall not exceed 50 per centum of the cost of any project assisted. . . ."[66] According to industry officials, no project has been approved and no funds have been expended under this program.[67]

[61] This figure includes 10 batteries whose operators noted that they may opt out of the LAER standards prior to January 1, 1998, under the provisions of Section 112(i)(8)(D) of the CAAA of 1990, and thus revert to the MACT track.

[62] 58 FR 57900.

[63] 58 FR 57900.

[64] 58 FR 57899.

[65] 58 FR 57899.

[66] The 1990 Amendments to the Clean Air Act, Section 301.

[67] USITC staff interview with industry officials, Feb. 1994.

The Clean Water Act

The coke industry must also comply with the provisions for permits and licenses of the Clean Water Act (CWA).[68] Under the National Pollutant Discharge Elimination System (NPDES) program operated by EPA, no pollutant may be discharged into the navigable waters of the United States without a permit.

The Resource Conservation and Recovery Act

The solid/contained waste generated by the coke industry is also subject to regulation under the Resource Conservation and Recovery Act (RCRA).[69] The major provisions of direct importance to the coke industry are the management of hazardous waste and the regulation of underground storage tanks.

Pollution Abatement Costs

The annual expenditures to comply with U.S. pollution abatement requirements are significant for the economy in general and for the coke industry in particular. Current estimates of the total for the economy exceed $90 billion dollars.[70] Nearly 75 percent of this amount is spent on abatement of air and water pollution, in about equal proportions, with the remainder spent for other environmental purposes, including treatment of solid and any hazardous waste. Although costs to the coke industry are not reported separately, most are believed to be reported to Census as part of the data for the primary metals industries.[71] This more aggregated industry had costs estimated to be approximately $2 billion for operating costs and $500 million for new capital expenditures in 1991.[72] According to responses to USITC questionnaires, pollution abatement expenditures for only the coke industry in that same year totaled $506 million, of which $200 million was for operating costs and $306 million for new capital expenditures.[73]

[68] Federal Water Pollution Control Act (CWA) of 1972 as amended in 1977, 1978, 1981, and 1987.

[69] RCRA was enacted in 1976 as an amendment to the Solid Waste Disposal Act, was amended in 1980 and the Hazardous and Solid Waste Amendments of 1984 (HSWA), and is up for reauthorization.

[70] Council on Environmental Quality, *Environmental Quality*. 22nd Annual Report of the Council on Environmental Quality, March 1992, p. 221.

[71] USITC staff interviews with industry officials, Jun. 1993.

[72] U.S. Bureau of the Census, "1992 Survey of Pollution Abatement Costs and Expenditures (MA-200)," Washington, D.C., January, 1993.

[73] Numbers in this section referring specifically to the coke industry were compiled from responses to Commission Questionnaires unless otherwise indicated.

A wide range of studies have examined both the costs and competitive effects of compliance with environmental regulation.[74] [75] [76] Most of the empirical studies have found little evidence that environmental measures much affected overall trade or investment.[77] [78] Some sectoral analyses report more substantial effects. For example, one multi-industry study using data for 1988 found that the average pollution abatement and control costs were only 0.54 percent of the value added by industry, with the highest figure reported being 3 percent for the cement industry.[79] A study of the copper industry concluded that the cost of environmental regulation has had substantial negative impacts on competitiveness.[80]

The portion of Commission's questionnaire that covers environmental control costs uses the Census form and definitions.[81] Some observers have argued that the pollution abatement costs reported on Census[82] surveys may understate environmental control costs[83] by omitting such items as monitoring and planning, environmental activities that are part of the production process, interest expense on equipment, and productivity loss.[84] Nevertheless, these Census surveys represent the most comprehensive data available and are the best available basis for comparison between industries at this time. The expenditures reported in response to the Commission's questionnaire by the coke industry for air pollution abatement, water pollution abatement, and handling of solid waste reflect their total expenditures for air pollution abatement. The data do not directly measure the incremental cost of recent changes in environmental regulations.

Operating Costs

The coke industry expended over $200 million in operating costs for pollution abatement in each year from 1990-92 (table 3-23). The integrated operations accounted for approximately 90 percent of the expenditures each year, a percentage comparable to their share of production. Of the three media, air pollution abatement required the largest expenditures, taking about 60 percent of total operating costs each year. Water pollution abatement fell from 31 percent of total operating costs in 1990 to 24 percent in 1992, while expenditures on solid waste rose from 6 percent to 17 percent.

The experience of the integrated and the merchant operations did not differ markedly in terms of the trends in total expenditures.[85] For both segments of the industry, the total expenditures were highest in 1991. In terms of allocations to the three media, the expenditures for air pollution abatement averaged about 4 percent higher for the integrated sector than for the merchant sector. Correspondingly, the merchants spent a larger percentage of their total abatement funds in 1991 for water pollution control. The share of the funds going to solid waste increased sharply for both segments, and the shares were similar for each.

The increase in pollution abatement costs from 1990 to 1991 are more apparent when the costs are viewed in terms of dollars per metric ton of production (table 3-24). These costs, which are a subset of production costs, ranged from 6.4 percent to 7.5 percent of the total cost of production for the integrated operations and from 5.9 percent to 9.7 percent for the merchant operations.[86] The average cost for integrated producers rose more than $2 per metric ton while that for the merchants rose nearly $4 per metric ton.

As noted earlier, expenses for air pollution abatement accounts for the largest share of the difference in total pollution abatement costs between the industry segments. For example, in 1992, the operating costs for air pollution abatement were $5.79 and $4.85 per metric ton for the integrated producers and the merchants, respectively. Depreciation expense, reflecting recent capital investments, is the largest expense item and also accounts for most of the increase since 1990.

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[74] U.S. Congress, Office of Technology Assessment, *Background Paper on Trade and the Environment*, OTA-BP-ITE-94 (Washington, DC: U.S. Government Printing Office, May 1992, p 97.

[75] Dean, Judith M., "Trade and the Environment: A survey of the Literature," Background Paper, *World Development Report, 1992*, World Bank, April 1991.

[76] Ugelow, "A Survey of Recent Studies on Costs of Pollution Control and the Effects of Trade," in Seymour J. Rubin and Thomas R. Graham (eds.), *Environment and Trade* (London: Frances Pinter Ltd., 1982;

[77] Leonard, H. Jeffrey, *Pollution and the struggle for the world product*. Cambridge, England. Cambridge University Press, 1988.

[78] Tobey, James. A. "The Effects of Domestic Environmental Policies on Patterns of World Trade: An Empirical TEst," *Kyklos*, 1990, Fasc. 2.

[79] Low, Patrick, "International Trade and the Environment: An Overview," in *International Trade and the Environment*, Patrick Low, Editor, The World Bank, Washington, D.C., Apr. 1992.

[80] U.S. Congress, Office of Technology Assessment, *Copper: Technology and Competitiveness*, OTA-E-367 (Washington, DC: U.S. Government Printing Office, Sep. 1988).

[81] U.S. Census, Form MA-200, Pollution Abatement Form.

[82] Bureau of the Census, Manufacturer's Pollution Abatement Capital Expenditures and Operating Costs, published annually.

[83] National Research Council, *Competitiveness of the U.S. Minerals and Metals Industry* (Washington, DC: National Academy Press, 1990).

[84] Chapman Duane, "Environment Standards and International Trade in Automobiles and Copper: The Case for a Social Tariff." *Natural Resources Journal*, vol. 31, winter, 1991, pp. 449-461.

[85] Given that the industry is in the midst of making both process changes and additions of environmental equipment to meet both current and future requirements, one should focus on the levels of expenditure and not particularly on any observed trends over the survey period.

[86] Production costs are taken from Table 3-13.

Table 3-23
Operating costs for pollution abatement, 1990-92

(Million dollars)

Item	Integrated Sector			Merchant Sector			Industry		
	1990	1991	1992	1990	1991	1992	1990	1991	1992
Operating costs:									
Air:									
Depreciation	26.9	31.3	47.7	3.2	4.7	6.1	30.2	36.1	53.8
Salaries and wages	21.2	24.5	21.2	2.3	2.6	2.4	23.6	27.0	23.7
Fuel/electricity	15.7	15.3	12.1	0.8	0.8	0.8	16.5	16.1	12.9
Contract work	1.8	2.8	2.7	0.1	3.1	0.7	1.9	6.0	3.4
Materials, leasing and miscellaneous	56.1	58.6	34.5	2.6	2.0	2.5	58.6	60.6	37.0
Adjusted total[1]	120.3	131.1	117.0	8.9	13.2	12.5	129.2	144.3	129.6
Water:									
Depreciation	4.7	4.7	5.1	1.0	1.0	1.0	5.7	5.7	6.1
Salaries and wages	7.6	8.0	5.8	1.2	1.1	1.3	8.8	9.2	7.1
Fuel/electricity	13.4	14.5	7.4	1.1	1.4	0.9	14.6	15.8	8.4
Contract work	2.5	1.9	2.8	0.3	0.5	1.1	2.8	2.4	3.9
Materials, leasing and miscellaneous	28.5	29.8	21.1	1.6	4.4	3.9	30.1	34.3	25.0
Adjusted total[1]	57.6	59.6	43.2	5.2	8.5	8.3	62.6	68.1	51.5
Solid/contained waste:									
Depreciation	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2
Salaries and wages	1.3	1.2	1.2	0.1	0.1	0.1	1.4	1.4	1.3
Fuel/electricity	2.5	2.8	2.0	([2])	0	0	2.5	2.8	2.0
Contract work	1.4	1.3	1.9	0	0.2	0.2	1.4	1.5	2.1
Materials, leasing and miscellaneous	5.4	13.7	27.5	0.7	1.3	2.3	6.1	14.9	29.5
Adjusted total[1]	10.3	18.5	32.3	0.9	1.8	2.5	11.2	20.3	34.8
Adjusted grand total[1]	188.2	209.3	192.6	15.0	23.5	23.3	203.2	232.8	215.8

[1] These operating costs are total operating costs, plus payments to governments for services minus pollution abatement costs offsets. Totals may not add owing to rounding and these adjustments.
[2] Less than $50,000.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table 3-24
Operating costs for pollution abatement per metric ton of production, 1990-92

(Dollars)

Item	Integrated Sector			Merchant Sector			Industry		
	1990	1991	1992	1990	1991	1992	1990	1991	1992
Operating costs:									
Air:									
Depreciation	1.09	1.53	2.00	1.28	1.98	2.44	1.11	1.59	2.06
Salaries and wages	0.75	1.03	1.13	0.86	1.00	0.90	0.76	1.02	1.10
Fuel/electricity	0.56	0.68	0.67	0.30	0.33	0.32	0.53	0.63	0.63
Contract work	0.09	0.16	0.16	0.01	1.28	0.25	0.08	0.30	0.18
Materials, leasing and miscellaneous	2.03	2.77	1.88	0.97	0.79	0.95	1.91	2.53	1.76
Adjusted total[1]	4.43	6.09	5.79	3.41	5.36	4.85	4.32	6.00	5.67
Water:									
Depreciation	0.20	0.25	0.29	0.40	0.41	0.40	0.22	0.27	0.30
Salaries and wages	0.25	0.32	0.28	0.40	0.40	0.44	0.27	0.33	0.30
Fuel/electricity	0.31	0.38	0.32	0.45	0.56	0.37	0.32	0.40	0.33
Contract work	0.12	0.11	0.17	0.10	0.21	0.45	0.12	0.12	0.20
Materials, leasing and miscellaneous	1.04	1.24	1.08	0.62	1.84	1.54	0.99	1.31	1.14
Adjusted total[1]	1.95	2.33	2.18	1.98	3.45	3.23	1.96	2.46	2.32
Solid/contained waste:									
Depreciation	0	0	0	0.04	0.05	0.06	0	0.01	0.01
Salaries and wages	0.06	0.07	0.01	0.05	0.06	0.03	0.06	0.07	0.01
Fuel/electricity	0.11	0.15	0	0	0	0	0.10	0.13	0
Contract work	0.07	0.07	0.11	0	0.08	0.09	0.06	0.08	0.11
Materials, leasing and miscellaneous	0.24	0.38	0.16	0.27	0.54	0.81	0.24	0.40	0.25
Adjusted total[1]	0.46	0.63	0.27	0.36	0.76	1.00	0.45	0.65	0.37
Adjusted grand total[1]	6.85	9.05	8.24	5.75	9.58	9.08	6.73	9.12	8.35

[1] These operating costs are total operating costs, plus payments to governments for services, minus pollution abatement costs offsets. Totals may not add owing to rounding and these adjustments.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Since coke ovens are operated continuously and since capital equipment and expense for both air and water pollution abatement represent significant parts of total operating costs, environmental costs may be more a function of capacity than of production (table 3-25). In these terms, the merchant plants show the largest increases since 1990, and their costs have exceeded those of the integrated plants in 1991 and 1992.

Table 3-26 relates the cost of pollution abatement to the costs of the coking process itself. In this table, the cost of coal has been deleted from the cost of production to eliminate differences caused by variations in coal prices that may be due largely to location of the coke plants. Thus, the value-added figures may more closely represent the relative environmental costs for the industry. This latter type of measure may also be a more valid method of comparing costs across countries as well as across industries and industry segments. In terms of percentage of value-added to coal, the costs of pollution abatement are shown to be a significant portion of the total costs of the coking process. The costs for the industry exceeded 17 percent of the value-added to coal during 1990-92.

New Capital Expenditures

The industry invested over $550 million in new capital for pollution abatement in 1990-1992 (table 3-27). The integrated operations accounted for approximately 89 percent of the expenditures. About 85 percent of the total investment was allocated to air pollution abatement; water pollution abatement was second, at just over 13 percent; and solid waste was third, at less than 3 percent.

For both the integrated sector and the merchant sector, new capital expenditures were highest in 1991. Investment in capital equipment for air pollution abatement rose sharply as the operations installed new equipment to meet the new emissions requirements. Investments in end-of-line equipment were substantially less than investments in production process changes. Investments in end-of-the line equipment for air pollution abatement included hoods and modifications to desulfurization equipment. Investments in production process changes for air pollution abatement included such items as new doors, new door and jamb-cleaning equipment, modifications to pushing equipment and spotting devices, and repairs and replacements of standpipes.[87] End-of-line investments for water included installed or modified water treatment facilities, while production process changes included modifications to ammonia and sulfur removal processes. In terms of expenditures per metric ton of capacity (table 3-28), the merchant sector invested more each year than did the integrated sector.

[87] Staff fieldwork, November 1993.

Projected Expenditures for Pollution Abatement

The coke industry is projecting capital expenditures for pollution abatement of $672 million during the next decade (table 3-29). Of this total, nearly $498 million is to be invested for air pollution abatement, with more than $131 million for water pollution abatement, and more than $42 million to help manage solid waste. Nearly two-thirds of the money is projected to be spent over the next 5 years, largely to meet the requirements of the compliance track chosen.

According to EPA, the MACT standards for existing batteries are expected to be met by better equipment, maintenance, and training, without having to rebuild batteries.[88] The EPA estimate for the industry's capital cost to meet the MACT requirements is $66 million, with total annual costs ranging between $25 million and $33 million.[89]

The EPA anticipates that meeting the LAER standards may require the installation of some new doors and jambs and possibly the rebuilding of some batteries.[90] According to responses to USITC questionnaires, about 4.1 million metric tons of the industry's current capacity is to undergo minor rehabilitation, and another 2.3 million metric tons is to undergo major rehabilitation over the next 5 years. EPA estimates the capital cost of meeting both the MACT and the LAER standards at $510 million with total annual costs of $84 million to $95 million.[91] The incremental costs of the LAER standards are expected to prompt some capital investment that would have been either delayed or not undertaken except for the more stringent requirements.[92] EPA expects the LAER standard to increase the price of blast furnace coke by less than 1.0 percent and foundry coke by 2.5 percent. EPA also projects a decline in production of blast furnace coke and foundry coke of 2.1 percent and 2.6 percent, respectively. Smaller increases in price and decreases in production were projected under the MACT standard. The incremental gain in environmental quality and reduced exposure to hazardous emissions has not yet been estimated. This topic will probably be addressed as EPA begins to develop the risk-based standards which are to be promulgated by 2003.

[88] 58 FR 57903.
[89] 57 FR 57910.
[90] 58 FR 57903.
[91] 58 FR 57911.
[92] For detailed estimates of projected capital and operating costs, please see EPA, Office of Air Quality, Planning and Standards, "Cost Analysis For The Coke Oven NESHAP," Research Triangle Park, North Carolina, April, 1992.

Table 3-25
Operating costs for pollution abatement per metric ton of capacity[1], 1990-92

(Dollars)

	Integrated Sector			Merchant Sector			Industry		
Item	1990	1991	1992	1990	1991	1992	1990	1991	1992
Operating costs:									
Air:									
Adjusted total[2]	4.14	4.90	4.89	3.19	4.83	4.54	4.04	4.89	4.85
Water:									
Adjusted total[2]	1.82	1.88	1.84	1.85	3.11	3.02	1.83	2.01	1.98
Solid/contained waste:									
Adjusted total[2]	0.43	0.51	0.23	0.34	0.68	0.93	0.42	0.53	0.31
Adjusted grand total	6.40	7.29	6.96	5.39	8.63	8.49	6.29	7.43	7.14

[1] Capacity includes active, hot idle, and cold idle.

[2] These operating costs are total operating costs plus payments to governments for services minus pollution abatement costs offsets. Totals may not add owing to rounding and these adjustments.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table 3-26
Operating costs for pollution abatement as percent of value-added, 1990-92

(Dollars)

Item	Integrated Sector			Merchant Sector			Industry		
	1990	1991	1992	1990	1991	1992	1990	1991	1992
Air:									
Adjusted total[1]	12.4	12.7	12.2	7.5	9.9	10.3	11.8	12.4	12.0
Water:									
Adjusted total[1]	5.5	4.9	4.6	4.4	6.4	6.9	5.3	5.1	4.9
Solid/contained waste:									
Adjusted total[1]	1.3	1.3	0.6	0.8	1.4	2.1	1.2	1.3	0.8
Adjusted grand total[1]	19.2	18.9	17.4	12.7	17.7	19.3	18.3	18.8	17.7

[1] These operating costs are total operating costs plus payments to governments for services minus pollution abatement costs offsets. Totals may not add owing to rounding and these adjustments.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table 3-27
New capital expenditures for pollution abatement, 1990-92

(Million dollars)

Item	Integrated Sector			Merchant Sector			Industry		
	1990	1991	1992	1990	1991	1992	1990	1991	1992
Air:									
End-of-line	32.7	72.2	27.2	6.9	9.1	2.2	39.5	81.3	29.4
Production process	66.6	174.1	42.2	4.0	20.6	16.0	70.6	194.7	58.2
Total	99.3	246.3	69.4	10.9	29.7	18.2	110.2	276.0	87.6
Water:									
End-of-line	15.7	7.5	7.5	0.2	0.8	0.4	15.9	8.4	7.9
Production process	1.0	17.9	12.2	8.2	0.3	0.1	9.2	18.2	12.3
Total	16.7	25.4	19.7	8.5	1.1	0.5	25.2	26.5	20.2
Solid/contained waste:									
End-of-line	0	0.3	0.6	1.6	0.2	0	1.6	0.5	0.6
Production process	1.4	2.8	5.1	0	0.5	0.7	1.4	3.3	5.8
Total	1.4	3.2	5.7	1.6	0.6	0.7	3.0	3.8	6.3
Grand total	117.4	274.9	94.8	21.0	31.4	19.4	138.4	306.3	114.1

Note.—Totals may not add due to rounding.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table 3-28
New capital expenditures for pollution abatement per metric ton of capacity, 1990-92

(Dollars)

	Integrated Sector			Merchant Sector			Industry		
Item	1990	1991	1992	1990	1991	1992	1990	1991	1992
Air:									
End-of-line	1.38	3.25	1.33	2.55	3.41	0.82	1.51	3.27	1.26
Production process	2.68	5.65	2.16	1.18	7.47	5.90	2.52	5.82	2.60
Total	4.06	8.87	3.48	3.72	10.89	6.71	4.02	9.09	3.87
Water:									
End-of-line	0.70	0.34	0.37	0.09	0.32	0.14	0.64	0.34	0.35
Production process	0.05	0.82	0.62	3.01	0.01	0	0.37	0.73	0.55
Total	0.75	1.17	0.99	3.10	0.33	0.15	1.00	1.08	0.89
Solid/contained waste:									
End-of-line	0	0.01	0.03	0.59	0.06	0	0.06	0.02	0.03
Production process	0.06	0.13	0.26	0	0.17	0.25	0.05	0.13	0.26
Total	0.06	0.15	0.29	0.59	0.23	0.25	0.12	0.15	0.28
Grand total	4.87	10.19	4.76	7.41	11.45	7.11	5.14	10.32	5.04

Note.—Totals may not add due to rounding.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table 3-29
Projected capital expenditures for pollution abatement

(Million dollars)

Item	Integrated Sector		Merchant Sector		Industry	
	1994-1998	1999-2003	1994-1998	1999-2003	1994-1998	1999-2003
Air	249.1	154.3	70.6	23.9	319.6	178.2
Water	53.6	40.5	26.6	10.5	80.2	51.0
Solid/contained waste	16.3	10.3	10.1	6.1	26.4	16.4
Total	319.0	205.0	107.3	40.5	426.2	245.5

Note.—Totals may not add due to rounding.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

CHAPTER 4
Industry and Market in Japan

Introduction

This chapter is an overview of the Japanese coke industry, including its basic trends in production, consumption, and trade over a 5- to 10- year period. The chapter also looks at specific competitive factors such as production costs, coke oven age, byproduct valuation, environmental factors, and transportation costs. A comparison of these factors for the U.S. and Japanese industries is presented in chapter 6.

Industry Structure

The Japanese coke industry is one of the largest in the world in terms of production capacity and export sales. Japan produces three main types of metallurgical coke—blast furnace, foundry, and general use; but blast furnace coke for steelmaking comprises more than 90 percent of the industry. Japan's coke industry is similar to the U.S. industry in that the two basic types of producers, integrated and merchant, compose the industry. However, within the Japanese integrated group, Japan further differentiates steel chemical producers from steel companies, and includes gas[1] coke producers within the merchant group. The integrated segment comprises 82 percent of the Japanese production capacity, of which steel chemical plants compose 17 percent; merchant producers compose the remaining 18 percent of production capacity, with gas producers representing 3 percent (table 4-1 and figure 4-1). Steel chemical producers are associated[2] with steel operations and typically sell all their coke output for blast furnace use, but are also more involved in the downstream chemical business.

[1] Gas producers are considered merchant producers because they sell their coke to consumers. Alternatively, steel chemical producers (as differentiated by Japanese statistics) are considered integrated producers because their coke is consumed at the production site by iron and steel producers.

[2] Nippon Steel Chemical is located at the same facility as Nippon Steel's Kimitsu works. Kansai Coke and Chemical has two facilities at Kobe Steel; one at Kakogawa works and the other at Kobe works.

Table 4-1
Japanese coke producers and capacities, 1992

(1,000 metric tons per year)

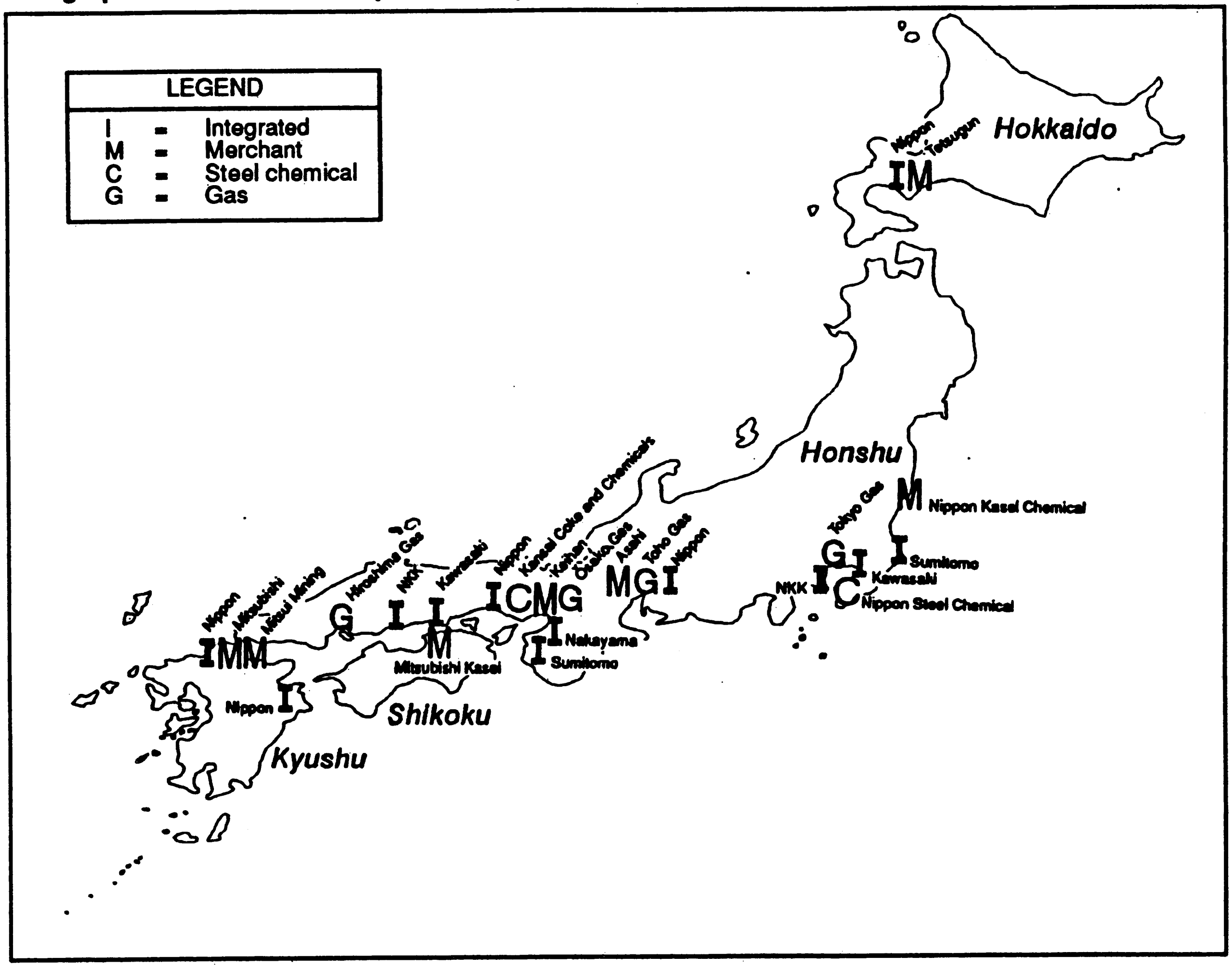
Integrated Company	Capacity	Merchant Company	Capacity
Nippon Steel Corp.	9,606	Mitsubishi Kasei Corp[1].	4,762
NKK Corp.	7,611	Mitsui Mining Co.	1,848
Kawasaki Steel Corp.	7,353	Tokyo Gas Co. Ltd.	689
Sumitomo Metal Ind. Ltd.	5,956	Nippon Kasei Chemical	480
Nippon Steel Chemical	4,585	Toho Gas	265
Kansai Coke and Chem. Ltd.	3,240	Osaka Gas[2]	259
Nakayama Steel Works	430	Hiroshima Gas	182
		Tetsugen Corp.	86
		Keihan	51
		Asahi Coke	22
Total	38,781	Total	8,644
Grand total			47,425

[1] Reflects closure of two batteries in Oct. 1992.

[2] Announced closure in January 1994.

Source: IISI, *World Cokemaking Capacity,* (Brussels: IISI, 1993); and interviews with Japan Coke Association officials.

Figure 4-1
Geographic distribution of Japan's coke producers



Source: IISI, *World Cokemaking Capacity*, (Brussels: IISI, 1993); and JISF, *The Steel Industry of Japan.*

Gas-producing coke operations were historically in the business of producing gas for sale to public utilities, and selling coke and other products as well. The number of gas producers, typically urban, has declined noticeably from 30 producers in 1963 to 4 producers in 1993.[3] [4] The other Japanese coke producers are the merchant producers that manufacture all types of coke and sell to domestic and foreign consumers.

Most Japanese coke producers are affiliated with other business entities. This relationship is important when the export of coke is concerned. The two coke producers exporting coke, Mitsubishi Kasei Corp. and Mitsui Mining Co., both use trading companies for these transactions. The exact affiliation between producers and trading houses in terms of equity interest is not known, but it has been reported that connections exist in a context of longstanding business relationships.[5]

In addition to the relationship between the coke producer and trading company, additional relationships affect the coke producers in Japan. Although

[3] Osaka Gas reportedly closed in January 1994.

[4] According to officials at the Ministry of International Trade and Industry and the Japanese Coke Association, the number of gas-producing coke producers has declined because of changing energy needs. The use of other energy sources, most notably liquefied natural gas, is reportedly more efficient.

[5] Testimony at the public hearing by counsel for Mitsubishi International Corp. (MIC) stated there were minor shareholdings between the producing company (Mitsubishi Kasei) and MIC, and that they are separate and independent companies but have a longstanding historical trading relationship with each other. U.S. International Trade Commission (USITC), *Metallurgical Coke: Hearing Before the Commission*, Oct. 5, 1993, transcript, p. 122; and USITC staff interviews in Japan.

17 companies produced coke in Japan during 1992, the control of these companies is more concentrated. For example, the Nippon Steel Group controls 30 percent of Japan's coke production capacity through Nippon Steel and Nippon Steel Chemical facilities.[6] The Mitsubishi Group that includes Mitsubishi Kasei Corp., has equity interest in Kansai Coke and Chemical and Nippon Kasei Chemical.[7] Together, these three producers account for another 18 percent of Japan's capacity.

Relationships between Japanese and U.S. companies also exist, but these ventures are primarily for downstream iron and steel operations.[8] However, Mitsubishi Corp. (general trading arm of Mitsubishi Group) has interests in Aristech Chemical Co., a U.S. chemical company that further refines crude byproduct chemicals from U.S. Steel's Clairton Works facility.[9]

Capacity

In 1992, Japan's coke industry had a capacity of 47.4 million metric tons (table 4-1) of which all are byproduct ovens. As shown in figure 4-2, Japan's coke capacity has decreased slightly during the past 5 years.

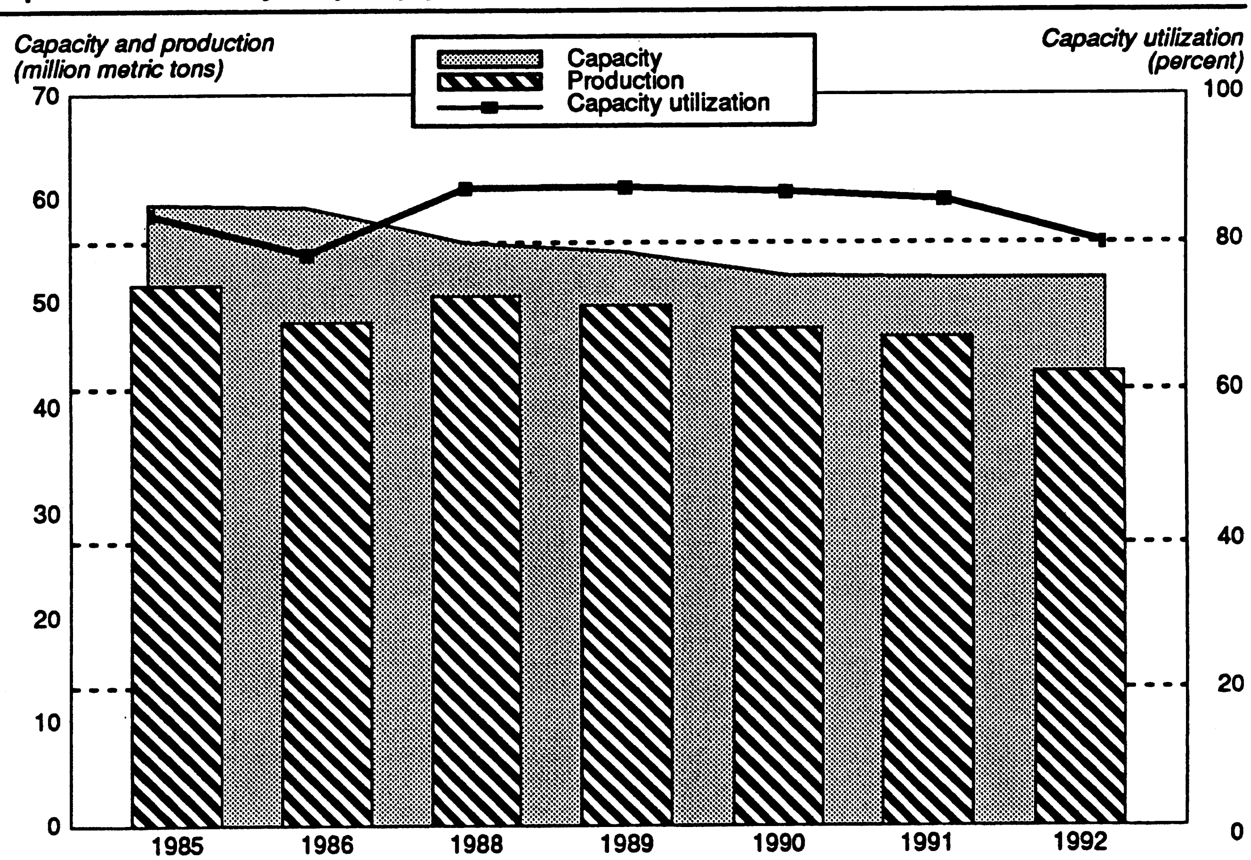
[6] *Industrial Groupings in Japan,* 9th ed. (Tokyo: Dodwell Marketing Consultants, 1990), pp. 181-82; and International Iron and Steel Institute, *World Cokemaking Capacity,*.

[7] Mitsubishi Kasei Corp., *Annual Report 1993; Industrial Groupings in Japan,* pp. 55-56; and USITC staff interviews with Mitsubishi Kasei officials in Japan.

[8] Refer to the USITC, *Steel Industry Annual Report,* USITC publication 2436, Sept. 1991, for information on joint ventures and relationships among U.S. and Japanese steelmakers.

[9] *Industrial Groupings in Japan,* p. 12.

Figure 4-2
Japan's coke industry: Capacity, production, and capacity utilization, 1985–92[1]



[1] Data for 1987 are not available.

Note.—Capacity reported in this figure differs from that reported in table 4-1 because they were obtained calculate capacity.

Source: MITI, *Yearbook of Coal, Petroleum, and Coke Statistics,* compiled by Research and Statistics Department.

Capacity is expected to decline further in 1994 due to the closure of Osaka Gas and the expected closure of another company in March 1994.[10] Japan's reduction in capacity since December 1988 was due primarily to the closure of many small merchant producers—seven gas and merchant producer ovens and three steel or steel chemical ovens. The average age of these ovens was 21 years as they closed. Mitsui Mining reports that the closing of one of their batteries (15 years old) in 1988 was due to the closing of a nearby blast furnace that accounted for the majority of their production output.[11] Another source reports that oven shut-downs during the 1980s were due to economic reasons attributed to blast furnace closings and energy conversion measures at gas companies, and not attributed to the age of the ovens.[12]

In addition to decreasing coke capacity, capacity utilization has also fallen (figure 4-2). During 1985-92, capacity utilization peaked at 87 percent in 1988, before declining to 80 percent in 1992.[13] According to Japanese coke producers, lower capacity utilization is a result of lowered demand by steel producers.[14]

The aging of coke ovens in Japan has become an iron and steel industry concern. The life expectancy of Japanese ovens is generally agreed to be about 35 years.[15] As shown in figure 4-3, over 75 percent of Japan's coke oven capacity is 20 to 30 years old. It is predicted that by 2005 aging ovens will mean a coke shortage for Japan.[16] In comparison, the United States has a larger percent (38 percent compared to 2 percent) of capacity that is over 30 years old, but also a larger percent that is under 20 years old (51 percent compared to 21 percent).

[10] USITC staff interviews with Japan Coke Association, Oct. 13, 1993.

[11] USITC staff interviews with Mitsui Mining Co. officials.

[12] Takizawa, Y., "The Life of Coke Ovens and New Cokemaking Processes Under Development in Japan," *The Life of Coke Ovens and New Coking Processes Under Development* (Brussels: IISI, 1993), p. 28.

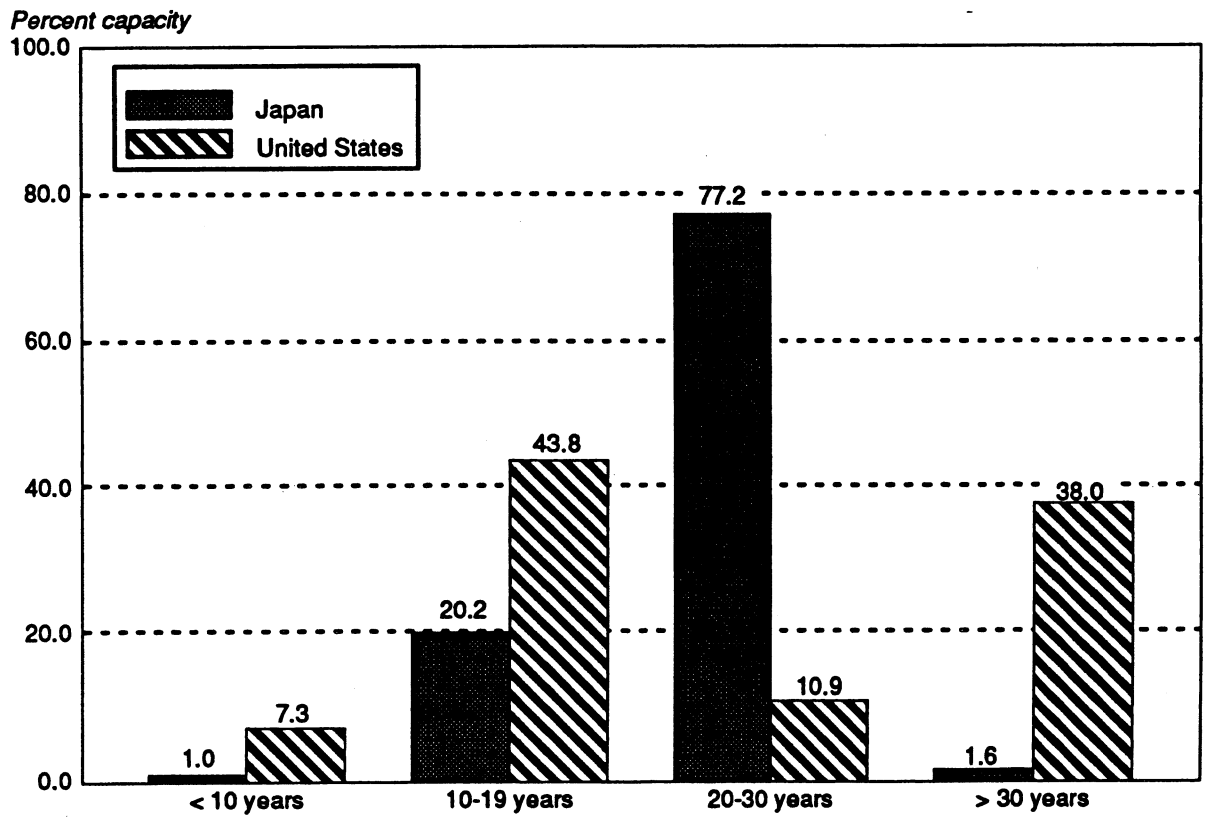
[13] Ministry of International Trade and Industry (MITI), Research and Statistics Department, *Yearbook of Coal, Petroleum, and Coke Statistics* (Japan, 1983-92), pp. 1-3.

[14] USITC staff interviews with Japanese coke industry, Oct. 12-22, 1993.

[15] USITC staff interviews with Japanese coke and steel industry officials, Oct. 12-22, 1993.

[16] "The Life of Coke Ovens and New Cokemaking Processes Under Development in Japan," p. 27.

Figure 4-3
Coke oven age: Relationship between Japanese and U.S. ovens



Source: IISI, *World Cokemaking Capacity*, (Brussels: IISI, 1993).

Production

Coke

Japan's metallurgical coke industry is dominated by blast furnace coke for iron and steel production. During the past 8-year period, blast furnace coke composed an average of 92 percent (44.1 million metric tons) of coke production; foundry, 2 percent (1.0 million metric tons); and general use,[17] 6 percent (2.9 million metric tons) (table 4-2). Fluctuations in production over the past 8 years are mostly attributable to changes in blast furnace coke production; production of foundry and general use coke has remained more stable. Production of coke reached the highest level of 51.74 million metric tons in 1985 and the lowest level of 43.42 million metric tons in 1992.

Although the basic production of coke in byproduct coke ovens is the same in Japan as in the United States, there are some minor variations in the preparation or finishing stages at certain facilities. In contrast to the United States where there is no use of dry quenching, 67 percent of Japan's capacity in 1992 was equipped with dry quenching equipment. Almost all of this capacity in Japan was installed at the integrated steel works where the energy recovery is used in the steelmaking process. On the other hand, nearly all the gas and merchant producers utilize wet quenching in Japan.

[17] Japan's general use coke is sometimes further distinguished by its form—briquettes or powder.

There are two main advantages to dry quenching compared with the traditional wet quenching method. First, coke quality is improved due to increased coke strength, and secondly, energy is recovered through heat transfer. However, installation of dry quenching equipment requires a substantial capital investment and higher associated operating costs.

Byproducts

The extent of recovery and processing of byproducts varies considerably by firm. Some of these materials are used directly in the coke operations while others are sold, processed, or used in other operations. According to industry officials in Japan, approximately 46 percent of the light oils are purified by the coke producer, while the remainder is sold, usually to related companies.[18] Industry statistics for the major byproducts obtained from coking operations are shown in table 4-3.[19] In addition to these basic byproducts, some Japanese producers refine or further process byproducts into numerous other downstream chemicals and products. While adding value to these byproducts does enhance the revenue stream from byproduct sales, additional costs are incurred as well.

[18] USITC staff interviews with the Japan Aromatic Industry Association, Inc., Oct. 15, 1993.

[19] Other major byproducts from coke operators include ammonia and sulfur. Because these are products of many chemical companies, separate statistics for coke oven producers are not available.

Table 4-2
Japanese metallurgical coke production, by types, 1985-92
(1,000 metric tons)

Type	1985	1986	1987	1988	1989	1990	1991	1992
Blast furnace	47,303	44,031	42,808	46,668	45,952	43,696	42,769	39,675
Foundry	1,112	1,030	896	1,008	1,023	1,080	1,071	948
General use	3,325	3,079	2,724	2,959	2,820	2,804	2,861	2,800
Total	51,741	48,140	46,429	50,635	49,795	47,580	46,701	43,423

Note.—Figures may not add to totals shown, because of rounding.

Source: MITI, Research and Statistics Department, *Yearbook of Coal, Petroleum, and Coke Statistics*

Table 4-3
Production of byproduct chemicals from coke operations, 1988-92
(1,000 metric tons)

Byproduct	1988	1989	1990	1991	1992
Crude coal tar	2,304	2,201	2,067	2,037	1,940
Crude light oils	648	632	599	593	563
Coke oven gas[1]	19,622	19,125	18,118	17,825	16,703

[1] Reported in million cubic meters.

Source: Data provided to USITC staff by The Japan Aromatic Industry Association, Inc., and MITI, *Yearbook of Coal, Petroleum, and Coke Statistics.*

Consumption

Over 90 percent of Japanese coke is used in blast furnaces for iron and steel production. Other major consuming industries include the foundry, ferroalloy, ceramic and cement, nonferroalloy, and the metal fabrication industries. The consumption of coke in Japan over the past 8 years has declined slowly after reaching a high of 50 million metric tons in 1985. Consumption reached the lowest level (41 million metric tons) of the 8-year period in 1992. During 1985-92, an average of almost 60 percent of Japanese coke was consumed internally.[20] Shipments and sales of coke are generally more prevalent for non-steel-consuming industries.

Consumption of coke in Japan is highly correlated to raw pig iron and crude steel production because this is the major consuming industry (figure 4-4). Like the U.S. steel industry, however, the Japanese steel industry has gradually increased the amount of steel it can produce from the same amount of coke.

The Japanese iron and steel industry has been a world leader in developing and employing alternative technologies that reduce its dependence on coke. These alternative technologies are pulverized coal injection (PCI), blast furnace automation, and electric arc steelmaking. These alternatives either substitute lower cost materials for coke, or replace the need for coke, all of which are aimed at increasing productivity to gain a competitive edge. As the Japanese industry faces the prospects of a coke shortage around 2005, the steel industry has examined these alternatives closely.[21]

During 1987-92, Japan's PCI coal use almost tripled from 2.26 million metric tons to 6.46 million metric tons.[22] By 1992, over 75 percent of the blast furnaces were equipped with PCI. This level of PCI coal accounted for over 20 percent of total industry coal consumption. Forecasts to the year 2000 indicate that 10 million metric tons of PCI coal will be used, accounting for approximately 28 percent of total coal consumption.[23] All the major Japanese steel producers are equipped to some degree with PCI equipment. The main sources of Japan's PCI coals are South Africa, Australia, and Indonesia.[24]

[20] MITI, *Yearbook of Coal, Petroleum, and Coke Statistics*, pp. 1-3.

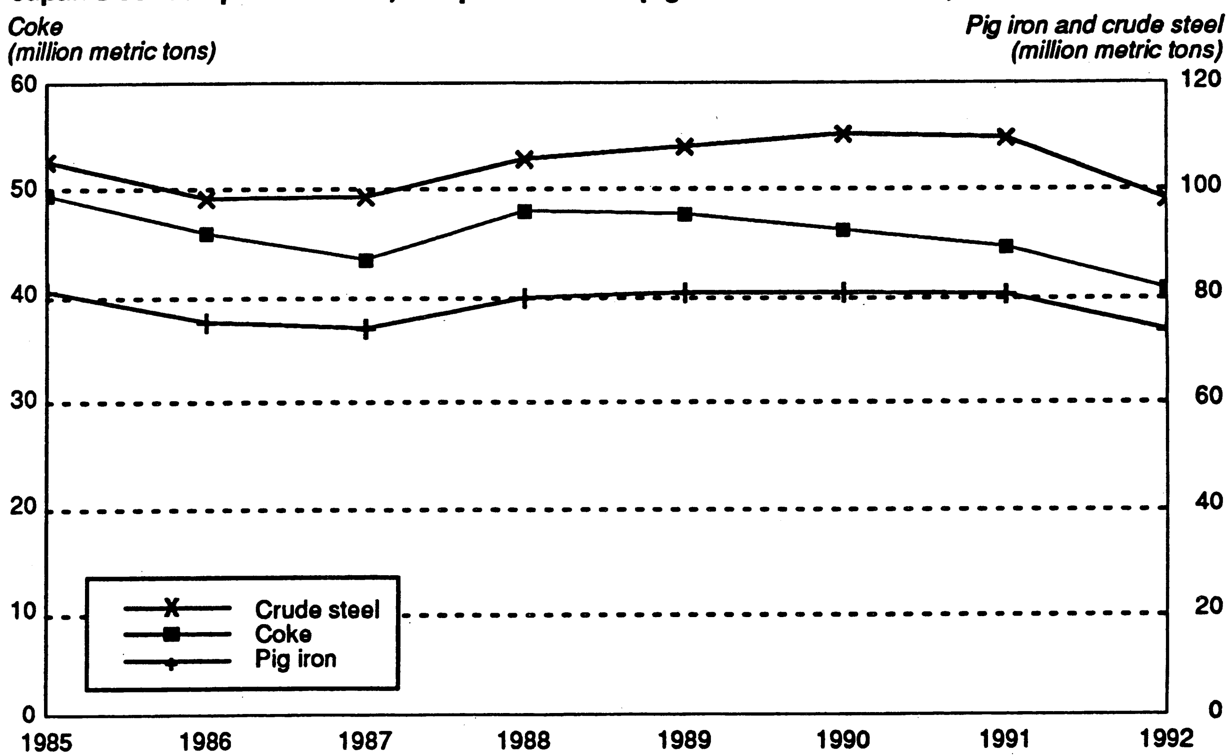
[21] USITC staff interviews with Japan Iron and Steel Federation.

[22] Jennifer Bennett, *PCI and Coke: Market Impacts of Changing Steel Technologies* (Petersfield, United Kingdom: McCloskey Coal Information Services Ltd., 1993), p. 51.

[23] Bennett; and "JSM Plans Steady Rise in PCI," *Coal Week International*, Mar. 9, 1993, p. 7.

[24] Bennett, pp. 64-69.

Figure 4-4
Japan's consumption of coke, and production of pig iron and crude steel, 1985-92



Source: MITI, *Yearbook of Coal, Petroleum, and Coke Statistics*, and JISF, *The Steel Industry of Japan 1993*.

Trade

During 1985-92, the significant sources of Japanese imports were China and Australia; in 1992 they accounted for 99 percent of imports. Imports of coke are subject to a 3.2 percent ad valorem tariff in Japan and have remained minimal compared with Japanese export levels (table 4-4). During the past 8-year period, imports increased through 1989 and fluctuated thereafter, but remained less than 1 percent of production during the period.

Japanese exports of coke have typically averaged approximately 5 percent of production and during the period 1985-92 have varied from a high of 3.2 million metric tons in 1987 to a low of 1.7 million metric tons in 1990. Although Japan has historically been a net exporter of coke, the recent impetus for increased coke exportation is related to the lack of domestic demand for coke.[25]

The largest export markets include the United States, Brazil, and Romania (table 4-5). Japanese exports are composed of blast furnace, foundry, and general use cokes; and are exported solely by the merchant producers.[26] In 1992, blast furnace coke accounted for 87 percent of exports, foundry for 5 percent, and general use coke for 8 percent.[27] Exports of blast furnace coke were mainly to industrialized countries that possess large steel industry infrastructures; exports to the United States consisted solely of blast furnace coke. Foundry coke was exported almost exclusively to other Pacific Rim countries; Taiwan, the Republic of Korea, and Thailand were the principal markets. General use coke in the form of briquettes or powder was exported to numerous countries, including the Republic of Korea, Philippines, India, and Australia.

[25] USITC staff interviews with Japanese coke industry, Oct. 12-22, 1993.

[26] According to USITC staff interviews with the Japanese coke industry, Mitsubishi Kasei and Mitsui Mining are the only two producing companies in Japan that export coke.

Costs

Transportation

Most integrated and merchant Japanese metallurgical coke producers are on the coast, which helps the import-export of raw material coal and metallurgical coke and other products (see figure 4-1). Nearly all metallurgical coke producers in Japan, including merchant producers, are also near large steel mills or other end users, thus shipping distances for

[27] MITI, *Yearbook of Coal, Petroleum, and Coke Statistics.*

Table 4-4
Japan's imports, exports, and trade balance of coke, 1985-92
(1,000 metric tons)

Year	Imports	Exports	Trade balance
1985	1	2,264	2,263
1986	33	2,348	2,315
1987	115	3,170	3,055
1988	220	2,898	2,678
1989	383	2,506	2,123
1990	327	1,731	1,404
1991	362	2,531	2,169
1992	185	3,066	2,881

Source: *Japan Exports & Imports, Commodity by Country* (Tokyo: Japan Tariff Association, Dec. 1985-92).

Table 4-5
Japanese metallurgical coke exports, by principal sources, 1985-92
(1,000 metric tons)

Market	1985	1986	1987	1988	1989	1990	1991	1992
United States	350	232	666	1,150	1,140	773	835	1,540
Brazil	0	26	685	425	438	97	847	636
Romania	641	753	499	327	234	248	260	0
Republic of Korea	99	85	118	125	108	98	117	112
Philippines	158	261	358	267	236	135	78	103
Taiwan	167	169	160	166	127	121	135	154
All other	849	822	684	438	223	259	259	521
Total	2,264	2,348	3,170	2,898	2,506	1,731	2,531	3,066

Source: *Japan Exports & Imports, Commodity by Country* (Tokyo: Japan Tariff Association, Dec. 1985-92).

domestic metallurgical coke are fairly short.[28] The wharves for metallurgical coke producers are often equipped to receive bulk carrier vessels for raw material discharging and product loading. These shipments are generally seaborne transport by pusher barge (2,000 metric tons) and coastal barge (1,000 metric tons), using contract shipping companies that may be affiliated with steel mills or large trading companies.[29] Most metallurgical coke shipments are sold on a long-term contract basis.

Exports[30] are loaded at the production facilities directly to vessels at the producers' loading berths.[31] The two exporters use soft loading to reduce degradation and maximize weight per shipment.[32] Japanese coke exports to the United States are generally shipped on Panamax vessels,[33] carrying 38,000 to 40,000 metric tons of coke. Transit times for delivery of Japanese coke are approximately 30-35 days for shipments to U.S. east coast and gulf ports, but only 15 days for west coast ports.[34] The U.S. ports that frequently handle Japanese coke are Baltimore, MD; Mobile, AL; and San Francisco, CA.

Most Japanese coke shipments to U.S. ports are under transportation contracts. According to maritime officials in Japan, bulk carrier rates are driven by demand for Atlantic Ocean to Pacific Ocean (Atlantic-Pacific) bulk product trade, including grain, iron ore, and coal. Trade in these products from Pacific Ocean ports to Atlantic Ocean ports ("backhaul") is less frequent, resulting in an imbalance in bulk carrier demand. Consequently, coke shipments from Pacific ports destined for Atlantic ports may obtain lower freight rates than for Atlantic-Pacific transport. Backhaul Panamax bulk carrier rates may be only one-half of those for Atlantic-Pacific trade. During the first half of 1993, bulk commodity shipment rates (grain) on Panamax vessel from U.S. gulf ports to Japan were approximately $20-26 per metric ton, while rates for coke from Japan to U.S. gulf and east coast ports were approximately $10-12 per metric ton, with east coast port rates nearer $12 per metric ton.[35] Similar Panamax shipments with U.S. west coast destinations range between $8-10 per metric ton.[36] These rates are fairly representative of ocean transportation costs derived from official statistics of actual coke shipments from Japan during the periods 1990-93 (table 4-6).[37]

28 USITC staff interviews with Japanese coke industry officials, Oct. 12-22, 1993.

29 Some domestic foundry coke shipments may be trucked because of the smaller quantities per shipment.

30 Because coke exports to the United States during 1988-92 comprised only blast furnace coke, research has focused primarily on blast furnace coke shipments.

31 Mitsui Mining Co.'s coke-loading facilities contain one berth of 110 meters and 3,000 dead weight and a loading capacity of 720 metric tons per hour or approximately 10,000 metric tons per day.

32 Mitsubishi Kasei Corp. employs a vertical coke loader that adjusts to the height of the coke pile during loading, reducing the distance the coke falls into the ship chamber to achieve soft loading.

33 Panamax vessels have a 60,000 to 70,000 metric ton dead weight capacity for bulk products. Panamax vessels fully ladened with coke are between 38,000 and 40,000 metric tons due to the relatively low bulk density of coke.

34 USITC staff interviews with U.S. and Japanese coke industry officials, Oct. and Nov. 1993.

Production[38]

Few data on costs of coke production in Japan are publicly available. Many cost components, such as energy and labor, depend on the level of automation of the plants and the extent to which coke oven gas is sold or used internally to produce steam or electricity. However, data are available for coal prices, the major raw material cost in coke production.[39] Metallurgical coal import values (c.i.f.) decreased universally during 1985-92 and this trend continued during January-June 1993 (table 4-7 and figure 4-5). Calculated unit values

35 Handling and associated fees at U.S. ports are approximately $2-3 per metric ton for metallurgical coke; USITC staff interviews with U.S. maritime industry officials, Nov. 1993.

36 USITC staff interviews with U.S. and Japanese maritime officials.

37 These costs are the difference between c.i.f. value at the first U.S. port of entry and customs value in Japan, and do not include inland transportation costs.

38 Due to exchange rate fluctuations, discussion of cost trends will be limited to yen-based data.

39 Metallurgical coal accounts for approximately 97 percent of raw material inputs in coke production. Other inputs include peat and peat coke. MITI, *Yearbook of Coal, Petroleum and Coke Statistics*.

Table 4-6
Metallurgical coke: Transportation charges[1] on U.S. imports for consumption from Japan, 1990-93

(Dollars per metric ton)

Product	1990	1991	1992	1993
Coke[2]	13.47	10.89	10.05	8.24

1 Ocean freight value was calculated as the difference between c.i.f. value at the first U.S. port of entry and customs value in Japan.

2 Metallurgical coke as provided for under HTS subheading 2704.00.00.15—Coke and semicoke of coal, commercially suitable for use as fuel, not including briquettes.

Source: Compiled from official statistics of the U.S. Department of Commerce.

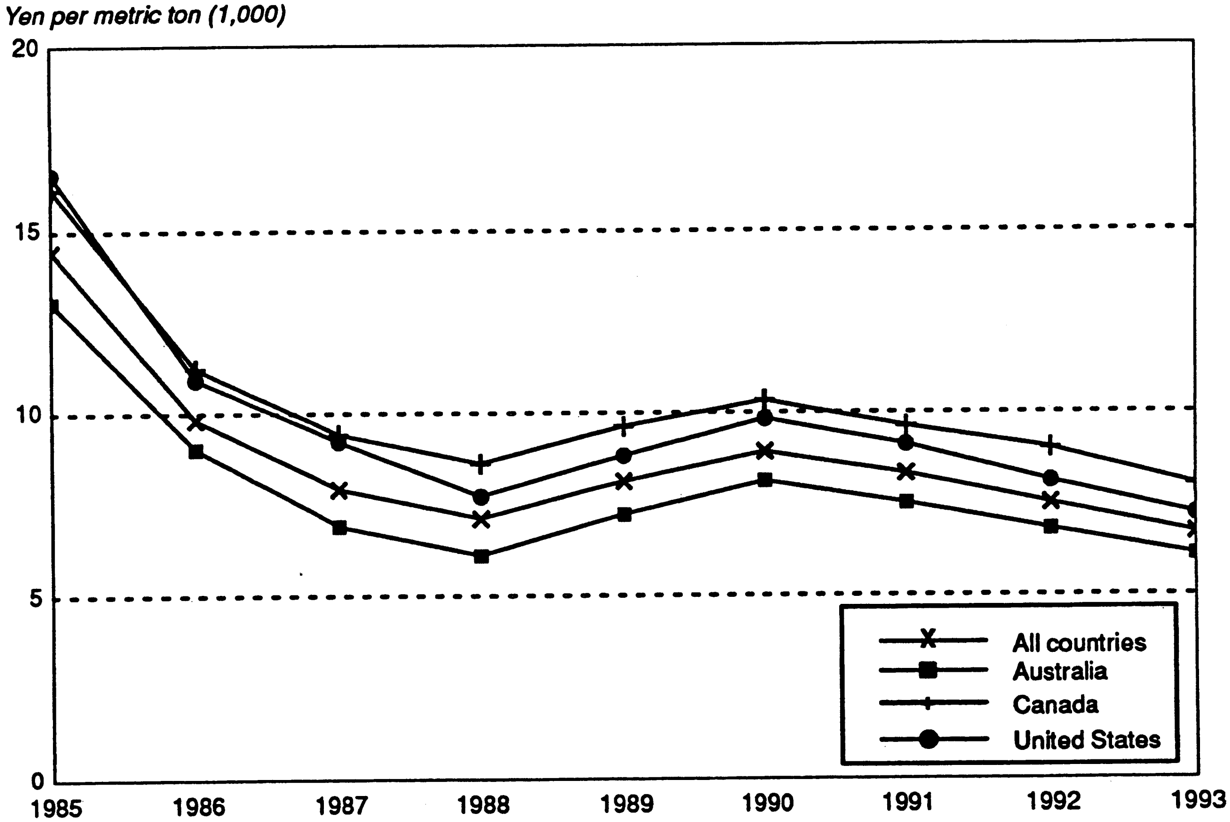
Table 4-7
Japanese metallurgical coal import values, c.i.f., by principal sources, 1985-92 and Jan.-June 1993

Source country	1985	1986	1987	1988	1989	1990	1991	1992	Jan.-June 1993
					Unit value *(yen per metric ton)*				
Australia	13,086	9,011	6,994	6,190	7,298	8,100	7,527	6,855	6,167
Canada	16,126	11,297	9,480	8,669	9,645	10,397	9,695	9,041	8,045
China	12,407	8,314	6,382	6,111	7,287	7,795	7,166	6,611	5,812
United States	16,550	10,986	9,254	7,714	8,809	9,809	9,109	8,165	7,289
Former USSR	12,890	8,908	7,057	6,498	7,584	8,338	7,668	7,158	6,284
South Africa	10,903	7,267	5,356	4,841	5,786	6,603	6,313	6,145	5,509
New Zealand	15,235	9,249	7,982	7,687	9,136	9,749	9,458	8,279	7,448
Indonesia	11,429	7,803	6,800	6,236	8,062	7,761	(1)	(1)	(1)
Brazil	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	9,234
Average[2]	14,471	9,883	7,934	7,186	8,181	8,980	8,318	7,568	6,758
					Unit value *(dollars per metric ton)*				
Australia	54.86	53.47	48.35	48.30	52.90	55.94	55.87	54.16	53.37
Canada	67.60	67.04	65.54	67.65	69.91	71.81	71.97	71.43	69.63
China	52.01	49.34	44.12	47.68	52.82	53.84	53.19	52.23	50.30
United States	69.38	65.19	63.98	60.20	63.85	67.75	67.62	64.51	63.08
Former USSR	54.03	52.86	48.79	50.70	54.97	57.59	56.92	56.55	54.39
South Africa	45.71	43.12	37.03	37.78	41.94	45.60	46.86	48.55	47.68
New Zealand	63.87	54.88	55.18	59.99	66.22	67.33	70.21	65.41	64.46
Indonesia	47.91	46.30	47.01	48.66	58.44	53.60	(1)	(1)	(1)
Brazil	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	79.92
Average[2]	60.66	58.64	54.85	56.08	59.30	62.02	61.75	59.79	58.49

[1] No data reported.
[2] Average unit import price for all countries.

Source: Japan Exports & Imports, Commodity by Country (Tokyo: Japan Tariff Association, Dec. 1985-92 and June 1993).

Figure 4-5
Japanese metallurgical coal import unit values for Australia, Canada, and the United States, and all countries, 1985-92, and Jan.-June 1993



Source: *Japan Exports & Imports, Commodity by Country* (Tokyo: Japan Tariff Association, Dec. 1985-92 and June 1993).

on a metric ton basis for metallurgical coal imports from Japan's primary source countries (table 4-8)—Australia, Canada, the former Soviet Union (USSR), and the United States—declined during 1985-92 and January-June 1993. Similarly, average unit values for all Japanese metallurgical coal imports decreased by 58.3 percent during the same period. Decreasing Japanese coal import values are indicative of the competitive nature of this internationally traded commodity.

Japanese producers, both integrated and merchant, blend several types of imported metallurgical coal to produce coke. The metallurgical coal content of metallurgical coke exports to the United States contained approximately 10 and 13 percent U.S. coals for Mitsubishi Kasei Corp., and Mitsui Mining Co., respectively. Both exporters indicated larger purchases of lower cost Australian and Chinese coals, with smaller U.S. coal purchases in recent years.[40] Based on import values and metallurgical coal content data, metallurgical coal costs are estimated at approximately ¥6,758 per metric ton (or $58.49 per metric ton) in the first half of 1993.

[40] USITC staff interviews with officials from Mitsui Mining Co. and Mitsubishi Kasei Corp, Oct. 18-20, 1993.

Because construction costs of new coke production facilities are substantial, the necessary capital, depreciation, and financing options are important considerations for the coke industry. Although average oven life is more than 30 years, the useful life of coke ovens under the tax law in Japan is 10 years.[41] Therefore, coke ovens are fully depreciated 10 years after construction for tax purposes in Japan compared to 15 years for the United States. Cost data and financing options related to new byproduct plant construction are not available. However, the development of the formed coke process by the Japan Iron and Steel Federation between 1978-86 reportedly cost 10 billion yen, of which half was financed by the Ministry of International Trade and Industry, and the remainder by four integrated steel producers.[42]

Byproduct Credits

The production of chemicals from byproduct coking operations is another source of income for coke

[41] Information provided by the Japan Coke Association, Feb. 1994.
[42] Information provided by the Japan Iron and Steel Federation, Feb. 1994.

Table 4-8
Japanese metallurgical coal imports, by principal sources, 1985-92

(1,000 metric tons)

Source country	1985	1986	1987	1988	1989	1990	1991	1992
Australia	27,244	24,861	24,533	24,730	26,694	27,162	30,033	29,156
Canada	16,717	16,082	15,339	18,569	17,338	17,688	17,261	14,253
United States	10,614	9,146	7,248	10,675	8,747	8,374	8,421	7,620
Former USSR	2,845	4,283	5,133	5,447	5,443	5,435	3,590	2,820
South Africa	1,419	1,898	1,390	1,480	1,344	1,253	1,350	1,777
China	1,220	1,249	1,285	1,180	1,172	1,491	1,672	1,447
New Zealand	197	101	173	224	233	232	303	412
Colombia	(1)	(2)	84	57	50	(2)	(2)	(2)
Indonesia	33	11	4	16	6	37	(2)	(2)
Greenland	(2)	(2)	(2)	(2)	(2)	(2)	12	(2)
Netherlands	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
India	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
Total	60,289	57,632	55,189	62,378	61,028	61,672	62,642	57,486

[1] Imports were less than 500 metric tons.
[2] No imports were reported from this country in this year.

Note.—Figures may not add to totals shown due to rounding.

Source: *Japan Exports & Imports, Commodity by Country* (Tokyo: Japan Tariff Association, Dec. 1985-92).

operators.[43] Because many of these chemicals, such as coal tar, are further processed by the producer or related chemical company, there are no published prices for these byproduct chemicals in Japan. However, statistical reporting of sales, both quantity and value, to the Ministry of International Trade and Industry was used to obtain unit values of these chemicals (table 4-9). According to officials at the Japan Aromatic Industry Association, Inc., Japanese prices for chemicals obtained from coking operations are generally equivalent to U.S. and world prices.[44]

Coke oven gas, the other major byproduct from coking operations, seems to be valued higher than coke oven gas in the United States because of the relatively higher cost of energy in Japan. Although no published data on prices of coke oven gas exist in Japan, producers report that the gas is sold on a calorific basis.[45] As shown in table 4-9, the value of coke oven gas was calculated at $0.19-0.22 per cubic meter during the period based on the price of natural gas.[46]

The total value of byproduct credits to coke operations in Japan has been highly disputed. In testimony to the Commission, Locker Associates stated that byproduct credits total $25 per ton of coke produced.[47] Japanese merchant producers reported that the byproduct credits are much higher than $25 per ton.[48] In a written submission to the Commission, Mitsubishi International Corp. states that "Sales of coke oven gas are therefore not a major contributor to profits for a domestic [U.S.] merchant producer. In contrast, coke oven gas is a major co-product in Japan."[49] This issue is further examined in chapter 6.

[43] Because byproduct credits are considered a negative cost, they are discussed in the cost section because of their relevance to overall operating costs.

[44] USITC staff interviews with officials of The Japan Aromatic Industry Association, Inc.

[45] USITC staff interviews with Japanese coke industry.

[46] The price of coke oven gas was calculated from natural gas prices using the calorific value equivalent of the coke oven gas.

[47] Testimony at the public hearing by Michael Locker, Locker Associates. USITC, *Metallurgical Coke: Baseline Analysis of the U.S. Industry and Imports*, Oct. 5, 1993, p. 97.

[48] USITC staff interviews with Japanese coke producers, Oct. 12-22, 1993.

Market Dynamics and Prices

Prices[50]

Published domestic price information for Japanese blast furnace coke does not exist according to Japanese industry officials.[51] However, available data for Japanese-produced foundry and general use coke indicate relatively stable domestic general use coke prices and slightly increasing foundry coke prices between 1988 and 1992. Delivered prices for general use and foundry coke increased less than 1 and 2.5 percent, respectively, during 1988-92 (table 4-10). Compared to U.S. prices reported in table 3-20, Japanese prices for foundry and general use coke are substantially higher but comparisons are difficult because prices are reported on a different basis. Prices reported in table 4-10 are delivered prices that include transfers and markups by brokers or middlemen while those available for the U.S. industry are on a f.o.b. basis.

[49] MIC written submission to the Commission, Dec. 16, 1993, pp. 3-4.

[50] Domestic prices were available for foundry and general use coke in Japan on a delivered basis sold through sales agents. Consequently, prices include profit margins, transport costs from the producer to the end user, and other transaction costs.

[51] USITC staff interviews with officials of the Japan Coke Association, Oct. 13, 1993.

Table 4-9
Valuation of byproduct chemicals in Japan, 1988-93

(Dollars per liter)

Byproduct	1988	1989	1990	1991	1992	Jan.-June 1993
Crude coal tar	0.12	0.10	0.12	0.14	0.13	0.14
Crude light oils	0.16	0.17	0.19	0.21	0.17	0.18
Coke oven gas[1]	0.22	0.20	0.19	0.19	0.20	(2)

[1] Reported in dollars per cubic meter. Value calculated from prices of natural gas in Japan based on the calorific value of the coke oven gas. During 1988-92, the value of natural gas in Japan ranged from $0.41 to $0.48 per cubic meter.

[2] Not available.

Note.—Data are calculated unit values (except as noted for coke oven gas) of quantity and value shipments (ex-factory) converted to U.S. dollars using the market exchange rate published in *International Financial Statistics.*

Source: Statistical Regulation figures reported to the MITI as published in *Plastics Industry News* and International Energy Agency, *Energy Prices and Taxes, Second Quarter, 1993.*

Table 4-10
Metallurgical coke: Domestic delivered prices of general use and foundry coke sold through agents, by types, 1988-92 and Jan.-Sept. 1993[1]

Type	1988	1989	1990	1991	1992	Jan.-Sept. 1993
	Unit value per metric ton *(yen)*					
General use	38,560	38,520	38,460	38,920	38,920	38,920
Foundry	59,850	60,080	60,880	61,940	61,350	61,350
	Unit value per metric ton *(dollars)*					
General use	300.90	279.21	265.63	288.92	307.50	344.18
Foundry	467.03	435.49	420.47	459.80	484.71	542.54

[1] During 1988-92 and Jan.-Sept. 1993, the Japanese yen appreciated 13.7 percent over the U.S. dollar (Source: International Monetary Fund, *International Financial Statistics,* Oct. 1993).

Source: *Monthly Report Basic Commodity Prices in Japan and Weekly Report Basic Commodity Prices in Japan,* Japan Economic Research Association, 1988-93.

Traditionally, the majority of Japanese blast furnace coke production was internally consumed by integrated steel producers. Consequently, market prices for blast furnace coke are not officially recorded.[52] In addition, Japanese producers report that there are no open market transactions for the sale of blast furnace coke because it is sold under contract or commissioned (tolled) for the steel mills.[53] However, price trends of manufactured products are monitored through annual price indexes reported by the Bank of Japan. These data indicate that during 1985-92, the average domestic price of Japanese coke[54] fluctuated but declined by 15.4 percentage points overall. Coke prices declined 15.8 percentage points by 1988, then rebounded 8.7 percentage points by 1990, before declining by 8.3 percentage points during 1991-92.[55]

Japanese coke import unit values[56] during 1987-92 from the two largest sources reveal increasing unit values for metallurgical coke. Unit values in yen for Australian and Chinese coke increased by 12.0 and 4.7 percent during 1987-92 (table 4-11). During the same period, the average unit value for all imports decreased by 36.3 percent.

Export values of Japanese coke were available on an f.o.b. basis for the period 1985-92. Average Japanese export values for all types of metallurgical coke declined from ¥20,860 ($87.45) per metric ton in 1985 to ¥11,407 ($90.12) per metric ton in 1992, a 45-percent decline[57]. Between 1985 and 1988, average export values decreased by 50 percent before increasing by 45 percent in 1989, and then decreasing again by 24 percent through 1992 (table 4-12). Export values for coke shipments[58] to the United States followed similar trends, declining prior to and after 1989.

The sharp increase in Japanese coke export values between 1988 and 1989 may be attributed to sharply increasing worldwide pig iron production between 1986 and 1989, when total pig iron production increased by 9.8 percent, from 496 million metric tons to 545 million metric tons per year.[59]

Quality and Product-related Characteristics

Japanese companies report that the quality factors are specified by the customer in the contract. Because Japan imports higher sulfur and higher ash coking coals from Australia and China, the coke produced from these coals also contains higher levels of these contaminants compared with U.S. coke. The two exporting companies, Mitsubishi Kasei and Mitsui Mining, report the following quality specifications for coke exported to the United States:

Ash	7-11.0 percent
Sulfur	0.7-0.8 percent
Volatile matter	1.0 percent
Moisture	5.0 percent

Breakage, or breeze generation, is typically measured before loading at the Japanese port; one company reports a maximum of 5 percent breakage before loading. However, by the time exported coke

[52] Bank of Japan, Research and Statistics Department, *Price Indexes Annual,* 1992, p. 286.
[53] USITC staff interviews with Japanese coke industry officials, Oct. 12-22, 1993.
[54] Price index data included blast furnace, foundry, general use, and pitch coke, and coal coke for export.
[55] Bank of Japan, p. 455.
[56] Import values for Japanese coke are reported on a c.i.f. basis for all types of coke. Separate data were not available on blast furnace, foundry, and general use coke.
[57] Since Japanese export values represent a summation of blast furnace, foundry, and general use coke shipments, shifts in product mix may, in part, account for value fluctuations for those countries known to import more than one type of Japanese coke.
[58] Nearly 98 percent of U.S. coke imported from Japan during 1985-92 was blast furnace coke.
[59] International Iron and Steel Institute, *Steel Statistical Yearbook 1992,* and *Monthly Report: Iron Production (IISI-91/92),* Apr. 1993.

Table 4-11
Metallurgical coke: Unit values for Japanese imports, c.i.f., by sources, 1987-92, and Jan.-June 1993

Source	1987	1988	1989	1990	1991	1992	Jan.-June 1993
	Unit value per metric ton *(yen)*						
Australia	16,914	17,388	16,947	17,950	17,532	18,940	18,431
China	12,322	9,737	12,313	13,775	11,690	12,907	14,378
All countries	23,200	15,158	15,666	15,805	14,398	14,770	15,714
	Unit value per metric ton *(dollars)*						
Australia	116.94	135.68	122.84	123.97	130.15	149.64	159.52
China	85.26	75.98	89.25	95.14	86.78	101.97	124.44
All countries	160.40	118.28	113.55	109.16	106.88	116.69	136.00

Source: *Japan Exports & Imports, Commodity by Country* (Tokyo: Japan Tariff Association, Dec. 1987-92 and June 1993).

Table 4-12
Japanese metallurgical coke export unit values, f.o.b. Japan, 1985-92

Market	1985	1986	1987	1988	1989	1990	1991	1992
	Unit value per metric ton *(yen)*							
United States	20,892	14,504	10,061	9,662	15,039	14,256	11,994	11,480
Brazil	(1)	11,548	9,832	11,668	15,817	12,938	12,305	10,857
Chile	21,814	15,992	11,345	9,846	15,595	18,636	(1)	(1)
Peru	22,245	15,583	13,426	(1)	(1)	(1)	(1)	(1)
Romania	21,333	15,723	12,212	11,066	15,808	13,445	12,911	(1)
United Kingdom	(1)	(1)	(1)	10,008	(1)	11,778	(1)	12,746
Philippines	15,432	10,539	7,758	8,060	10,480	12,650	11,180	9,815
Taiwan	20,851	14,981	14,951	15,440	18,498	20,748	17,837	14,868
South Korea	19,424	14,601	10,800	9,933	12,588	14,167	13,696	12,058
India	20,632	14,089	12,930	10,447	11,293	17,490	13,477	10,281
Average	20,860	14,822	10,536	10,366	15,052	14,722	12,836	11,407
	Unit value per metric ton *(dollars)*							
United States	87.58	86.07	69.56	75.40	109.01	98.46	89.04	90.70
Brazil	(1)	68.52	67.97	91.05	114.65	89.36	91.35	85.78
Chile	91.45	94.90	78.44	76.83	113.04	128.71	(1)	(1)
Peru	93.25	92.47	92.82	(1)	(1)	(1)	(1)	(1)
Romania	89.43	93.30	84.43	86.35	114.58	92.86	95.84	(1)
United Kingdom	(1)	(1)	(1)	78.10	(1)	81.35	(1)	100.70
Philippines	64.69	62.54	53.63	62.89	75.96	87.37	82.99	77.55
Taiwan	87.41	88.90	103.37	120.48	134.09	143.29	132.41	117.47
South Korea	81.43	86.64	74.67	77.51	91.24	97.84	101.67	95.27
India	86.49	83.60	89.39	81.52	81.86	120.80	100.04	81.23
Average	87.45	87.86	72.85	80.89	109.11	101.68	95.29	90.12

[1] No data reported.

Source: *Japan Exports & Imports, Commodity by Country* (Tokyo: Japan Tariff Association, Dec. 1985-92).

reaches its destination, the percent breeze may vary considerably, depending on the number of times it is handled.[60] Some U.S. purchasers can unload directly at their steel works. Shipments to other purchasers involve additional handling due to the need for inland transportation.

Implications of Environmental Regulations

Background

The laws and regulations affecting coke ovens were set and controls were implemented by jurisdiction in the 1960s and 1970s. The Basic Law for Environmental Pollution Control (1967) is the point of reference for environmental regulation in Japan. Subsequently, the Air Pollution Control Law in 1968 and the Water Pollution Control Law in 1970 created a series of environmental acts in Japan that, among other things, stipulate the national emission standards or tolerance levels for various pollutants, including dust and particulates. The Environment Agency of Japan was created in 1971 to serve as the focus of development for national environmental regulation. The Environment Agency regulates air and water pollution, solid waste disposal, and promotes conservation of natural resources.[61]

The Japanese Diet passed a New Basic Environmental Law on November 12, 1993. However, implementing regulations could take a year or more to develop and finalize.[62] According to government officials, the Environment Agency intends to revise the existing Air Pollution Control Law to conform to the New Basic Law. Currently no standards for fugitive emissions from coke ovens specifically relate to hazardous air pollutants. The New Basic Law may contain specific regulation of hazardous (or toxic) emissions in the air.[63] However, it is not anticipated that new national legislation will directly single out the production of coke.

The regulation of pollution in Japan involves—(1) national rules and guidance; (2) prefectural and municipal rules and guidance; (3) local ordinances; and (4) local agreements. The key distinctions separating these four forms are enforceability and the level of stringency of the requirements. The prefectures and municipalities in Japan are the primary developers of environmental measures. The plans of the prefectures and the measures taken by the other local governments follow the related national policies.[64]

Federal rules, prefectural rules, and local ordinances are legally binding. In contrast, the government does not have the power to enforce national and prefectural guidance. The two different levels of government generally develop the guidance in consultation with industry, and once guidance is officially adopted, industry generally complies with the guidance. National rules are the least strict, with prefectural rules and local ordinances permitted to be stricter if necessary to meet local conditions.[65]

A key part of the Japanese regulatory process is the development of agreements between local governments and industry. These agreements are intended to match control strategies to the emission sources and needs of the local areas. The national emission limits thus often serve as guidelines and not as strict requirements.[66] These agreements are formal written commitments by the local industries to control emissions; and are sometimes based differently than the way rules or ordinances are based. For example, a local agreement may be based on the level of total emissions or volumes of waste rather than specific concentrations or tolerances.[67]

Air Pollution Emissions

Japan has similar ambient standards to those in the United States for essentially the same pollutants.[68] The national emission standards for three pollutants particularly relevant to the coke and steel industry are shown in table 4-13.[69] Emissions of sulfur oxides (SO_x) and nitrous oxides (NO_x) are continuously monitored, particularly at large stationary sources. In some cases, the data are reported by telemetry to local and prefecture agencies.[70] It is unclear whether the coke industry makes such reports. Additional standards exist for areawide pollutant load controls where industry has had trouble satisfying ambient standards. Such areawide emission standards are based on a pollutant load reduction plan for certain types of soot and smoke. Both SO_x and NO_x have been designated in some areas, and some prefectures have reportedly enacted this type of standard.[71]

[60] U.S. industry officials estimate that approximately 1 percent breeze is generated for each handling.
[61] USITC staff interview with Japan's Environment Agency, Oct. 13, 1993.
[62] U.S. Department of State, Telegram No. 15879, Nov. 15, 1993.
[63] USITC staff interview with Japan's Environment Agency, Oct. 13, 1993.

[64] U.S. Congress, Congressional Budget Office, *Environmental Regulation and Economic Efficiency*, Washington, DC, Mar. 1985.
[65] USITC staff interview with Japan's Environment Agency, Oct. 13, 1993.
[66] U.S. Congress, Mar. 1985.
[67] USITC staff interview with Japan's Environment Agency, Oct. 13, 1993.
[68] U.S. Congress, Mar. 1985.
[69] Ishimitsu reports that there is no emission standard for dust.
[70] USITC staff interview with Japan's Environment Agency, Oct. 13, 1993.
[71] Yutaka Ishimitsu, "Environmental Pollution Control in Japan," paper presented at meeting of the OECD Steel Committee, Oct. 26, 1992.

Table 4-13
National emission standards in Japan: Pollutants particularly related to the steel industry

Substance	Regulatory standard
Air:	
SO_x	17.5[1] K value
NO_x	170 ppm
soot and dust	150/100[2] mg/Nm^3
Water:	
pH[3]	5.8 - 8.6 mg/l (rivers)
	5.0 - 9.0 mg/l (coastal waters)
BOD[4]	160 mg/l (daily average 120)
COD[5]	200 mg/l (daily average 150)
Dissolved iron	10 mg/l
Phenols[6]	5 mg/l
n-Hexane extracts[7]	5 mg/l (mineral oil)
Cyanide compounds[8]	1 mg/l

[1] National minimum.

[2] The lower value applies to newly installed facilities in areas where other smoke-generating equipment is installed and the combination poses a danger of emitting pollutants exceeding ambient environmental standards.

[3] pH = measure of acidity level, with 7.0 being neutral and values above 7.0 increasingly alkaline.

[4] BOD = Biochemical Oxygen Demand (standard is a maximum value).

[5] COD = Chemical Oxygen Demand (standard is a maximum value).

[6] A class of organic compounds that have one or more hydroxy groups attached to the benzene ring. Most common examples are phenol, cresols, xylenols, resorcinol, and naphthols. (*The Condensed Chemical Dictionary*).

[7] n-Hexane = saturated aliphatic hydrocarbon.

[8] Cyanide compounds exist in many forms; for example, hydrogen cyanide can be recovered from coke oven gas. (*The Condensed Chemical Dictionary*).

Source: Adapted from Yutaka Ishimitsu, "Environmental Pollution Control in Japan," paper presented at meeting of OECD Steel Committee, Paris, Oct. 26, 1992.

Locations where coke ovens operate and where, in some cases, local governments have set standards reportedly stricter than national guidelines are shown in tables 4-14 and 4-15. Data are not available as to the form and number of coke industry-government agreements. It appears that emission standards in Japan do not require use of specific control technologies although certain environmental control procedures have reportedly become industry standards.[72]

The coke industry controls oven emissions in Japan, as in the United States, using essentially the techniques described in chapter 2. Charging emissions are controlled by a combination of gas collection devices. Lid leaks are controlled through sealing, and many batteries reportedly use automatic lid cleaners and closers. Oven door leaks are controlled primarily by self-sealing doors and maintenance programs. Some batteries reportedly still use luted doors. A majority of batteries reportedly use hoods over both the push side and coke side doors to capture more of the emissions that occur as the coke is pushed from the oven into the quench car. One company, Mitsubishi Kasei Corp., has reportedly developed and licensed technologies for "smokeless" pushing and charging to other coke producers in Japan and abroad.[73]

[72] Ibid.

[73] Mitsubishi Kasei Corp., prehearing submission, Sept. 22, 1993.

Water Pollution Emissions

The national emission standards for pollutants particularly related to the steel industry and thus to the coke industry are shown in table 4-4. Local governments have often negotiated stricter emission agreements with coke operations.[74] The treatment of wastewater from coke operations in Japan reportedly often calls for the use of biological treatment processes.[75]

Pollution Abatement Costs

No data are available as to the costs of pollution abatement for the coke industry in Japan. Thus, Japanese costs cannot be compared with the costs shown for the U.S. coke industry in chapter 3. According to the Environment Agency, Japan has used tax incentives, financial assistance, and loans to encourage pollution control.[76] The tax mechanisms reportedly include (1) accelerated depreciation and special capital cost allowances for installing antipollution equipment and (2) favorable treatment for

[74] USITC staff interview with Japan's Environment Agency, Oct. 13, 1993.

[75] Yutaka Ishimitsu.

[76] Japanese Government, Environment Agency, *Establishing a Basic Law on the Environment*, Report of the Central Council for Environmental Pollution Control and the Nature Conservation Council, Oct. 20, 1992.

Table 4-14
Japanese standards for soot and smoke facilities

Prefectures and cities	Coke batteries	Local ordinances and guidelines
Hokkaido	3	Stricter regulation limited to facilities which separate tar and gas-liquid from coke oven gas.(0)
Fukushima	4	Severer SOx emission regulation, and 20% severer NOx emission standards.(G)
Ibaraki	9	Severer SOx emission regulation.(G) Hydrogen cyanide emission standard.(O)
Chiba	18	Total emission control for NOx.(G)
Aichi	8	5 or 20% more stringent NOx emission standards to designated factories.(G)
Hyogo	7	Total emission control for NOx.(G)
Wakayama	6	Severer SOx emission regulation.(O) Standards of chrome, cyanide, etc. at a site boundary of a factory.(O)
Okayama	13	None.
Hiroshima	8	None.
Kagawa	3	None.
Oita	4	Emission standard of SOx by combustion of heavy oil.(O) More stringent emission standards of soot and dust.(O)
Kawasaki city	3	Emission standards per 1,000 calories; soot and dust, and NOx.(O)
Nagoya city	2	Total emission control for SOx.(G)
Osaka city	3	More stringent emission standards.(G)
Kitakyushu city	9	Severer emission standards of NOx.(G)
Total	100	

Key: (O) = ordinance; (G) = guideline

Source: Government of Japan, Environment Agency, data acquired during field work, Oct. 1993. Data as of yearend 1992.

capital gains from the sale of property in pollution-controlled areas if the proceeds are reinvested in noncontrolled areas.[77] No data are available on how much such assistance goes to the coke industry in Japan.

[77] Stephen F. Clarke, *The Tax Treatment of Expenditures on Antipollution Equipment and Facilities in Selected Foreign Countries,* paper read at the Law Library of Congress, conference on Tax and Environmental Policies and U.S. Economic Growth, 1991 symposium series sponsored by the American Council for Capital Formation, Center for Policy Research, Washington, DC, Sept. 12, 1991.

Table 4-15
Japanese standards for particulates-discharging facility

Prefectures and cities	Coke batteries	Local ordinances and guidelines
Hokkaido	3	Regulation of stock yard.(O)
Fukushima	4	None.
Ibaraki	9	Standards of cyanide, fluoride, manganese, and particulates at a site boundary of factory.(O)
Chiba	18	None.
Aichi	8	Regulation of smaller coke oven: over 20 tons per day for raw material.(O)
Hyogo	7	Standards of chrome, cyanide, etc. at a site boundary of a factory.(O)
Wakayama	4	Regulation of stock yard.(O)
Okayama	13	None.
Hiroshima	8	None.
Kagawa	3	None.
Oita	4	None.
Kawasaki city	3	None.
Nagoya city	2	None.
Osaka city	3	None.
Kitakyushu city	8	None
Total	97	

Key: (O) = ordinance; (G) = guideline.

Source: Government of Japan, Environment Agency, data acquired during field work, Oct. 1993. Data as of yearend 1992.

CHAPTER 5
Industry and Market in Other Selected Countries

This chapter examines the coke industry and potential for coke exports in China and the former Eastern bloc. Among the countries of the former Eastern bloc, Poland and the Czech Republic are the only net exporters of coke; therefore, they were chosen for a more detailed study.

China

China's coke industry consists of both merchant and integrated producers, with combined capacity of known byproduct ovens during 1992 of an estimated 57 million[1] metric tons per year. Table 5-1 shows the byproduct coke-making capacity of China's major producers by province, and figure 5-1 is a map of China's main metallurgical coke production facilities.[2]

[1] This figure excludes the output of small batteries whose combined coking capacity is approximately 5 million metric tons per year.

[2] For a complete list of production facilities in China, see International Iron and Steel Institute, *World Cokemaking Capacity* (Brussels, 1993), pp. 71-76.

Table 5-1
People's Republic of China modern coke capacity by Provinces, 1992

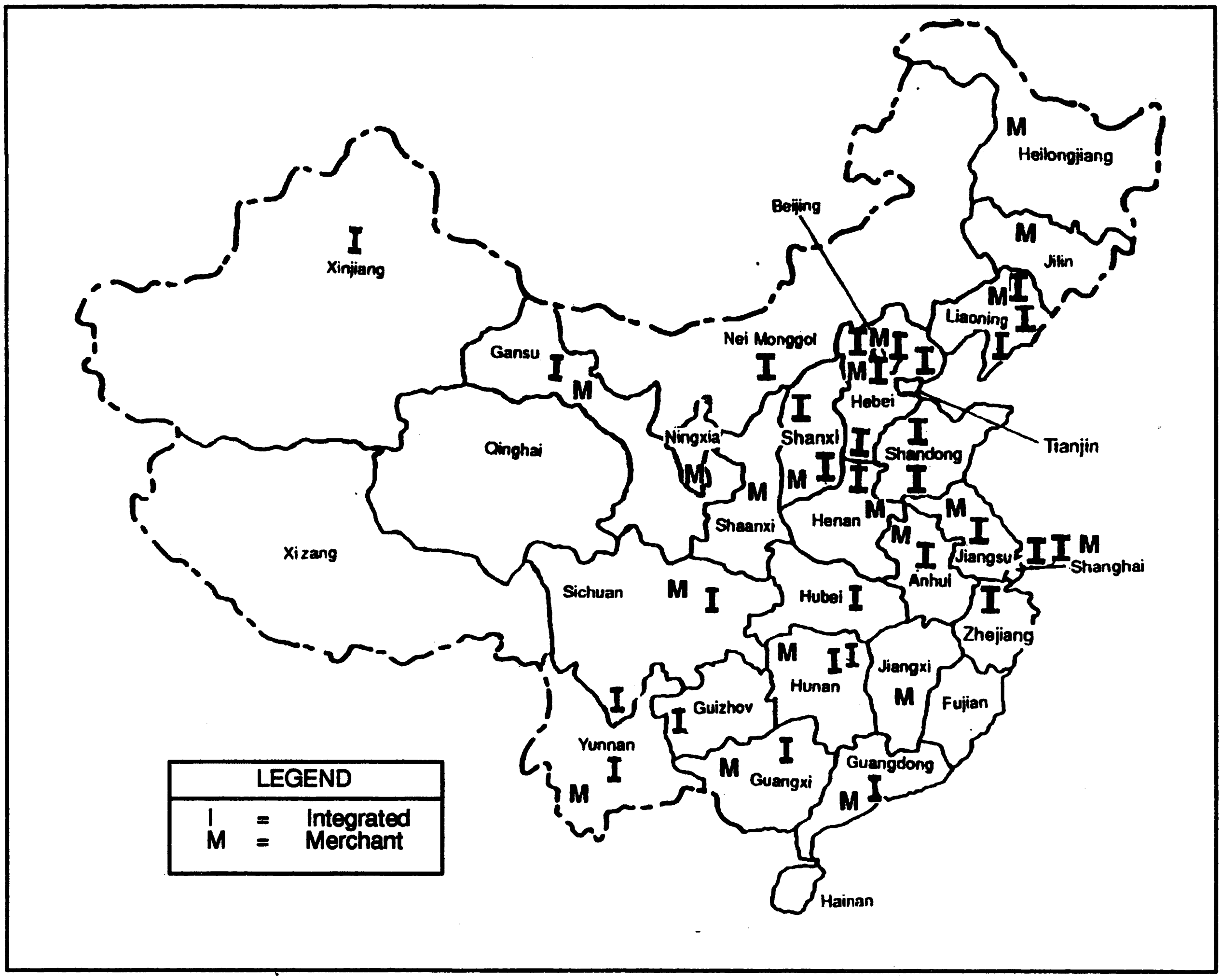
(Million metric tons per year)

Integrated Company	Capacity	Merchant Company	Capacity
Anhui	1.8	Anhui	1.3
Beijing (city)	1.5	Beijing (city)	2.6
Fujian	.4	Gansu	.1
Gansu	.9	Guangdong	.6
Guangxi (city)	.3	Guangxi (city)	.2
Guizhou	.9	Hebei	1.4
Hebei	3.4	Heilongijiang	.9
Henan	.8	Henan	.9
Hubei	3.2	Hubei	.8
Hunan	1.1	Hunan	.2
Inner Mongolia (region)	1.8	Inner Mongolia (region)	.3
Jiangsu	1.2	Jiangsu	.9
Jiangxi	1.2	Jiangxi	.3
Jilin	.6	Jilin	.8
Liaoning	6.9	Liaoning	1.8
Shandong	1.7	Nigxia	.1
Shanghai (city)	3.4	Shandong	.9
Shanxi	.9	Shanghai (city)	2.4
Sichuan	3.6	Shanxi	.3
Xingiang (city)	.3	Shianxi	2.0
Yunnan	.6	Sichuan	.4
Zhejiang	.3	Tanijing (city)	.9
		Yunnan	.6
Total	36.6	Total	20.6
Grand total			57.2

Note.—This table excludes the output of small batteries whose combined dry cokemaking capacity is approximately 5 million tons per year.

Source: IISI, *World Cokemaking Capacity,* (Brussels: IISI, 1993).

Figure 5-1
Geographic distribution of China's coke producers



Source: U.S. Department of the Interior, Bureau of the Mines.

In addition to byproduct production, China also has over 20 million metric tons of "beehive capacity" about which little is known. In Chinese statistics, coke produced in beehive ovens is labelled "antique," whereas coke produced in byproduct recovery ovens is labelled "modern". Ownership of the antique coke production facilities is not clear. Although local governments appear to own these facilities, individual operators often operate them for profit. In general, antique coke is of lower quality and less efficiently produced than modern coke. Nevertheless, the production costs of antique coke are much less, hence, its continued use.[3]

Compared to U.S. coke capacity (figure 5-2), China's integrated[4] oven capacity is relatively young. Almost half of China's capacity is under 10 years of age while only 3 percent is more than 30 years of age. Despite the growing independence of enterprises, government ownership and central planning are still prevalent in the country's heavy industry. The state finances the construction of new steel factories and of matching facilities to produce coke, and provides financial aid to existing firms to expand and modernize.

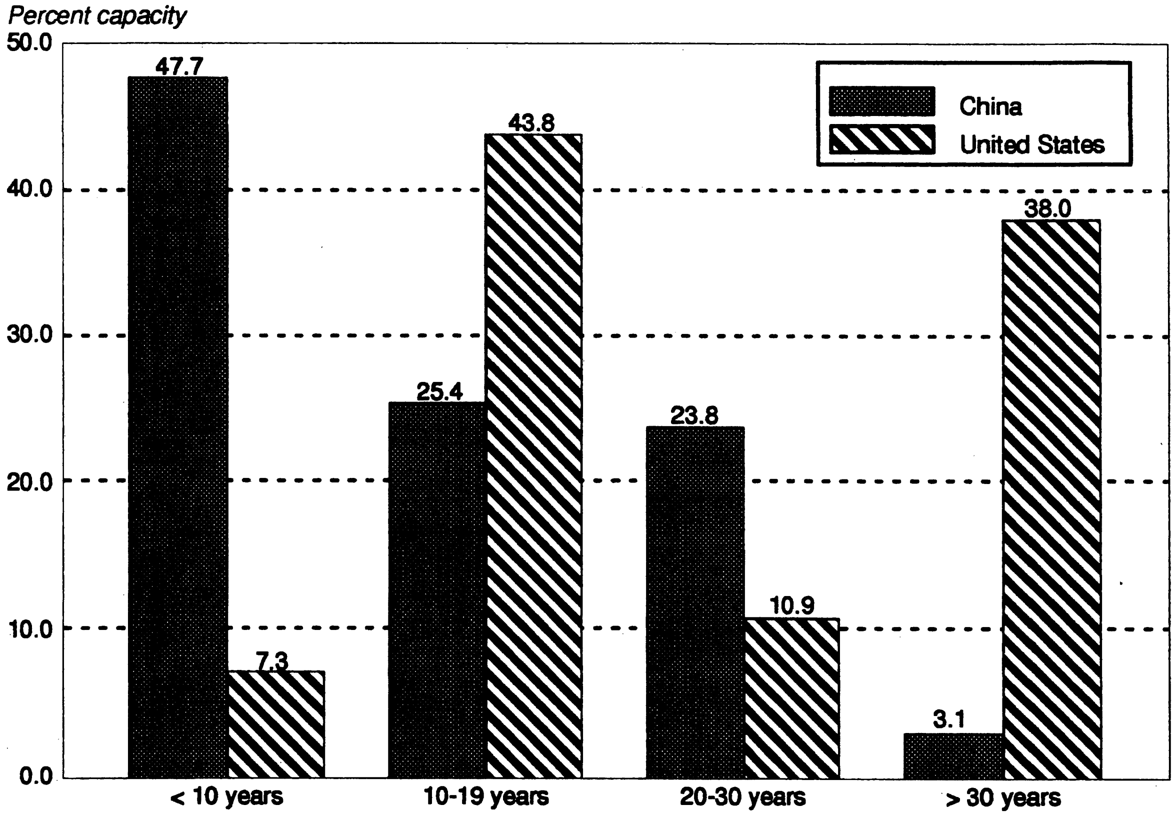
[3] More detailed cost comparisons are presented later.
[4] Oven age is only available for the integrated ovens.

Production

Although modern coke has gradually come to dominate China's total supply, antique coke production has remained significant. Most of the antique coke is used locally for home heating, but some of it is sold to steel mills. During 1991-93, the metallurgical industry produced about 53 percent of the national coke supply, all of which was modern coke. The remainder is produced in the chemical and construction industries, and in villages.

Table 5-2 shows China's total coke (that is, metallurgical and other coke) production by modern

Figure 5-2
Coke oven age: Relationship between Chinese and U.S. ovens



Source: IISI, *World Cokemaking Capacity*, (Brussels: IISI, 1993).

Table 5-2
Chinese coke production, by types, 1980, 1985, and 1990-93
(Million metric tons)

Year	Modern	Antique	Total
1980	34.05	9.38	43.43
1985	38.36	9.66	48.02
1990	51.30	21.98	73.28
1991	53.98	19.56	73.54
1992	58.00	20.00	78.00
1993 (forecast)	61.38	21.00	82.38

Source: Lawrence Berkeley Laboratory and the Energy Research Institute of China, *China Energy Book*, July 1992, p. II-26; China energy specialist, Lawrence Berkeley Laboratory, interview with USITC staff, Dec. 2, 1993. "Antique" coke production for 1992 and all production figures for 1993 are estimates.

and antique methods for 1980, 1985, and 1990-93. Figure 5-3 shows the country's coke production and consumption during 1985-92. In response to energy shortages in the country during the early 1980s, the authorities deregulated the operation of coal mines. The deregulation led to increased coal production for local use and is associated with a jump in antique coke production during the second half of the 1980s.[5]

The condition and technological level of ovens producing modern coke range widely. From 1985 to 1990, investment to expand and modernize coke production increased by an estimated 150 percent in constant prices.[6] The share of capital investment in coke facilities within the coal subsector (including coke, coal gas, and coal products) increased from 11.9 percent during 1985, to 32.1 percent during 1989. The authorities would like to see more modern coke and less antique coke produced,[7] but what measures they will take to achieve this goal are unknown.

The government is concerned about the environmental impact of coke production.[8] Since the mid-1980s, the authorities have tried to reduce and to control pollutant emissions and the effluent that are polluting ground and surface waters and which are incidental to the operations of integrated steel companies.[9] However, analysts widely believe that environmental protection measures do not affect coke production at integrated steel companies in China as much as they do in the developed countries. Moreover, producers of antique coke are apparently not influenced by either economic or administrative means to abide by pollution control standards.[10]

Consumption

During 1991-93, the metallurgical industry consumed (used or exported) 70 percent of total coke production; households, the chemical industry, mechanical industry, construction, and other industries accounted for the remaining 30 percent.[11] Beyond use in blast furnaces, steel mills in China also use coke breeze extensively for sintering.[12]

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[5] China energy specialist, Lawrence Berkeley Laboratory, interview with USITC staff, Dec. 2, 1993.

[6] Lawrence Berkeley Laboratory and the Energy Research Institute of China, *China Energy Book*, July 1992, pp. III-23 and III-28.

[7] China energy specialist, Lawrence Berkeley Laboratory, interview with USITC staff, Aug. 24, 1993.

[8] China specialist, East-West Center, interview with USITC staff, Dec. 6, 1993.

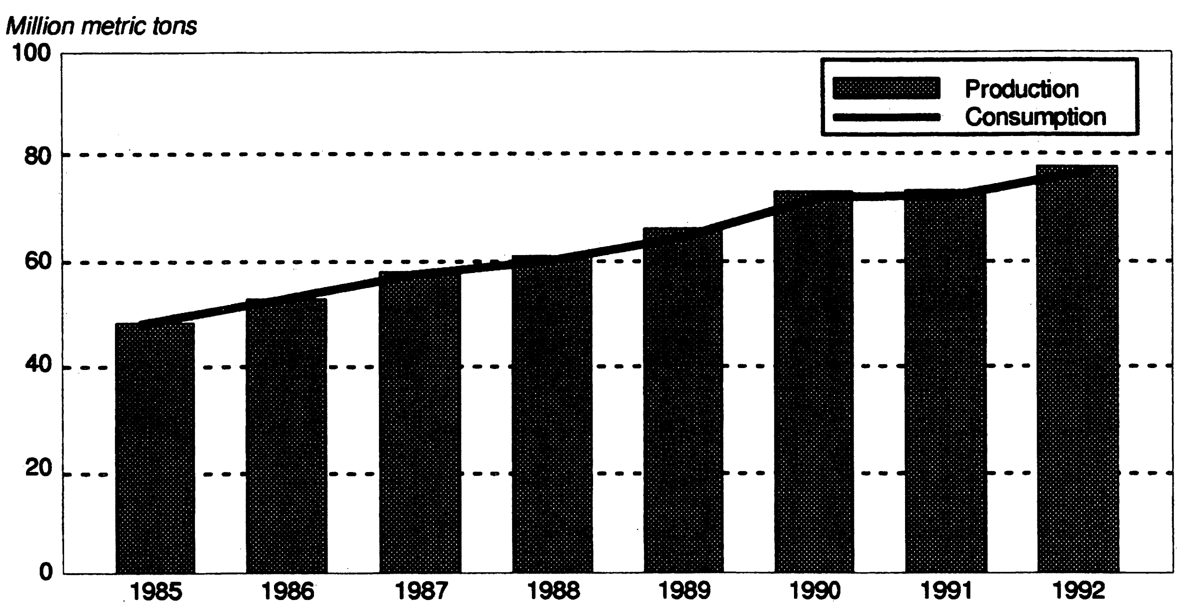
[9] U.S. Department of the Interior, Bureau of Mines (Mines), *The Iron and Steel Industry of China*, Mar. 1990, p. 16.

[10] China specialist, East-West Center, interview with USITC staff, Aug. 24, 1993.

[11] East-West Center, consultants on the Far East to the U.S. Department of Energy, Honolulu, Hawaii, facsimiles, received by USITC staff on Aug. 24, 1993, and on Dec. 14, 1993.

[12] McCloskey Coal Information Service, *PCI and Coke: Market Impacts of Changing Steel Technologies*, Aug. 1993, p. 29.

Figure 5-3
China's production and consumption of coke[1], 1985-92



[1] Includes metallugical and other types of coke.

Source: United Nations, *Energy Statistics Yearbook*; and Lawrence Berkeley Laboratory and the Energy Research Institute of China, *China Energy Book*.

Led by the planned expansion of steel production, metallurgical coke consumption is expected to continue to rise rapidly until at least the end of the decade. The following tabulation shows China's crude steel output during 1980, 1985, and 1990-92, and estimates for 1993, 1995, and 2000 (*million metric tons*):[13]

1980	1985	1990	1991	1992	1993	1995	2000
37.1	46.8	66.4	71.0	80.0	86.6	86.2	112.1

Major new steel plants to be completed during the 1990s include Jinang, Meishan, Shijiuso, Zhanjiang, Baoshan, and Zhenjaing.[14] After the year 2000, the expansion of steel capacity is likely to slow down or stop.

Based on the authorities' strong commitment to increase steel production, China will continue to build coking capacity to meet blast furnace needs.[15] In the past, the annual increase in metallurgical coke production paralleled the needs of its expanding steel industry.[16] Even if this trend continues, it remains hard to foretell the level of domestic demand for coke even at the end of this decade. This demand depends largely on the technological characteristics of steel mills scheduled to come into operation by the end of the decade and on the extent of modernization of existing steel plants. Modernization of the steel sector, leading to a reduction in demand for coke per unit of steel output, may or may not be significant during the ensuing years. Unlike other major steel-producing countries, China is not expected to increase significantly the share of steel produced by electric arc furnaces. The ratio of steel produced by these furnaces, which amounted to 21.1 percent during 1990, is projected to grow only to 22.3 percent by the year 2000.[17] However, pulverized coal injection, now at a relatively low level in China, could increase by the end of the current decade, moderating demand for coke.[18] The modernization in China's steel industry depends to a great extent on the amount of foreign capital that the sector will attract. Estimates for the steel industry's annual demand for coke by the year 2000 range from 62 million metric tons[19] to the neighborhood of 78 million metric tons.[20] Without serious conservation efforts, nonmetallurgical uses of coke may increase from an annual level of 23 million metric tons during 1991-93 to 34 million metric tons by 2000, pushing total demand for coke to between 85 and 112 million metric tons per year by 2000.[21]

[13] *Statistical Yearbook of China*, 1992, p. 441. The 1993 data are forecasts based on January-June 1993 data. For 1995 and 2000 estimates, see McCloskey, p. 6.

[14] PaineWebber, *World Steel Dynamics*, No. 19, May 1993, p. 41.

[15] McCloskey, p. 43.

[16] Mines, *The Iron and Steel Industry of China*, p. 5.

[17] McCloskey, p. 5.

[18] Ibid.

[19] Ibid.

[20] Calculation based on data provided by the East-West Center, Aug. 24, 1993.

[21] East-West Center, facsimile, Aug. 24, 1993.

Trade

China, currently not an importer of coke, has a two-tier tariff system. A minimum tariff of 6 percent ad valorem is applied to imports from countries with whom China has trade treaties. A general tariff of 11 percent ad valorem is applied against imports from other countries. The following tabulation shows China's coke exports during 1985-93 (*million metric tons*):[22]

1985	1986	1987	1988	1989	1990	1991	1992	1993(e)
0.37	0.46	0.61	1.03	1.66	1.30	1.08	1.08	2.00

At present, China's main coke export market is Brazil; other destinations include Japan, India, Western Europe, the United States, and Peru.

In 1993, the United States imported approximately 12,000 metric tons of coke from China with a value of $676,000, yielding an average unit value of about $57 per metric ton.[23] An undetermined portion of these shipments consisted of foundry coke, as China is marketing good foundry coke in the United States at very competitive prices.[24] During the rest of this decade, low domestic costs should allow Chinese coke producers to maintain a strong price-based competitive position. The growing role of market forces and profits in China's economy, along with increasing entrepreneurship, may help China's coke exporters to gain shares in international markets.

The growing domestic demand for coke, prompted by expanding Chinese steel production, and the lack of adequate rail transportation and port infrastructure will retard China's ability to increase its coke (as well as coal) exports in the near future.[25] Despite rapid progress during the past decade, some of the country's coastal areas remain inaccessible to rail traffic, and seaport capacity is stretched to the limit. Nevertheless, the authorities have ambitious plans to eliminate this trade bottleneck.[26]

Taking all these factors into consideration, China's annual capacity to export good coke will most likely be in the range of 1.0-3.0 million metric tons during 1994-96, and will increase to 2.5-4.5 million metric tons by the end of the decade.[27]

[22] Lawrence Berkeley Laboratory and the Energy Research Institute of China, *China Energy Book*, July 1992, p. VI-3; East-West Center, facsimile, Dec. 14, 1993. The 1992 and 1993 figures are estimates.

[23] Based on official trade statistics of the U.S. Department of Commerce. USITC questionnaire data collected for this study indicate that the value and unit value of these imports are considerably higher.

[24] USITC staff interviews with officials of the domestic coke industry.

[25] Ibid.

[26] Mines, *Mineral Industries of Asia and the Pacific*, 1990, p. 85; China specialist, Mines, interview with USITC staff, Aug. 4, 1993.

[27] East-West Center, facsimile, Dec. 14, 1993. See also, PaineWebber, p. 133.

Prices and Costs

The prices of some inputs used in coke production (for example, the price of electricity and transportation), may still be subsidized by the state. Similarly, the prices of some coke byproducts sold by integrated steel companies to government entities (for example, coke oven gas sold as town-gas blend to municipal governments) may also not be sold at market-generated prices.[28] Such distortions prevent the calculation of meaningful production costs.[29] However, it appears that prices charged in domestic transactions involving coke are not directly regulated by the state and market forces might play some role in these transactions.

It appears that at present the pollution control costs imposed by the authorities on the coke industry as a whole do not resemble those imposed on coke producers in developed countries.[30] This may mean a current temporary cost advantage for China's coke producers and exporters. However, any cost advantage stemming from differing environmental standards may gradually disappear. Analysts expect a forceful emergence of environmental consciousness in China early during the next decade.[31]

During the second half of 1993, the average cost for integrated companies to produce 1 ton of good modern coke ranged from 346 yuan ($60 at the official exchange rate and $38 at the black market rate) to 400 yuan ($69 at the official exchange rate and $44 at the black market rate).[32] The price of coke in domestic transactions is estimated to be in the range of 363-420 yuan per ton ($40-47). In Shanxi Province, where there is significant antique coke production, the cost of producing 1 ton of antique coke was estimated at 34 to 35 yuan ($4) with selling prices ranging between 46 ($5) and 55 yuan ($6) per ton.[33] The major reasons for the difference are capital costs and coal prices. The costs for building one annual ton of byproduct coke capital costs of producing modern coke in byproduct ovens significantly exceed those of producing antique coke in beehive ovens. According to the estimates of the East-West Center, during 1993, the average capital capacity was 600 yuan ($67) for modern coke and 40 yuan ($4) for beehive coke facilities.[34] The average annual rate of depreciation for coke facilities in China is reported to be 10 percent.

The difference between the costs of antique and modern coke encourages integrated steel companies to export their internally produced, good modern coke to the extent that they can compensate for such a reduction from their internal supply by buying acceptable-quality antique coke. During 1992, export prices (f.o.b. Chinese port) averaged $71 per metric ton, and ranged from $65 per metric ton to $110 per metric ton.[35] During the first 8 months of 1993, the average export price was $66 per metric ton, but some Chinese coke was sold for $75-80 per metric ton during the period. Coke for export appears of relatively low quality and is priced accordingly.[36]

The Former Eastern Bloc[37]

Serious problems beset the metallurgical coke producers in the former Eastern bloc.[38] The command economy of the communist period overdeveloped the steel industry, which resulted in significant cokemaking capacity and production in the region. The growing strength of market forces since 1989 has shown the regional steel industry to be oversized, antiquated and facing significant decline.[39] The steel capacity that survives is expected to be technologically advanced and to use less and less coke per unit of steel output, as in the rest of the cokemaking world. Consequently, regional demand for coke is projected to decline.[40]

The communist regimes placed little emphasis on environmental protection. As a result of market reforms, the costs of regional environmental cleanup

[28] China specialist, Mines, interview with USITC staff, July 28, 1993; China energy specialist, Lawrence Berkeley Laboratory, interview with USITC staff, Aug. 24, 1993.

[29] State subsidies through low input prices and capital grants artificially reduce the cost of coke production, whereas artificially low byproduct prices increase them.

[30] East-West Center, facsimiles, Aug. 24, 1993 and on Dec. 14, 1993.

[31] Ibid. and China specialist, East-West Center, interview with USITC staff, Dec. 14, 1993.

[32] China specialist, East-West Center, interview with USITC staff, Dec. 20, 1993. The official exchange rate used to convert dollar earnings into the domestic currency was 5.8 yuan to the dollar, and the average black market rate was 9 yuan to the dollar. Firms in China use the black market rate to evaluate the dollar costs of domestic resources (China specialist, East-West Center, interview with USITC staff, Nov. 3, 1993). In early 1994, the official rate was moved to nearly coincide with the 1993 black market rate. For the remainder of the text, the black market rate is used to convert yuan prices into dollars.

[33] Ibid.

[34] East-West Center, facsimiles, Aug. 24, 1993. Capital costs for expanding modern coke capacity ranged from 250 yuan/ton to 1000 yuan/ton ($28 to $111) during 1993. Ibid.

[35] PaineWebber, p. 25 and East-West Center, facsimile, Dec. 14, 1993.

[36] USITC staff interviews with officials of the domestic coke industry.

[37] The former Soviet republics, the Baltic States, and the countries of Central and Eastern Europe (Albania, Bulgaria, the Czech Republic, Hungary, Poland, Romania, and the Slovak Republic.)

[38] 38 Specialist on the former Eastern bloc, Mines, interview with USITC staff, July 6, 1993; PaineWebber, p. 96.

[39] Statements by representatives of former Eastern bloc countries to the steel seminar held at the Organization for Economic Cooperation and Development (OECD), Oct. 25 and 26, 1993. Specialist on the former Eastern bloc, Mines, interview with USITC staff, July 6, 1993; Economic Commission for Europe, *The Steel Market in 1991*, ECE/STEEL/78, New York, 1992, p. 45.

[40] Specialist on the former Eastern bloc, Mines, interview with USITC staff, July 6, 1993.

and protection will pass gradually onto the producers and consumers of environmentally damaging products.[41] The cost and price of coke should increase with the installation of capital equipment designed to reverse environmental degradation. Market forces that allow higher coke prices are expected to encourage use of less and less of the product in the former Eastern bloc. Table 5-3 shows coke production in the former Eastern bloc during 1991 and 1992, which is believed to be 30 percent lower than peak output of the early 1980s. Metallurgical coke represents an estimated 70 percent of total coke production in each country. The remaining coke is used mainly as household fuel.

Although Russia and Ukraine are the largest regional producers of coke, the prevailing legal-administrative uncertainties throughout the former Soviet Union mean that even the government agencies within these countries lack reliable coke industry data.[42] Time series data were disrupted for the former Soviet Union when the country dissolved in 1991. Although U.S and other non-Soviet analysts have studied the oil and gas sectors of the former Soviet republics, they have largely ignored the local coke industries.

Beyond token quantities, Russia and Ukraine have not sold metallurgical coke outside the former Soviet Union.[43] Both countries imported metallurgical coke from Poland until 1992. The position of these countries in future metallurgical coke trade is unclear. Although traders doubt that the former Soviet republics can take a great role in the world coke market in the near future, other sources maintain that the annual coke surplus in the former Soviet republics as a bloc could amount to 4.7 million metric tons during 1995, and to 7.9 million metric tons by 2000.[44]

Poland

The Polish coke industry is composed of both merchant and integrated producers, and some of the production of the integrated producers is currently sold on the open market. The industry is concentrated in southern Poland near the coal reserves of the Silesian Basin (figure 5-4). Total coke-making capacity reached 20 million metric tons per year during the 1980s, with merchant coking capacity estimated at 5-8 million metric tons per year during that period. Significant reductions in capacity have occurred in recent years, yielding current capacity of approximately 13.3 million metric tons (table 5-4). Capacity utilization has been around 80 percent of operating and hot idle facilities over the past 2 years. The majority of Poland's coke oven capacity was built during the last 10 years (58 percent) with relatively little capacity (11 percent) over 20 years of age (figure 5-5). The majority (79 percent) of Poland's oven

[41] Statements by representatives of former Eastern bloc countries to the OECD steel seminar, Oct. 25 and 26, 1993.

[42] "At present, a study on the coke industries of the former Soviet states would amount to a study on the obstacles to do such a study." Chief executive of a London-based coal and coke trading company, interview with USITC staff, Sept. 9, 1993. See also McCloskey, p. 42.

[43] During 1992, the coke-producing countries of the former Soviet Union exported 31 mt to Germany. International Legal Counsel, facsimile, received by USITC staff on Sept. 9, 1993.

[44] Chief executive of a London-based coal and coke trading company; McCloskey, p. 43.

Table 5-3
Production of coke in the former Eastern bloc, 1991-92

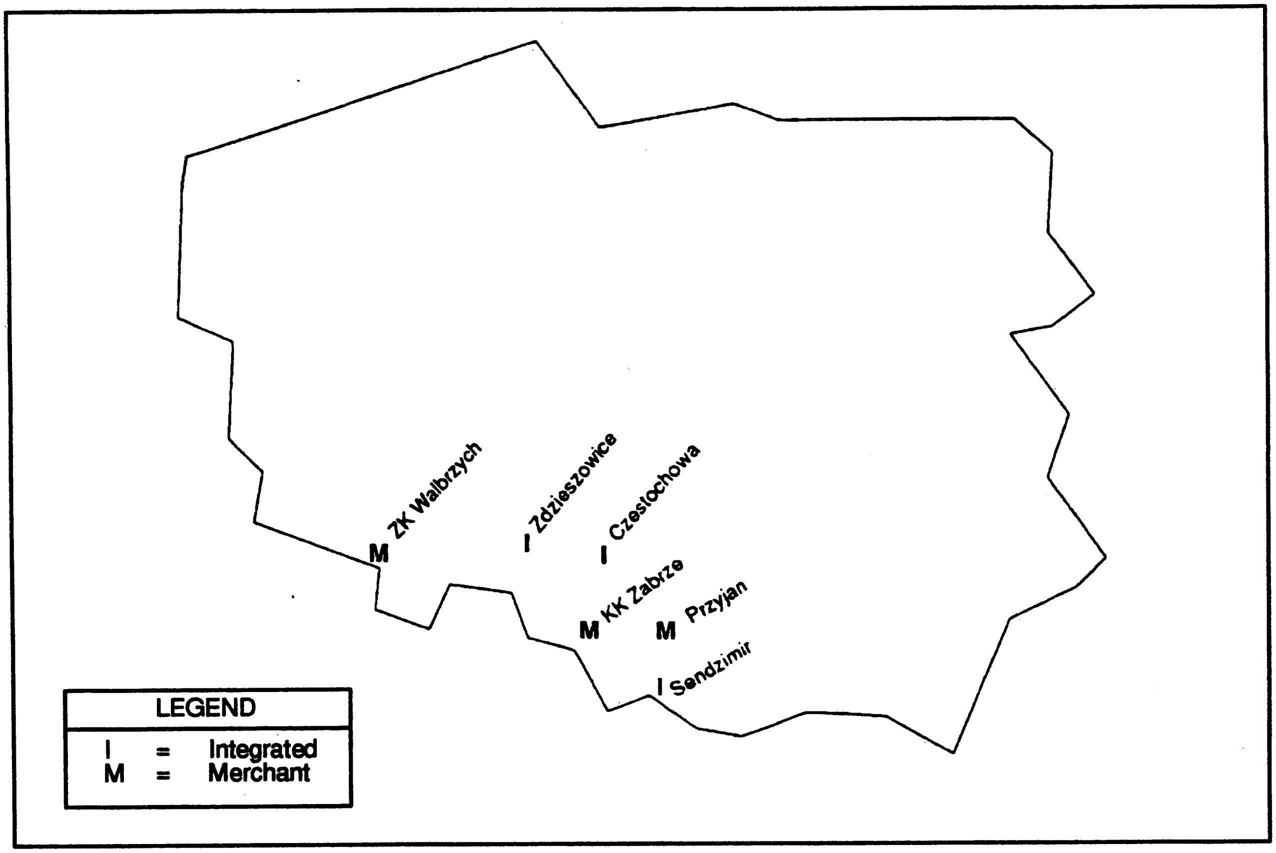
(Million metric tons)

Region/Country	1991	1992
Central and Eastern Europe:		
Former Czechoslovakia	8.6	7.6
Hungary	0.9	0.9
Poland	11.4	11.0
Romania	2.7	3.0
Subtotal	23.6	22.5
Former Soviet republics:		
Russia	32.6	30.6
Ukraine	28.4	27.5
Kazakhstan	3.4	3.2
Georgia	0.3	0.2
Subtotal	64.7	61.5
Total[1]	88.3	84.1

[1] Because of rounding, figures may not add to the totals shown.

Source: AISI, facsimile, received by USITC staff on Aug. 17, 1993.

Figure 5-4
Geographic distribution Poland's coke producers



Source: Coal-Chem Engineers and Consultants.

capacity is under 20 years of age while approximately half (51 percent) of U.S. oven capacity is under 20 years old.

Although the legislature has approved guidelines for the privatization of metallurgical enterprises, all coke-making facilities remain state owned. The actual privatization of metallurgical companies has been slowed by widespread industry bankruptcies and difficult labor-management relations. Privatization is unlikely to separate the ownership of integrated coke facilities from the ownership of the rest of an integrated steel works.[45] However, if any integrated steel firm is liquidated, its coke-making facilities may survive as an independent enterprise.[46]

[45] Coal-Chem engineers and consultants, Pyskowice, Poland, interview with USITC staff, Nov. 10, 1993. In Mexico and Germany, where the privatization of the respective steel sectors has been recently completed, coke facilities became the property of the same group that purchased the steel works. Mexican and German delegates to the OECD steel seminar, interview with USITC staff, Oct. 26, 1993.

[46] Coal-Chem Engineers and Consultants, Nov. 10, 1993.

Production

The following tabulation shows Poland's coke production during 1985-92 and its estimated level during 1993 (*million metric tons*):[47]

1985	1986	1987	1988	1989	1990	1991	1992	1993(e)
16.6	17.0	17.4	17.4	16.9	14.1	11.4	11.0	9.8

About 70 percent of the country's total coke output may be considered metallurgical coke.[48] The rest is coke used mainly to heat homes, a market segment in which both blast furnace coke plants and merchant coke producers are active. The country's coke production and consumption were fairly consistent throughout the 1980s, but both declined abruptly in the early 1990s because the country experienced its worst economic downturn since World War II (figure 5-6). Inventories of coke in Poland's steel industry are in the 100,000-to-200,000 metric ton range.[49]

[47] Mines, *1991 Minerals Yearbook*, vol. 3, *Mineral Industries of Europe and the U.S.S.R.*, July 1993, p. 209.

[48] USITC staff interviews, Sept. 20, 1993.

[49] International Energy Agency analyst, interview with USITC staff, Oct. 27, 1993.

Table 5-4
Poland's coke producers and capacities, 1992

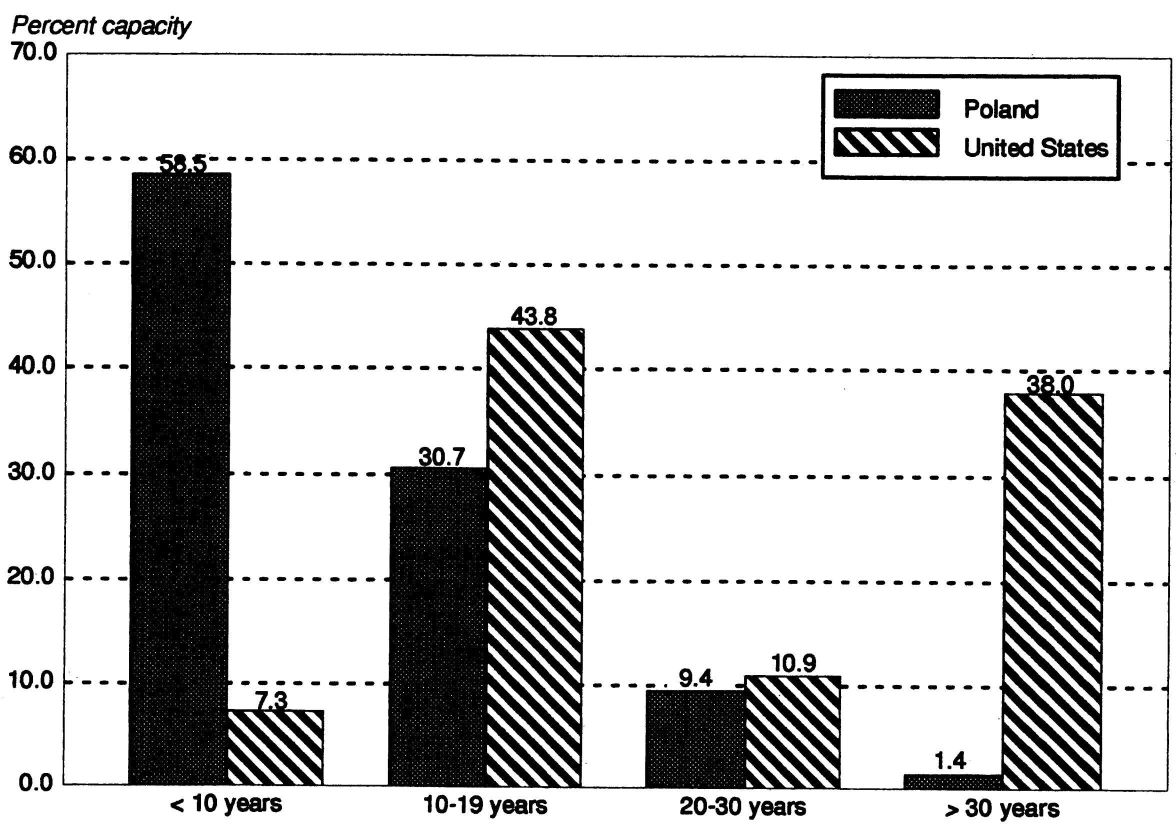
(Million metric tons per year)

Integrated Company	Capacity	Merchant Company	Capacity
Zdzieszowice	4.3	Przyjan	2.3
Sendzimir	1.4	KK Zabrze	2.0
Czestochowa	1.0	ZK Walbrzych	1.3
Bobrik[1]	.4		
Kosciusko[1]	.6		
Total	7.7	Total	5.6
Grand total			13.3

[1] Coke-making facilities at Bobrik and Kosciusko were closed in 1993 and 1992, respectively.

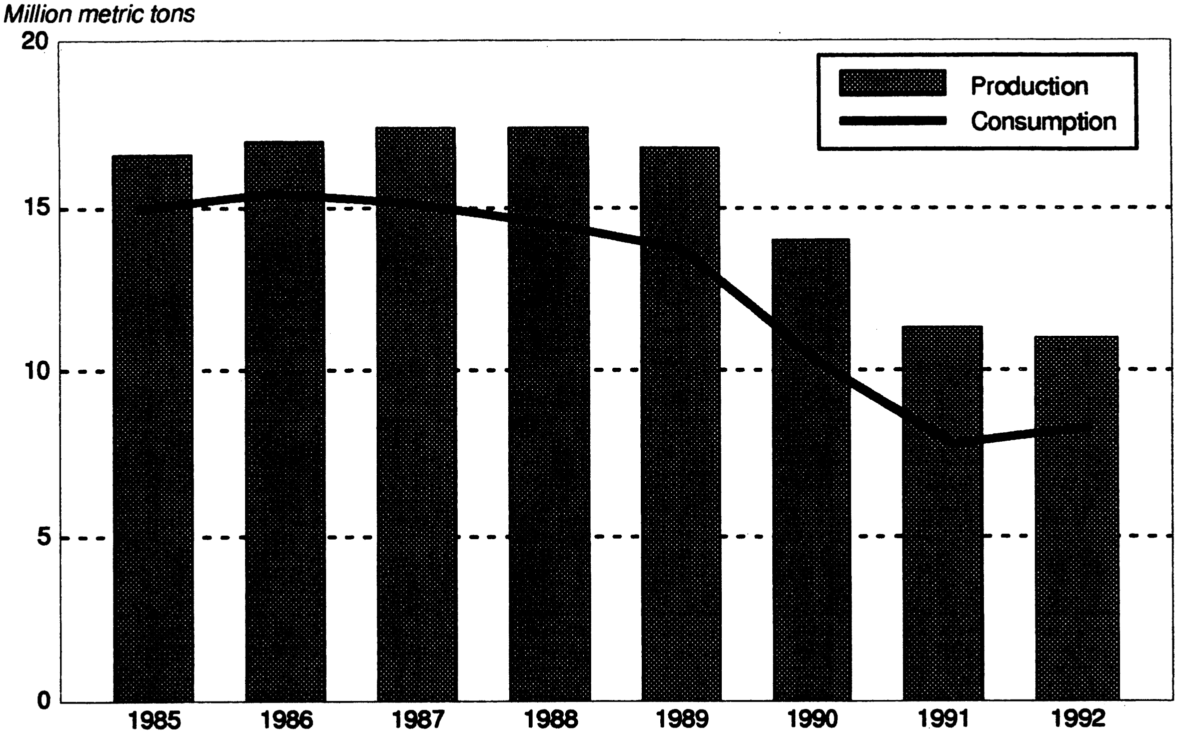
Source: IISI, *World Cokemaking Capacity*, and discussions with Polish industry officials.

Figure 5-5
Coke oven age: Relationship between Polish and U.S. ovens



Source: IISI, *World Cokemaking Capacity*, (Brussels: IISI, 1993).

Figure 5-6
Poland's production and consumption of coke[1], 1985-92



[1] Includes metallugical and other types of coke.

Source: United Nations, *Energy Statistics Yearbook*; the International Iron & Steel Institute; and the U.S. Department of the Interior, Bureau of the Mines.

During 1988-91, coke output was declining while coke exports were increasing. Although both output and exports declined during 1992-1993, Poland's coke production capacity in the future is projected to decrease less than domestic demand, allowing continued exports. The gradually increasing enforcement of higher environmental standards is raising the costs of coke production through pollution taxes or through capital expenditures aimed at avoiding the need to pay such taxes.[50]

Over one-half of Poland's coke-making capacity consists of side-charged batteries.[51] In such batteries, the opening of doors in the course of loading and unloading requires the simultaneous removal of top lids, substantially increasing the quantity of harmful emissions.[52] Technical factors make it hard, though not impossible, to convert a side-charged battery to top-charging.[53] Some of the country's coke batteries use the dry quench process that, according to U.S. experts, produces good coke.

Most Polish coke batteries are fairly new, but still may need much upgrading, replacement, or even closing to reduce emissions of particulates and volatile toxic organic compounds. Reducing toxic organics in coke-making effluents and water treatment at certain facilities is a priority. Western consultants hired by the Polish Government have recommended the closing of a number of coke ovens because they are simply uneconomic.[54] It is unclear whether this advice will be followed, and if so when the shut-downs would take place.

Consumption

Poland's steel industry is technologically out-of-date, and consumption of coke, following steel production, declined steadily throughout the late 1980s and early 1990s, before rebounding slightly in 1993, as shown by the following tabulation of steel production (*million metric tons*):[55]

1987	1988	1989	1990	1991	1992	1993(e)
17.1	16.9	15.1	13.6	10.4	9.8	10.5

[50] For details on Poland's environmental problems and measures taken by the government to deal with them, see Mines, *1991 Minerals Yearbook*, vol. 3, p. 209; International Energy Agency, *Energy Policies, Poland, 1990 Survey*, Paris 1991, p. 127.

[51] USITC staff interviews, Oct. 14, 1993.

[52] U.S. Environmental Protection Agency, facsimile, received by USITC staff on Sept. 28, 1993.

[53] Ibid.

[54] USITC staff interviews, July 12, 1993.

[55] Mines, *1991 Minerals Yearbook*, vol. 3, p. 209; presentation of the Polish delegation to the OECD steel seminar.

The country's steel capacity is projected to decline by 39 to 50 percent from 1993 to 2002.[56] In 1992, the Polish Government launched a 10-year plan to achieve this goal while simultaneously modernizing and privatizing the steel industry.[57] The modernization will raise the ratio of steel produced in electric arc furnaces from 19 percent during 1993 to 37 percent during the year 2000, so that the domestic consumption of coke will decline more than steel capacity during the remainder of the decade.[58] Although at present Polish steel mills do not use the technology of pulverized coal injection into blast furnaces, a number of them contemplate introduction of this technology.[59]

In the foreseeable future, some Polish steel producers are expected to maintain coke capacity over and above their internal requirements. Then blast furnace producers are expected to export more coke or to produce more home-heating type of coke for the domestic market. However, Poland's coke surplus is projected to reach only about 1.1 million metric tons during 1995 and 1.2 million metric tons during the year 2000.[60]

Trade[61]

Exports of coke fluctuated in recent years, peaking at 3.7 million metric tons during 1990 and declining to 2.0 million metric tons during 1993. The following tabulation shows Poland's coke exports during 1985-93 (*million metric tons*):[62]

1985	1986	1987	1988	1989	1990	1991	1992	1993
1.64	1.58	2.26	2.85	3.15	3.70	3.50	2.64	2.00

The decline during 1992-93 is likely because of the drop in shipments to the former Soviet republics, primarily to Russia and Ukraine. Currently most of Poland's coke is exported to Western Europe (Germany, Austria, Belgium, the United Kingdom) and Brazil. Export transactions are conducted mainly by international coke-trading companies.

Polish coke exports to the United States have been sporadic during the past 10 years: 13,923 metric tons in 1984 and 107,643 metric tons in 1989. According to industry sources, Inland Steel contracted in 1993 for the purchase of 40,000 metric tons of coke from Poland, and the shipment was reportedly landed in early 1994.

Prices and costs

In Poland, the ex-factory price of metallurgical coke is estimated to be twice the price of the coal blend used.[63] During the second quarter of 1993, the average price of the coal blend was 617,300 zlotys per metric ton or $36.52. Consequently, the average price of metallurgical coke was about $73. By yearend, as a result of sharp increases in the price of coal in August, the average price of metallurgical coke rose to 1.9 million zlotys or about $90 per metric ton.[64]

The Ministry of Environmental Protection imposes taxes on coke producers for emissions of sulfur dioxide, nitrogen oxide, benzene, etc. Pollution taxes are expected to increase in an effort to meet European Union environmental standards toward the end of the 1990s.[65] Currently, environment-related investments are limited to small projects, such as new equipment and better sealed systems. However, a number of producers are planning fundamental improvements through the construction of new batteries. Both environmental taxes and capital investment are raising the costs of coke production. Coke producers complain of frequent and erratic changes in tax regulations.[66]

Although the sporadic increases in the price of coal reduce the profitability of coke exports, the continued devaluation of the zloty tends to restore financial performance. Analysts maintain, at least during 1993, that the depreciation of the Polish currency was roughly at par with the overall increase in the domestic price level.[67] Nevertheless, this process creates an uncertainty of profits in coke operations.[68]

Total shipping costs from the Silesian plants to U.S. east coast ports are in the range of $20-$30 per ton.[69] The total is composed of overland (rail) costs, estimated to be in the range of $12 to $15 per metric ton, and overseas shipping from the Baltic ports to U.S. destinations, estimated to be in the range of $8 to $15 metric ton.[70]

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[56] Ibid.

[57] Ibid.

[58] McCloskey, p. 24. For example, The Warsaw Steelworks, in which Lucchini Siderurgica S.p.A. (Lucchini) of Italy owns the majority of stocks, intends to replace some of its open-hearth furnaces with two electric arc furnaces. Mines, *1991 Minerals Yearbook*, vol. 3, p. 209.

[59] McCloskey, pp. 51 and 58.

[60] McCloskey, p. 42.

[61] Poland does not have a history of importing coke. Any such imports would face a 7-percent value added tax.

[62] United Nations, *Energy Statistics Yearbook*, 1983-90; Polish national statistics.

[63] USITC staff interviews, Nov. 8, 1993. The variation around this average is not known. According to some sources this variation may be significant. Since some of Poland's coke batteries have been completely written off, their operation does not entail capital costs. Average annual depreciation rates are believed to be 5-percent per annum.

[64] The exchange rate of the Polish currency was 16,904 zlotys to the dollar during the second quarter and 21,000 to the dollar in December 1993.

[65] The Economist Intelligence Unit, *Business Eastern Europe*, May 24, 1993, p. 4.

[66] USITC staff interviews, Jan. 10, 1993.

[67] PlanEcon analyst, interview with USITC staff, Dec. 20, 1993. As a result of devaluation being roughly proportional with price inflation, the dollar prices of inputs remained approximately unchanged during 1993.

[68] In addition to one-time, large devaluations, the Polish currency is also subject to a regular monthly, so-called crawling-peg devaluation of 1.6 percent.

[69] International Energy Agency official, interview with USITC staff, Nov. 5, 1993; USITC domestic interviews, Nov. 8, 1993.

[70] Ibid. For a description of Poland's main coal exporting ports, see International Energy Agency Coal

Czech Republic

The Czech Republic's coke industry comprises both merchant and integrated producers, all state-owned. Coke-making capacity in Czech regions peaked at 8-10 million metric tons per year during the 1980s, before declining to 6.2 million metric tons in 1993 (table 5-5). During 1993, capacity utilization was 85 percent of operating and hot idled facilities. A number of batteries have recently shut down as a result of declining demand and the rising cost of coke production.[71]

Integrated steel companies produce for both their own use and for sale to other steel companies. Merchant coke producers are associated with coal mines. They produce both metallurgical and other types of coke. All production capacities are in the Ostrava region (figure 5-7). Although most of the coke produced in the Czech Republic comes from relatively new ovens (figure 5-8) and some of which is of high-quality, the country's coke-making facilities badly need modernization and the installation of environmental control equipment. More than one-half of the country's batteries are the heavily polluting side-charging types.[72]

Production

The bulk of former Czechoslovakia's coke production took place in the Czech regions. Following the breakup of the country on January 1, 1993, the Czech Republic inherited cokemaking capacity that exceeded its declining domestic demand. As in the case of Poland, cokemaking capacity is expected to decline to less than steelmaking capacity, allowing for a margin of exportable surplus. The costs of coke production will likely increase as new standards to reduce the level of sulfur dioxide and nitrogen oxide emissions by coke ovens are expected as an environmental cleanup has begun.[73].

After peaking at 8.5 million metric tons in 1988, the Czech Republic's coke production has steadily declined to an estimated 5.3 million metric tons in 1993. Integrated producers have typically accounted for two-thirds of total production. Whereas integrated companies have produced metallurgical coke exclusively, the merchant sector produces both metallurgical coke and other types of coke. The "other" coke is used primarily for home heating and represents about 30 percent of coke production (table 5-6).

Consumption

As in Poland, Czechoslovakian central planners overestimated the country's need for a steel industry, which the new market forces show now as overbuilt, especially in the Czech Republic.[74] Crude steel output in the Czech Republic has been declining since 1989, as shown in the following tabulation (*million metric tons*):[75]

1989	1990	1991	1992	1993
10.0	9.4	7.6	6.9	6.6

[70]—*Continued*
Research, *Major Coalfields of the World,* IEAACR/51, Jan. 1993, p. 92.

[71] McCloskey, p. 41.

[72] USITC staff interviews, Jan. 11, 1994.

[73] For details, see Joint Publications and Research Service (JPRS), *Eastern Europe,* Sept. 17, 1993, pp. 28-30; International Energy Agency, *Energy Policies, Czech and Slovak Federal Republic, 1992 Survey,* Paris 1992, pp. 99-101.

[74] During 1993, crude steel capacity amounted to 9.1 million metric tons in the Czech Republic and amounted to 4.2 million metric tons in the Slovak Republic. Three of the four integrated steel works, Trinec, Nova Hut, and Vitkovice, are in the Czech Republic; the VSZ is in Slovakia. Presentation of the Czech delegation to the OECD steel seminar during Oct. 25-26, 1993.

[75] Ibid.

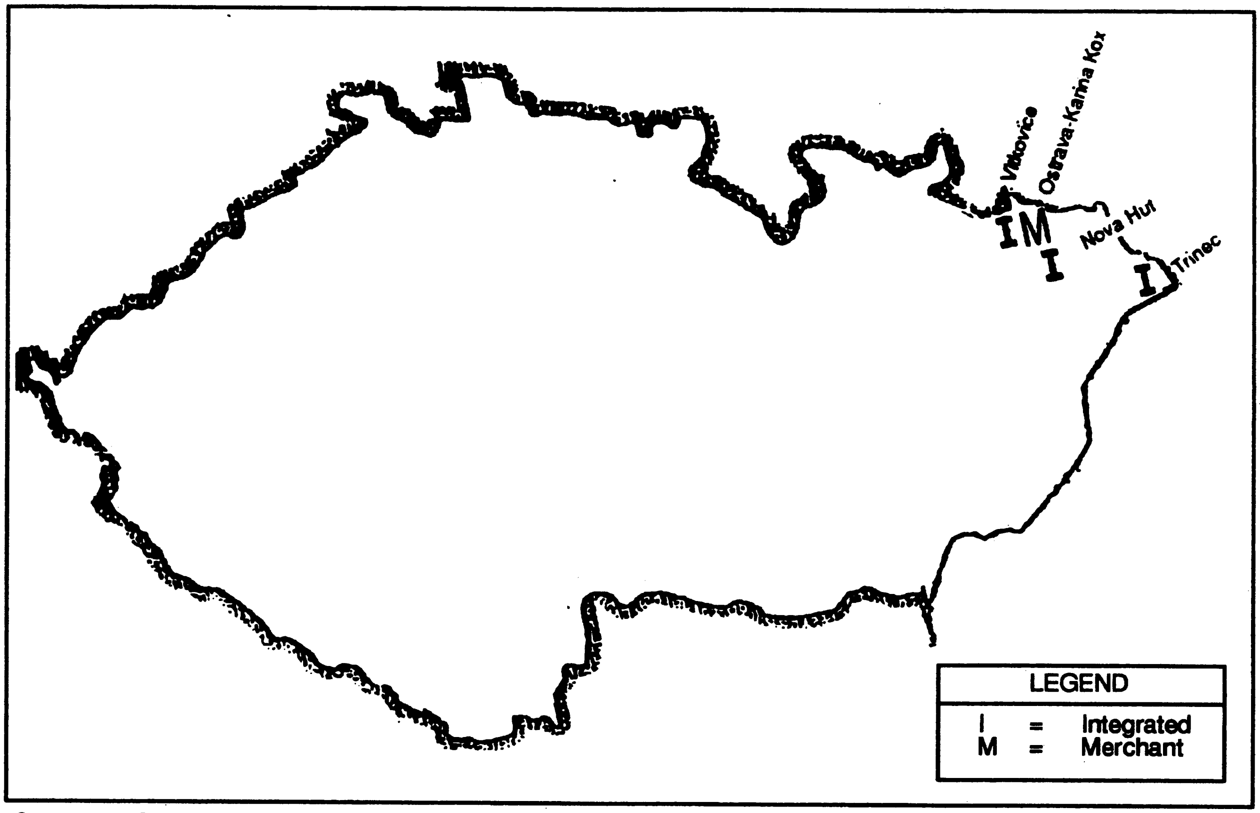
Table 5-5
The Czech Republic's coke producers and capacities, 1993

(Million metric tons per year)

Furnace Company	Capacity	Merchant Company	Capacity
Nova Hut	2.7	Ostrava-Karina Kox	1.8
Trinec	1.1		
Vitkovice	0.6		
Total	4.4	Total	1.8
Grand total			6.2

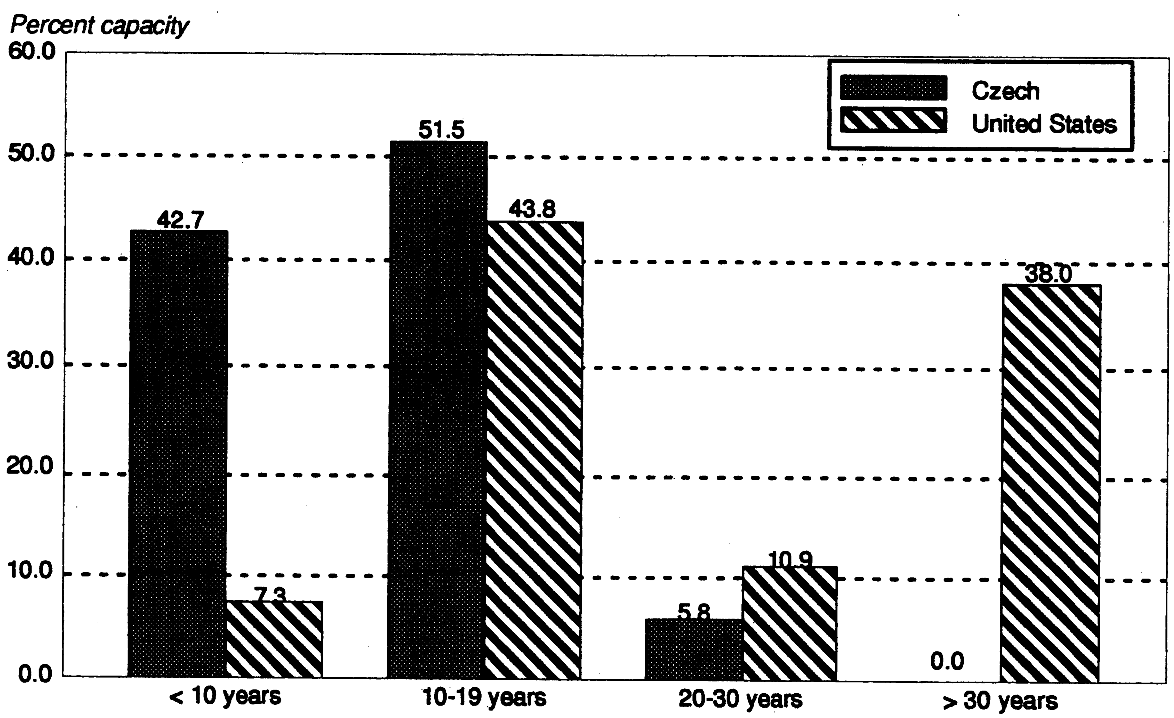
Source: IISI, *World Cokemaking Capacity,* and Czech national statistics.

Figure 5-7
Geographic distribution Czech Republic's coke producers



Source: U.S. Environmental Protection Agency.

Figure 5-8
Coke oven age: Relationship between Czech and U.S. ovens



Source: IISI, *World Cokemaking Capacity*, (Brussels: IISI, 1993).

Table 5-6
Czech coke production by types, 1987-93

(Million metric tons)

Source	1987	1988	1989	1990	1991	1992	1993
Metallurgical	6.0	5.5	5.4	5.0	4.6	4.0	3.7
Other	2.4	3.0	2.4	2.3	1.9	1.7	1.6
Total	8.4	8.5	7.8	7.3	6.5	5.7	5.3

Source: Ministry of Industry and Trade of the Czech Republic, facsimiles, received by USITC staff on Sept. 8, 1993, and on Dec. 3, 1993.

Under a Czech Government plan, the country's steel capacity is projected to decline by more than 40 percent between 1989 and the year 2000.[76] The proportion of steel produced by electric arc furnaces is projected to rise from an estimated 13.4 percent during 1990 to an estimated 28 percent by the year 2000.[77] With the decrease of steel capacity and the shift to electric steelmaking during the rest of the 1990s, it is expected that demand for metallurgical coke will also decline. Figure 5-9 shows the former Czechoslovakia's coke production and consumption during 1983-92.[78]

Trade

The Czech Republic does not import metallurgical coke. The following tabulation shows the former Czechoslovakia's coke exports during 1985-92 (*million metric tons*):[79]

1985	1986	1987	1988	1989	1990	1991	1992
1.16	1.00	1.32	1.38	1.43	1.19	1.17	1.17

Export figures for the Czech Republic prior to the breakup of Czechoslovakia, which went into effect on January 1, 1993, could not be determined.[80] Coke exports from the Czech Republic in 1993 are projected to be at the level of 1.07 million metric tons.[81] The major buyers of Czech coke are Germany, Austria, other countries in Central and Eastern Europe, and Sweden.[82] Coke is shipped to these destinations by rail or barge on the Elbe, or the Danube or by combined methods.

The combined coke surplus in the Czech Republic and Slovakia has been estimated at 1.4 million metric tons during 1995, declining to 1.0 million metric tons during 2000.[83] The Czech Republic is expected to account for 70 to 80 percent of the surplus. That is, the exportable surplus in the Czech Republic will be in the range of 0.98 million metric tons to 1.12 million metric tons in 1995, and it will be in the range of 0.70 million metric tons to 0.80 million metric tons by 2000.

Prices

Domestic prices were rising in late 1993, increasing approximately by 7 percent between September and December, when the ex-factory price of metallurgical coke was 2,348 korunas ($80.40).[84] Recent export prices for Czech coke are significantly higher than domestic prices.

The Czech Government considers its data confidential on the costs of Czech coke production and its price policy regarding coke.[85] However, data in the public domain do not suggest that coke production is subsidized. According to Zdenek Bohm, director of the Ferrous Metallurgy Corp., an association of Czech steel manufacturers, state support for the Czechoslovak steel industry was cut off in mid-1992.[86] However, the prices of some inputs used in coke production, for instance coal prices, may still be below their costs of production.

Environmental Costs

The Ministry of Environment imposes taxes on coke producers that vary according to the type and level of polluting emissions. A graduated payment schedule allows polluters a grace period to install

[76] Ibid.

[77] McCloskey, p. 23. The figures lump together the Czech and Slovak republics.

[78] This figure shows production and consumption for Czechoslovakia; information solely on the Czech Republic is not available.

[79] The Economist Intelligence Unit, *Czechoslovakia, Country Profile, 1990-91*, p. 25; Czech Statistical Office, facsimile, received by USITC staff on Oct. 5, 1993.

[80] Data published for Czechoslovakia indicate an average annual export of 1.2 million mt coke during the second half of the 1980s. The Economist Intelligence Unit, *Czechoslovakia, Country Profile, 1990-91*, p. 25.

[81] Czech Statistical Office, facsimile.

[82] Ministry of Industry and Trade of the Czech Republic, facsimile, received by USITC staff on Sept. 8, 1993; USITC staff interviews, Nov. 30, 1993.

[83] McCloskey, p. 42.

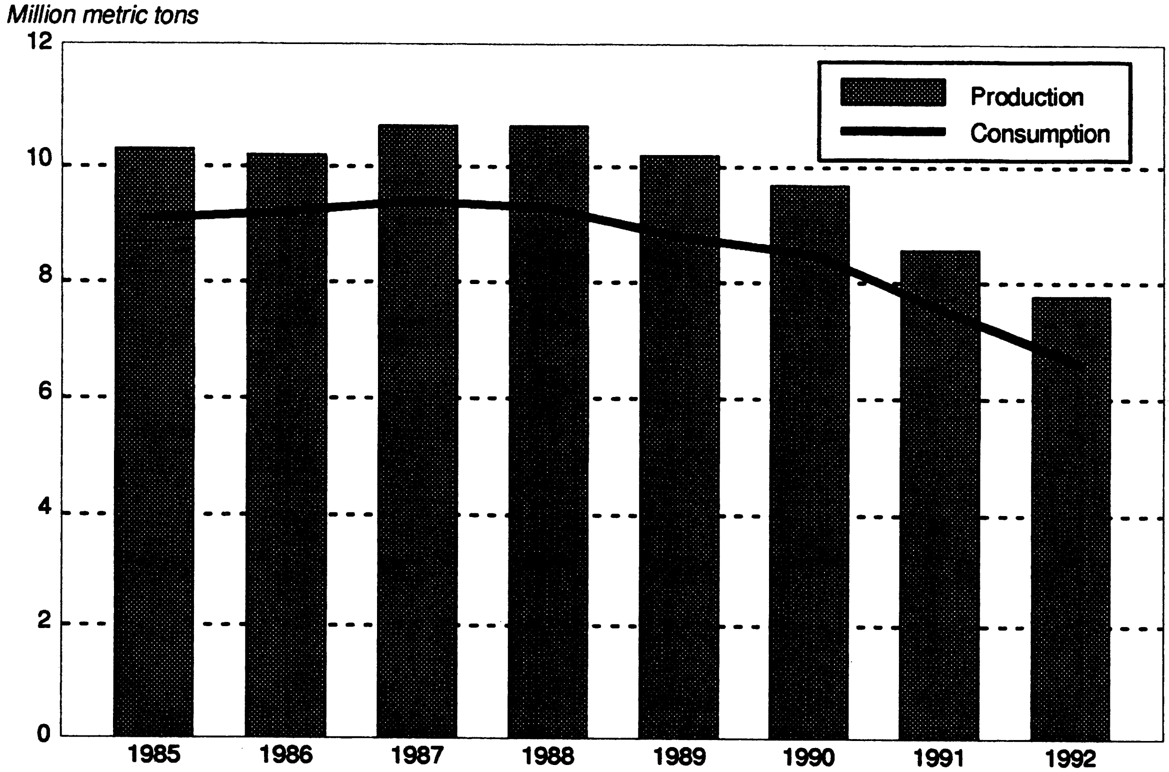
[84] Ministry of Industry and Trade of the Czech Republic, facsimile, received by USITC staff, Dec. 3, 1993.

[85] Ministry of Industry and Trade of the Czech Republic, facsimile, received by USITC staff, Sept. 8, 1993. Estimates based on the published price of metallurgical coal indicate that a significant portion of the costs of coke production must be recovered through the sale of byproducts to make coke production and exports profitable.

[86] Zdenek Bohm, general manager, Steel Federation of Czechoslovakia, remarks at the conference on steel survivor strategies, June 22-24, 1992, New York.

[87] Kaiser Engineers International, Presentation to U.S. Trade and Development Program (T.D.P.) on Results of Steel Plant Restructuring and Modernization Program Study for Czechoslovakia, Apr. 1992, attachment B.

Figure 5-9
Czechoslovakia's production and consumption of coke[1], 1985-92



[1] Includes metallugical and other types of coke.

Source: United Nations, *Energy Statistics Yearbook*; the International Iron & Steel Institute; and Ministry of Industry and Trade of the Czech Republic.

emission control equipment until 1997. Beginning in 1997, it will require full payments. Consequently, the cost of coke production is increasing, and will continue to increase, either by incurring tax liabilities, capital expenses, or by a combination of the two. Coke producers in the Ostrava region are installing or planning to install pushing control equipment and coke-oven byproducts wastewater treatment plants to control nitrates. They also plan to build facilities to desulfurize coke oven gas.[87] It appears that the largest increases in capital investments to control the environmental damage associated with coke production will take place prior to 1998. According to regulations, beginning in 1998, if pollution associated with any aspect of steel production exceeds certain stipulated levels in the city of Ostrava, steel firms and, consequently coke ovens, in the environs must shut down operations.[88]

Transportation Costs

It would cost a minimum of $23 per metric ton to ship coke from the Ostrava region to an U.S. east coast port through Germany. The total comprises overland (rail) costs to a port along the Elbe river ($3), barge transportation to Hamburg ($10), and overseas shipping ($10). Additional handling charges may apply as well. Railing coke through Poland to a Baltic port would be another alternative, although it is apparently too costly at this time. According to some reports, Polish railroads, citing shortage of capacity on their Northbound lines, charge much more for Czech than for domestic users.[89] However, with the projected decline of Polish coal exports, the use of Poland's Northbound lines may also decline, leading to lower rates for nondomestic users. If Czech shippers were charged the same rate as domestic shippers in Poland, the cost of rail transportation from the Ostrava region to Baltic ports would be in the range of $13 to $16 per metric ton. Thus, counting $8-$15 per metric ton for overseas shipping, total shipping costs from the Ostrava region to the East Coast would be in the range of $21 to $31 per metric ton.[90] The recently completed canal system, connecting the Rhine, the Main, and the Danube, may offer some cost savings to those Czech coke exporters shipping to European destinations.[91]

[88] USITC staff interviews, Jan. 11, 1994.
[89] Ibid.

[90] USITC staff interviews, Jan. 13, 1994.
[91] International Energy Agency analyst, interview with USITC staff, Nov. 5, 1993.

CHAPTER 6
Comparative Assessment of the U.S. Industry and Selected Competitors

The U.S. coke industry is operating in a constantly changing market. Competitive pressures from substitute materials and foreign producers are challenging the U.S. industry. More restrictive environmental rules have also forced cokemakers to make decisions about new operating practices and capital investment strategies while production costs rise. Links between sources of supply and sites of consumption have been disrupted due to restructuring in the steel industry which has led to independent closures of coke ovens and blast furnaces at formerly integrated steel works. This, in turn, has resulted in new geographic relationships and new business affiliations between producers and consumers. At the same time, the continuing evolution of new iron- and steelmaking processes and products are resulting in a decline in demand for coke. Falling domestic consumption and excess worldwide coke capacity add to industry concerns about growing imports and declining prices and revenues.

These market and competitive changes mean uncertainty for the industry. First, the final requirements of environmental regulation are still unclear and the full impact is as yet unknown. Second, new ironmaking technology suggests a certain reduction and possible elimination of the need for coke in steelmaking in the long-term. Third, weak financial performance for many merchant producers and integrated steelmakers[1] limits the available investment funding to replace or rehabilitate coke facilities. Fourth, existing and potential foreign competitors are also operating in changing markets and, in some cases, in changing political and economic environments, as in China and Eastern Europe.

This chapter is organized in four major sections. The first section highlights supply factors for the U.S. coke industry, assessing it relative to its counterparts in Japan, China, Poland and the Czech Republic. The second section highlights demand-related factors in the markets in these countries. The third section examines metallurgical coke imports and their effect on the U.S. market. The fourth section draws together various perspectives on the future of coke production and consumption in the U.S. market.

[1] For information on the financial performance of steelmakers, see U.S. International Trade Commission, *Steel: Semiannual Monitoring Report,* USITC Publication 2655, June 1993.

Analysis of Coke Supply

This report has presented a broad array of market measures and competitive factors for the domestic and foreign coke industries. The following section provides a comparative assessment of the U.S. coke industry relative to selected foreign competitors with respect to supply-related factors. Demand-related factors are discussed in the following sections.

Industry Parameters

The U.S. coke industry ranked third among the countries studied here in 1992, both in terms of capacity and production. U.S. capacity utilization rates are in the middle of those of the competitors studied (table 6-1). Except for the Chinese industry, all industries have experienced a net loss of capacity during the 1988-1992 period. The U.S. industry has lost a large percentage (18.3 percent) of capacity over that period; the industries in Japan (5.8 percent), Poland, and the Czech Republic have also lost capacity over that period (table 6-1).[2] Production of coke at facilities owned by U.S. integrated steel producers accounted for 84 percent of total production, similar to the situation in Japan (82 percent) in 1992. The ratio of integrated production to merchant production in China, Poland, and the Czech Republic was somewhat lower. This difference is perhaps due to the higher production and consumption of nonmetallurgical coke in those countries. However, because of the presence of several large U.S. steelmakers selling coke in the open market, only 64 percent of total U.S. shipments were to associated facilities. Although captive consumption still dominates the U.S. coke market, coke in the United States is increasingly traded on the open market. The willingness of steelmakers to rely increasingly on noncaptive sources for coke supplies affords more opportunities for domestic merchant coke producers and imports.

[2] IISI, *World Cokemaking Capacity,* (Brussels: IISI, 1993)

Table 6-1
Metallurgical coke: Industry structure measures for the U.S. coke industry with respect to producers in China, the Czech Republic, Japan, and Poland, 1992

	United States	Japan	China	Poland	Czech
Capacity *(million mt)*	23.7	47.4	62.0	9.0	4.5
Production *(million mt)*	21.2	43.4	55.0	7.7	4.0
Capacity utilization	89.8%	91.6%	88.7%	85.6%	88.9%
Change in capacity 1988-92 *(percent)*	-18.3	-5.8	Increased	Decreased	Decreased
Integrated/merchant production *(percent)*[1]	84/16	82/18	64/36	54/46	67/33
Coke imports *(million mt)*	1.9	0.2	0	0	0
Coal Supply	Domestic	Imported	Domestic	Domestic	Domestic

[1] As a percent of total production. Integrated production overstates captive consumption, because several integrated firms are significant players in the open market. Approximately 36 percent of U.S. domestic metallurgical coke shipments are to unrelated companies.

Source: Compiled by USITC staff from various sources. For details, see separate country chapters.

Among the countries studied, imports represent a significant share of domestic consumption only in the U.S. market. U.S. metallurgical coke imports seem to be competing in geographic markets where inland transportation requirements are limited or in areas far removed from the primary producing areas, where total transportation costs are competitive relative to domestic suppliers. Japanese, Australian, and Canadian imports accounted for 98.8 percent (80.4, 15.9, and 2.5 percent respectively) of U.S. metallurgical coke imports entered under HTS heading 2704 during 1992. Although coke imports have historically shown significant year-to-year variability, current U.S. imports are dominated by a few long-term contracts, indicating that foreign suppliers may have become a more permanent fixture in the U.S. market.

Cost Structure

The relative competitiveness of domestic and foreign coke producers is determined by a number of factors, including the cost of production inputs, the valuation of byproduct credit streams, the costs and constraints imposed by environmental regulation, the installed technology, and the role of governmental institutions. A comparison of these factors is presented for U.S. as well as for foreign producers of coke in table 6-2. The available information is inconclusive as to which country, if any, has an overall competitive advantage. As shown in the table, domestic producers appear to hold an advantage over the foreign producers for certain factors. While in other instances, foreign producers seem to hold an advantage over domestic producers. It should be noted that this report bases its analysis on industry averages, and that the relative competitive position of individual firms may differ from industry norms suggested in this report.

Input and Product Values

Except for Japan, all countries studied used domestic sources for virtually all of their metallurgical coal supplies. After the closing of its last indigenous metallurgical coal mine in 1992, Japan must now import all its metallurgical coal. Access to domestic coals seems to confer a competitive advantage to the producers in the United States, China, and Poland. Average coal costs calculated for each country indicate a cost disadvantage for Japan, despite efforts to lower costs by blending coals with lower prices stemming from its need to import coal (table 6-2). Coal costs are also relatively high in the Czech Republic despite good metallurgical coal reserves near coke production facilities.

Information on other costs, such as labor, other raw materials, energy inputs, environmental control, and maintenance were unavailable for countries other than the United States. However, given the similarities in basic cokemaking technology, coal costs in the United States accounted for 60 percent of total costs; coal costs must represent a significant proportion of the total costs for foreign producers as well.

The costs incurred in producing coke are offset to some degree by the value of production process byproducts. Firms operating byproduct recovery ovens are multi-product firms, with possible economies arising from the presence of overhead or fixed costs that can be applied to more than one product. These firms also have the flexibility to allocate such costs among the multiple products as they see fit. Coke producers that are also steel producers have even more flexibility regarding the allocation of costs among products.

Byproduct coke oven operations throughout the world, of course, produce the same basic products (coke, coke oven gas, tar and light oils). The importance of these products, however, in terms of value generated and contribution to reducing overall

Table 6-2
Metallurgical coke: Cost factors of the U.S. coke industry with respect to producers in China, the Czech Republic, Japan, and Poland, 1992

	United States	Japan	China	Poland	Czech
Input & Product Values					
Ave. cost of coal[1]	$52	$60	$22[2]	$36	$57
Natural gas prices[3]	$0.10	$0.45	(4)	$0.12	$0.10
Electricity prices *(kwh)*	$0.05	$0.15	(4)	$0.04	$0.05
Coke oven gas[3] *(calculated)*	$0.05	$0.20	(4)	$0.06	$0.05
Light oils[5]	$0.12	$0.17	(4)	(4)	(4)
Crude coal tar[5]	$0.12	$0.13	(4)	(4)	(4)
Technical Factors					
Coke yield[6]	0.73	0.72	0.71	0.74	0.72
Average oven age	25.1	21.5	12.8[7]	11.8	10.0
Percentage of ovens greater than 6.0 meters	17.8	59.3	13.7	9.2	11.0
Forthcoming environmental controls	Yes	Maybe	Unknown	Yes	Yes
Government Policies					
Government ownership	No	No	Yes	Yes	Yes
Control of raw materials	Private	Private	Government	Government	Government
Control of overland transportation	Private	Private	Government	Government	Government
Import tariffs *(percent)*	0	3.2	6-11	7[8]	0
R & D support	Maybe	Yes	Yes	Unknown	Unknown

[1] Delivered value per metric ton of coal.
[2] 1993 upper limit at average black market rate.
[3] Per cubic meter.
[4] Data not available.
[5] Per liter.
[6] Tons of coke produced from 1 ton of coal charged (total coke produced divided by total metallurgical coal consumed).
[7] Based on 64 percent of reported capacity.
[8] Represents VAT on energy products.

Source: Compiled by USITC staff from various sources. For details, see separate countries chapters.

operating costs, may differ substantially by country and by facility. Quantity yields of coke and byproduct chemicals are generally consistent due to similar technologies used in cokemaking and byproduct recovery facilities, but some differences in yields do occur, chiefly because of varying coal quality and plant efficiency.

It has been claimed that higher byproduct values in Japan may allow Japanese producers to profitably sell metallurgical coke at lower prices than U.S producers.[3] This claim is possible because the high cost of energy in Japan makes the energy-yielding outputs of the metallurgical coke production process relatively more valuable than in the United States.

In an attempt to quantify differences in the value of the byproduct stream, unit values in Japan and the United States were collected for the major first-stage byproducts. Unit values for the tar and light oil products were available from published sources for both countries. Although tar prices in the two countries were the same, the constituents of the light oil product appear to command a higher value in the domestic Japanese market despite a worldwide market for these chemicals (table 6-2).

Unit value data on coke oven gas (COG) was not available for the Japanese market. Although data collected by questionnaire for this study did report unit value information for the U.S. industry, unit values were constructed for the two industries, using the same method in order to have comparable results.[4] This method does indicate that Japanese COG calculated at $0.20 per cubic meter has a significantly higher value than U.S. COG calculated at $0.05 per cubic meter (table 6-2) indicating a cost advantage for Japanese producers. However, this analysis is incomplete because it does not consider two related, mitigating

[3] Counsel for Mitsubishi International Corp., posthearing submission, Dec. 16, 1993, p. 3-4.

[4] International Energy Agency data on delivered natural gas prices for industrial users support the estimate. Value on a caloric basis of the gas was converted to value per cubic meter of coke oven gas. Unit values for domestic COG reported on the questionnaires ($0.03) averaged slightly lower than the calculated value.

factors: (1) the net energy balance of the process, and (2) the relative costs of production inputs. A coke oven/byproduct recovery facility consumes as well as produces considerable amounts of energy. If net energy flows are balanced, or the facility is a net consumer of energy, higher values for the energy produced would not confer a competitive advantage. On the other hand, if there is a significant amount of net energy produced, these unit value differences can generate a significant competitive advantage. If indeed there is significant net energy generated, the value of the revenue streams from the sale of energy must be weighed against the cost of producing the energy. It is, after all, the net revenue, or profit, from byproduct production that is important in determining its contribution to the overall profitability of the coke-making company.

Information gathered during this investigation indicates that 40-60 percent of COG is typically used to fire the coke ovens. Producers have several options for disposal of the remaining gas. At some facilities, the excess gas is used to generate steam and electricity needed to run the coke ovens and byproduct recovery plant. At others, COG is transferred or sold as a fuel to affiliated or unaffiliated businesses.

Producers who sell COG to outside customers or who use it in blast furnaces or sintering plants must purchase electricity or other forms of energy to run their coke plants and associated facilities. Therefore, in order to accurately compare the net value of the COG not used to fire the batteries, the net energy balance of the operation must be determined. However, the Commission was unable to do so because it lacked sufficient data on electrical production costs, purchases, and sales in the U.S. and Japan. Therefore, precise assessment of net energy balance could not be made for purposes of analysis in this report.

Although the operation of coke batteries and byproduct recovery plants do apparently result in a net generation of energy at most facilities, conclusive evidence was not available to determine how much variation occurs from plant to plant and what the ramifications are of these variations on the profitability of byproduct generation. Although the value of COG in Japan is relatively higher, the cost of purchasing alternative types of energy is also relatively more expensive.[5] Although it seems that the gross value of Japanese byproduct streams are greater than gross U.S. byproduct streams, the lack of Japanese cost data precludes the calculation of the net revenues or profits from such sales. However, aggregated data for the U.S. industry indicate that the value from byproduct credits averages about twice the cost of purchased energy, indicating that the Japanese industry most likely has a competitive advantage stemming from their byproduct revenues.

[5] For example, electricity prices in Japan are reported as three times those in the United States. The International Energy Agency, *Energy Prices and Taxes*, 2nd quarter, 1993.

Technical Factors

Byproduct oven technology is mature and the basic design of ovens hardly varies around the globe, but some technological variables occur that can lead to cost differentials. The net effect of these cost differentials on the relative competitiveness of national industries is obscure as various technical factors, variations in specific plant designs, and a variety of operating variables all interact at once. In some countries, technical advancements may be limited to only a few facilities.

Nevertheless, U.S. and foreign coke industry officials and suppliers of coke oven technology have indicated in discussions with USITC staff that three factors—oven height, oven age, and the required level of pollution control—can have significant effects on production costs. All three factors interact to some degree. Generally speaking, when all other factors remain the same, new, tall ovens operating under less strict environmental standards would fall at the low-cost end of the spectrum, while short, old ovens operating under strict environmental standards would fall at the high-cost end of the spectrum.

The cost advantages stemming from taller ovens were identified as lower per ton labor requirements and lower per ton capital costs. Because a tall oven has a greater volume, capital costs and labor requirements are spread over more tons of production. Tall ovens do not inherently require more labor and, although the cost to build tall ovens is greater, the unit (per ton) costs are less. As shown in table 6-2, the U.S. industry has, on average, shorter ovens than the Japanese industry and taller ovens that the Chinese, Polish and Czech industries. This indicates that the U.S. industry is at a disadvantage relative to Japanese competitors and an advantage relative to the other industries for this factor.

Expenditures for pollution control, of course, also have an impact on the costs of production. Hoods to catch emissions when doors are opened to push coke, added door maintenance or replacement to fix leaks, and changes in work practices all tend to push costs up. Because a battery of taller ovens has fewer doors, offtakes, and charging lids than a shorter battery with the same capacity, it therefore has fewer emission points and requires relatively smaller expenditures on pollution control.[6] However, many other variables affect total pollution control costs, so it is not clear if this represents a significant competitive advantage.

As coke ovens age, their productivity declines[7] and maintenance costs increase. Average coke oven age is somewhat higher in the United States than in Japan, and considerably higher than in China,[8] Poland,

[6] Ibid.

[7] As ovens age, longer cycle times at lower temperatures are necessary, therefor lowering the productive capacity for a given period of time.

[8] Estimated average oven age for the Chinese industry was based on 64 percent of reported capacity.

and the Czech Republic (table 6-2). Not only are U.S. ovens relatively old on average, but a significant portion exceeds the average 30-year expected life span. In 1992, 38 percent of U.S. effective capacity and 54 percent of the 4,744 ovens exceeded 30 years in age.[9] [10] Although this indicates that many batteries are nearing the end of their useful life, another interpretation is that domestic producers have become skilled at extending the useful life of short, old ovens, a possible competitive advantage, given the high costs of new construction or even rebuilds. Operating costs of these shorter older ovens may be higher than for newer taller ovens, but newer ovens would face a significant capital cost disadvantage leading to an indeterminate result with respect to cost competitiveness.

Government Policies

This study has reaffirmed the conclusion of other studies: that comparison of environmental regulation and control schemes in various countries is extremely difficult. Cleanliness standards and programs vary so much between and within countries that meaningful comparison is beyond easy reach and calculating relative costs is hampered by the lack of production and environmental cost data for the various industries. However, as shown in chapter 3, it is certain that environmental costs in the U.S. coke industry will rise as new emission standards stemming from the 1990 Clean Air Act Amendments take effect over the next 26 years. As shown in chapter 4, no new Japanese emissions standards affecting the Japanese producers were identified in the course of this study. In China, Poland and the Czech Republic, it seems likely that environmental costs will rise in the near future as concern for the environment continues to increase, raising their cost structures from current levels.

Differing from the arrangement in the United States and Japan, the Governments of China, Poland and the Czech Republic own or control the coke industry, the metallurgical coal industry, and the railroads, which are the primary means of overland transportation. The effect of such control over these industries is unclear, although any advantages or disadvantages stemming from such control diminish as Poland and the Czech Republic attempt to introduce market reforms, including privatization, into their economies.

Governments in several countries are offering support to their coke industries in the form of research and development funding. The Japanese Government provided 5 billion yen between 1978 and 1986 (approximately $20 million) to support a research and development project on formcoke, which would allow the production of coke from less expensive coals. This represents half of the project cost, with integrated producers paying the other half of the project cost. In the United States, the 1990 Clean Air Act Amendments have authorized U.S. Government support for research, development, and installation of pollution control technologies for coke production, but so far funds have not been committed.

Import duties are also a factor. Coke enters the United States and the Czech Republic duty free, but the industries in Japan and China are protected from import competition by duties of up to 3.2 percent and 11 percent, respectively.

Analysis of Coke Demand

Restructuring in the steel and other consuming industries has increased the uncertainty in the world market for metallurgical coke as well. Some parallels can be drawn between the experience in the United States and that in Japan, Poland and the Czech Republic. The steel industries in all these countries have been shrinking, leading to declines in coke consumption. In contrast, China has been expanding its steel production capability and, as a result, its consumption of coke.

Consumption

Consumption of coke has been in long term-decline in most of the countries examined. Recent peaks in consumption were reached during the 1988-89 period. Over the 4-year period spanning December 1988 to December 1992, consumption in the United States fell by about 16 percent, while consumption in Japan also fell by approximately 16 percent (table 6-3). The decline in U.S. consumption was slightly less than the decline in U.S. capacity (18 percent) over the same period. Although Japanese production fell by 14 percent, Japanese capacity fell by only 6 percent over the same period, indicating an increase in excess capacity. Between 1988 and 1992, consumption of all types of coke (metallurgical and nonmetallurgical) declined in Poland (43 percent) and Czechoslovakia[11] (29 percent) as well, while consumption in China increased significantly (28 percent). It is suggested that the decline in consumption of metallurgical coke in Poland and Czechoslovakia was even steeper during this period, because no factors have been identified that would result in declines of consumption of nonmetallurgical coke during that period.

Of the countries studied, only in the United States do imports account for a significant share (8 percent in 1992) of consumption. China, Poland and the Czech Republic import no coke and Japan imports only a relatively small quantity (table 6-3).

[9] International Iron and Steel Institute, *World Cokemaking Capacity 1993*, pp. 28-30.

[10] Although the accepted useful life of coke ovens is generally 25-30 years, productivity decreases with age, and may decline below the break even point before this time, as shown by the Inland Steel decision to shut down its 23-year-old, 6-meter coke ovens a year earlier (December 1993) than previously announced because of rapidly deteriorating oven conditions.

[11] Consumption data for the regions that became the Czech Republic are not available.

Table 6-3
Metallurgical coke: Demand factors for the U.S. coke industry with respect to producers in China, the Czech Republic, Japan, and Poland, 1992

	United States	Japan	China	Poland	Czech
Consumption *(million mt)*	22.8	40.5	54.0	5.1	2.8
Consumption changes 1988-92 *(percent)*[1]	-16.4	-15.5	Increased	Decreased	Decreased
Ratio of imports to consumption	8.3	0.5	0.0	0.0	0.0
Exports *(million mt)*	0.6	3.1	1.1	2.6	1.2
Major export markets	Canada Mexico Brazil	U.S. Brazil Taiwan	Brazil Japan India	Germany Austria Belgium	Germany Austria E. Europe
Transportation costs to U.S. East coast or Gulf ports *(per metric ton)*[2]	—	$10-12	$17-21[3]	$20-30	$21-31
Average domestic blast furnace coke prices *(per metric ton)*[4]	$102	$90[5]	$40-47[6]	$90[7]	$80[7]

[1] Consumption data to calculate net changes were not available for China, Poland, and the Czech Republic.

[2] Per metric ton and includes overland and ocean freight and marine insurance. Not included are handling and associated port charges of $2.00-3.00 per metric ton at U.S. ports.

[3] F.o.b. on vessel.

[4] F.o.b. point of shipment and per metric ton.

[5] Average export unit values. Japanese domestic prices are not available.

[6] 1993 data, includes "modern" coke only.

[7] 1993 data.

Source: Compiled by USITC staff from various sources. For details, see separate country chapters.

Export Markets

U.S. coke exports are small, accounting for only about 3 percent of total production. Export markets are somewhat limited, with most of the exports going to neighboring Canada and Mexico. U.S. exports are also destined for Brazil, where they compete with Japanese and Chinese coke, as well as to Japan, Venezuela, Norway and Sweden. Exports from Poland and the Czech Republic have historically gone to the former Soviet Union and to both Eastern and Western European countries. All foreign industries studied are larger exporters than the U.S. industry.

Transportation

Changes in traditional domestic supply patterns have resulted from restructuring in the integrated steel sector, shifting from formerly balanced facilities with respect to coke production and coke consumption to either net coke sellers or purchasers. Although the majority of coke is still consumed at blast furnaces a short distance from the source of supply, domestic steelmakers as a whole are increasingly meeting their coke needs from outside sources, including foreign suppliers, and frequently they need to transport their coke for considerable distances.[12] Transportation costs are becoming an increasingly important factor in the cost of coke for many consumers, for whom coke transportation costs at one time hardly mattered. Despite the difference in distance traveled by imports and domestic shipments, the cost effectiveness of ocean freight mitigates the disadvantage of long shipping distances from most of the countries studied here, to certain domestic consumers. Ocean freight rates for metallurgical coke from Japan are approximately $10-12 per metric ton to east coast and Gulf State ports.[13] Estimated costs of shipping Polish and Czech coke to similar ports, including both overland and ocean freight, are $20-30 per ton. By comparison, estimated blast furnace rail rates from Pittsburgh, PA, to either Chicago, IL (about 466 miles), Birmingham, AL (about 937 miles), or Baltimore, MD (314 miles) are $20, $23, and $21 per metric ton,

[12] Questionnaire data indicate that 62 percent of reported open market metallurgical coke shipments, by quantity, were transported between 100 and 500 miles, while 20 and 18 percent were transported less than 100 or more than 500 miles, respectively, during 1993.

[13] According to U.S. industry officials, handling and associated port charges for imported metallurgical coke are approximately $2-3 per metric ton.

respectively.[14] In certain transactions, domestic producers may actually face higher transportation costs than the producers of the imported product. However, for producers and consumers operating in the same steel-producing districts, freight rates can be as low as $2.00 to $3.00 per ton,[15] yielding a significant transportation advantage over imported coke.

Average 1992 prices for blast furnace coke in the United States apparently exceed domestic prices in China, Poland, and the Czech Republic. Domestic prices for blast furnace coke in the Japanese market are not available, but average Japanese export unit values ($90 per mt) are below average U.S. prices ($102 per mt) as well. However, in 1992 Japanese home market delivered prices for foundry ($485 per metric ton) and general use ($308 per metric ton) coke were significantly higher than U.S. domestic prices (f.o.b.) for foundry ($153 per metric ton) and industrial ($116 per metric ton) coke. Average c.i.f. values for Japanese imports into the United States ($103 per mt in 1992) were roughly equal to average U.S. domestic prices. According to U.S. Bureau of Census data, significant variability exists with respect to import values of Japanese coke entering the country at gulf ports ($97-98 per metric ton) and at Baltimore ($112 per metric ton) in 1992. However, imports in the gulf region must be transported to inland consumers, unlike at Baltimore, adding additional transportation costs.

Imports and the Domestic Market

Imports of coke into the U.S. market have shown a wide degree of year-to-year variability and have several general characteristics: (1) a limited number of sources; (2) a limited number of importers/consumers; (3) most current import sales are the result of long-term contracts; and (4) most imports are being sold to integrated facilities that were once self-sufficient in coke.

Almost 90 percent of U.S. coke imports come from two merchant facilities in Japan. Imports from Australia and Canada come from one integrated company in each country with excess coke production capacity. In 1992, only 4 steelmaking facilities, of a total 18 surveyed, reported purchasing imported coke. Approximately 94 percent (by quantity) of these purchases were on contracts ranging from 2 to 4 years, most of which will expire at the end of 1994.

Although imports represent only about 8 percent of total domestic consumption, they account for roughly one-fifth of open market sales of blast furnace and foundry coke. This distinction is drawn to indicate that imports compete on two different levels in the domestic market. In the open market, imports are competing against domestic sellers for the limited number of domestic purchase contracts. However, imports, along with domestic sales, also compete with the captive production of coke in the long run. Steel plants that are partially or completely self-sufficient in coke but requiring significant capital investment in coke plants face "make or buy" decisions.[16] Several U.S. steel plants, including the two that purchase most of the Japanese coke in the United States (the Fairfield, AL, works of USX and the Sparrows Point, MD, works of Bethlehem Steel) have shut down all of their coke ovens and rely on imported purchases instead of making the necessary capital expenditures to maintain production. Inland Steel also has opted to replace captive production of coke with purchases, although Inland currently relies primarily on domestic sources. National Steel, on the other hand, recently faced a make or buy decision and reacted by spending a reported $300 million on rebuilding one of its batteries to sustain captive production.

An attempt was made to statistically model the effect of imports on the domestic coke market. The U.S. metallurgical coke industry and its market have several characteristics that render a price analysis relatively complex in nature. A major share of coke production is consumed in captive operations and therefore is not destined for the open market. As discussed earlier, coke that is sold on the open market is generally made with other products, so that the production of metallurgical coke is determined jointly with the other products. Finally, the demand for coke is changing in response to technological and structural changes in the consuming industry that cannot be readily captured in statistical modeling.

The demand for domestic blast-furnace metallurgical coke is generally considered to be price-inelastic.[17] Likewise, the supply of metallurgical coke is inelastic, except perhaps within a narrow price range. Metallurgical coke batteries must be continually run at some minimum level, as restarting a cold battery is extremely expensive. Output does not change much with changes in price, but price is expected to be highly sensitive to changes in supply, resulting from new (e.g. import) sources of metallurgical coke.

A simple descriptive reduced form model of the metallurgical coke market was constructed in order to conduct a statistical analysis of the effect of coke imports on the domestic coke industry.[18] Ten years of quarterly data were used, ending with 1992.

[14] These rates assume shipment in standard-size coal cars (50 ton or 3,400 cubic feet). Lower rates are attainable by using larger cars (60-, 70-, 80-ton capacity).

[15] USITC interviews with domestic coke and rail industry officials.

[16] Cost data collected for this report show that integrated producers operating costs are 11 to 22 percent higher than domestic merchant producers, indicating the possibility of cost savings stemming from a decision to buy, rather than make, coke.

[17] The quantity demanded depends on the level of output of iron, and is relatively insensitive to metallurgical coke prices in the short run. Conversely, an exogenous increase in the supply of metallurgical coke will have a large effect on price.

[18] Various multiple equation models were tested, including a three-equation model, with equations for U.S. demand, U.S. coke supply, and Japanese coke supply; and

The hypothesis tested was that the domestic U.S. spot price of blast furnace coke is determined by the level of imports, along with other factors such as domestic iron production, the price of COG, and the price of coal. These other variables are included along with import levels because they represent (1) overall demand for coke (blast furnace production), (2) the effect of byproduct price changes (COG), and (3) the price of the primary production input (metallurgical coal).

Spot prices were used primarily because time series data on contract prices are not available, despite the fact that the overwhelming majority of coke is sold on a long term contract basis. However, coke contracts typically set quantity levels for a period of years, with prices renegotiated quarterly or annually. Changes in contract prices can therefore be expected to reflect changes in spot prices in direction and general magnitude, albeit with some lag in response. Hence, spot prices are a viable proxy for coke prices in general.

The model found a statistically significant correlation between the U.S. spot price of coke and the level of imports, and no significant correlation between blast furnace production, the price of COG, and the price of coal, therefore confirming only part of the hypothesis. This correlation was positive (prices and imports move concurrently in the same direction), which can be considered evidence that import supplies are predominantly demand driven. That is, higher demand drives up the price, which in turn increases the supply of imported coke in the domestic market. This is not to say that in the absence of such imports prices might not be higher, but year to year increases in coke imports have been associated with both price increases as well as price declines. However, over the last few years (1990-1992) imports have generally been rising during a period of falling domestic spot and contract prices and decreasing average import unit values, perhaps indicating a change in the factors underlying longer term trends. One significant change is that some consumers have demonstrated a new willingness to rely solely on imported coke. The availability of large, dependable import sources gives consumers greater options concerning the source of their coke supply.

Outlook

It is expected that the U.S. metallurgical coke industry will continue to face change and uncertainty in the critical areas of environmental regulation, capacity, consumption, and imports, all of which will affect production levels and the economic performance of producers.

Environmental regulation of the U.S. industry will affect both the future cost structure and capacity levels. Costs are expected to continue to rise for producers who meet the deadlines imposed by the regulations engendered by the Clean Air Act Amendments of 1990 (CAAA). Others will choose to close capacity as they reach deadlines. The decision whether to close or to meet the environmental regulations depends to a large degree on expectations for future price levels.

Capacity declines have been forecast in a number of different studies. Sources vary widely on projected capacity levels for coke (table 6-4), but all agree that some decline is certain. Estimates of the decline in capacity range from 10 to 37 percent. All of these studies consider the regulatory deadline dates associated with the CAAA to be critical periods of capacity decline. Several of these studies also forecast a decline in domestic consumption by the turn of the century. Sources again vary widely on projected consumption levels (table 6-4), but all agree that both will decline to some extent. During the period 1990-2000, U.S. consumption of metallurgical coke is forecast to decline between 10 and 23 percent, based on integrated producers' reduction in coke demand and declining overall steel output.[19]

Most authors also foresee capacity declines outstripping consumption declines, resulting in shortfalls that would need to be filled with imports.[20] These shortfall projections are largely based on declining capacity resulting from oven closures that are expected to outpace declining coke consumption during this period, particularly around 1995, when new emission standards become effective. A shortfall in U.S. coke production of anywhere between 5 and 12 million metric tons per year is predicted, depending on the number of oven and blast furnace closures.[21]

Increasing imports from producers in Poland and China are likely, given late 1993 import data and discussions with consumers who report recent spot purchases from these sources. It is not yet clear whether such transactions will evolve from a spot basis

[18]—*Continued*
a two-equation model, for U.S. demand and Japanese supply. The multiple equation models were characterized by a high degree of collinearity among the variables making the equations either unestimatable or unstable. In addition, the persistence of a positive relation between imports and prices in the demand equation indicated that the model did not capture important supply and demand forces.

[19] *Forecast Coke Demand in the Integrated Steel Industry: 1990 to 2020*, Industrial Economics, Inc., Jan. 1992, p. 1.

[20] Jennifer Bennett, *PCI and Coke: Market impacts of Changing Steel Technologies*, McCloskey Coal Information Service, Aug. 1993; William Hogan, "The future world crisis in coke", *Iron and Steel Engineer*, Dec. 1992; Thomas G. Walton, *Controlling Emissions From By-product Coke Oven Charging, Doors, Lids and Offtakes*, Research Triangle Institute, Aug. 1991; James Neumann, *Forecast Coke Demand in the Integrated Steel Industry: 1990 to 2020*, Industrial Economics Incorporated, 1992.

[21] *Merchant Coke Plant in British Columbia*, H.S. Halvorson Consultants Ltd., Feb. 1993. William T. Hogan, "The Future World Crisis in Coke," *Iron and Steel Engineer*, Dec. 1992.

Table 6-4
Metallurgical coke: Published capacity and consumption forecasts for the U.S. industry through year 2000

	Period *(year)*	Net Change *(percent)*	Beginning of Period *(million mt)*	End of Period *(million mt)*
CAPACITY:				
International Iron & Steel Institute	1992-2000	-10	23.8	21.5
McCloskey Coal Information Service[1]	1992-2000	-37	23.4	14.8
Industrial Economics, Inc.	1990-2000	-33	27.0	18.0
USITC Questionnaires	1992-1998	-19	23.7	19.2
CONSUMPTION:				
McCloskey Coal Information Service[1]	1992-2000	-10	23.3	20.9
Industrial Economics, Inc.	1990-2000	-23	25.0	19.0
Research Triangle Institute	1990-2000	-22	([2])	([2])

[1] Forecasts are for blast furnace coke only.

[2] Data not available.

Source: Compiled by USITC staff from various sources.

to a contract basis, thereby assuring imports over a period of years, as consumers reportedly still need to be convinced about the quality and reliability of coke from these sources.

Anticipated coke shortages over the longer term indicate increasing costs for blast furnace operators and increasing justification for investment in technology and equipment that allows replacing coke with other energy sources. Thus, U.S. metallurgical coke producers may experience a stabilization or increase in prices as a result of constrained supply in the next several years. In cases where producers are considering rebuilding shuttered ovens, stronger coke prices may be critical to their decision.

APPENDIX A
REQUEST LETTER

Rec'd 5/6/93
To: Docket
cc: The Commission

DOCKET NUMBER
1755
Office of the Secretary
Int'l Trade Commission

COMMITTEE ON WAYS AND MEANS

U.S. HOUSE OF REPRESENTATIVES
WASHINGTON, DC 20515-6348

Industries

May 6, 1993

RECEIVED
OFC OF THE SECRETARY
U.S. INT'L TRADE COMM.
'93 MAY -6 P4:24

The Honorable Don E. Newquist
Chairman
U.S. International Trade Commission
500 E Street, S.W.
Washington, D.C. 20436

Dear Mr. Chairman:

Metallurgical coke is an essential, energy-based industrial material used primarily in steel industry blast furnaces to make iron that is subsequently refined into steel. The U.S. metallurgical coke industry is facing increasing imports, particularly from Japan. A critical production situation is developing for the U.S. industry, and facilities may have to be closed. As a result, the United States, which has the largest coking-coal reserves in the industrialized world, is becoming increasingly dependent on imported sources.

On behalf of the Committee on Ways and Means, and under the authority of section 332(g) of the Tariff Act of 1930, I am requesting that the Commission conduct a baseline analysis of the U.S. coke industry and how it is affected by increasing imports from major world producers, particularly Japan. Other producing countries such as China and the former Eastern Bloc should also be studied, as time permits. In its report, the Commission should evaluate the impact of significant market and trade issues related to consuming industries on the availability of coke in the United States, Japan, China, and the other nations to be studied. The report should also analyze the production practices and other factors associated with coke production in the United States and, to the extent feasible, in the other countries to be studied.

More specifically, among the issues the Commission should review for the U.S. market as well as the markets in Japan, China, and the former Eastern Bloc nations are:

(1) Coke market practices, such as cost recovery, pricing policies, by-product valuation (i.e., coal chemicals), and coke quality;

(2) Environmental controls and costs;

(3) Transportation costs in the U.S. market;

(4) Other market factors, such as government support, quality, and other significant market factors; and

(5) Other major factors affecting the production of coke.

A public hearing should be scheduled in order to obtain the views of interested parties. The Committee would appreciate receiving the study no later than 9 months after receipt of this letter. Thank you for your attention to this important matter.

Sincerely yours,

Dan Rostenkowski
Chairman

DR/fpp

APPENDIX B
FEDERAL REGISTER NOTICE

terminating the investigation with respect to Keys.

No petitions for review, or agency or public comments were received.

This action is taken pursuant to section 337 of the Tariff Act of 1930, as amended (19 U.S.C. 1337), and Commission interim rule 210.53(h) (19 CFR 210.53(h)).

Issued: May 24, 1993.

By order of the Commission.

Paul R. Bardos,

Acting Secretary.

[FR Doc. 93-13025 Filed 6-2-93; 8:45 am]

BILLING CODE 7020-02-P

[Investigation No. 332-342]

Metallurgical Coke: Baseline Analysis of the U.S. Industry and Imports

AGENCY: United States International Trade Commission.

ACTION: Institution of investigation and scheduling of public hearing

SUMMARY: Following receipt of a request on May 6, 1993, from the House Committee on Ways and Means, the Commission instituted investigation No. 332-342, Metallurgical Coke: Baseline Analysis of the U.S. Industry and Imports.

EFFECTIVE DATE: May 21, 1993.

FOR FURTHER INFORMATION CONTACT: General inquiries regarding the investigation may be directed to Ms. Cynthia B. Foreso (202-205-3348) or Mr. Eric Land (202-205-3349), Energy, Chemicals, and Textiles Division, Office of Industries, U.S. International Trade Commission, Washington, DC 20436. For information on legal aspects of the investigation, contact Mr. William Gearhart of the Commission's Office of the General Counsel (202-205-3091). The media should contact Ms. Peg O'Laughlin, Director, Office of Public Affairs (202-205-1819). Hearing-impaired persons can obtain information on this study by contacting the Commission's TDD terminal on 202-205-1810.

SUPPLEMENTARY INFORMATION:

Background

As requested, the Commission in its report will seek to provide a baseline analysis of the U.S. coke industry and how it is affected by increasing imports from major world producers, particularly Japan. Other producing countries such as China and the former Eastern Bloc will also be studied. In its report, the Commission will evaluate the impact of significant market and trade issues related to consuming industries on the availability of coke in the United States, Japan, China, and the other nations to be studied. The report will also analyze the production practices and other factors associated with coke production in the United States and, to the extent feasible, in the other countries to be studied.

More specifically, as requested by the Committee, the Commission, in conducting its study, will review for the U.S. market and the markets in Japan, China, and the former Eastern Bloc nations the following issues:

(1) Coke market practices, such as cost recovery, pricing practices, by-product valuation (i.e., coal chemicals), and coke quality;
(2) Environmental controls and costs;
(3) Transportation costs in the U.S. market;
(4) Other market factors, such as government support, quality, and other significant market factors; and
(5) Other major factors affecting the production of coke.

Public Hearing

A public hearing in connection with this investigation will be held in the Commission Hearing Room, 500 E Street, SW., Washington, DC 20436, beginning at 9:30 a.m. on October 5, 1993. All persons shall have the right to appear by counsel or in person, to present information, and to be heard. Requests to appear at the public hearing should be filed with the Secretary, United States International Trade Commission, 500 E Street, SW., Washington, DC 20436, no later than noon, September 17, 1993. Any prehearing briefs (original and 14 copies) should be filed with the Secretary not later than noon, September 27, 1993. Any post hearing briefs should be filed by October 15, 1993.

Written Submissions

In addition to or in lieu of filing prehearing or posthearing briefs, interested parties are invited to submit written statements concerning the matters to be addressed in the report. Commercial or financial information that a party desires the Commission to treat as confidential must be submitted on separate sheets of paper, each clearly marked "Confidential Business Information" at the top. All submissions requesting confidential treatment must conform with the requirements of section § 201.6 of the Commission's Rules of Practice and Procedure (19 CFR 201.6). All written submissions, except for confidential business information, will be made available for inspection by interested persons in the Office of the Secretary to the Commission. To be assured of consideration by the Commission, written statements relating to the Commission's report should be submitted at the earliest practical date and should be received no later than October 15, 1993. All submissions should be addressed to the Secretary, U.S. International Trade Commission, 500 E Street SW., Washington, DC 20436.

Issued: May 21, 1993.

By order of the Commission.

Paul R. Bardos,

Acting Secretary.

[FR Doc. 93-13022 Filed 6-2-93; 8:45 am]

BILLING CODE 7020-02-P

DEPARTMENT OF LABOR

Employment and Training Administration

Defense Conversion Adjustment (DCA) Demonstration Projects To Be Funded With Department of Defense (DoD) Funds

AGENCY: Employment and Training Administration, Labor.

ACTION: Notice.

SUMMARY: The U.S. Department of Labor, Employment and Training Administration (DOL/ETA), announces a second round of Defense Conversion Adjustment (DCA) demonstration projects to be funded with Department of Defense (DoD) appropriated funds. DoD has provided funds to ETA to support programs to provide retraining and readjustment services for dislocated workers under title III of the JTPA. DoD has also provided funds for demonstration projects to encourage and promote innovative responses to dislocations resulting from reductions in defense expenditures or by the closure of military installations. This notice describes the process that eligible entities must use to apply for demonstration funds, the subject areas for which applications shall be accepted for funding, how grantees are to be selected, and the responsibilities of grantees. It is anticipated that approximately $5 million will be available for this round of funding. Based on the availability of funds and the needs of the Department, additional competitions for DCA demonstration projects may be announced.

DATES: Applications for grant awards will be accepted commencing June 3, 1993. The closing date for receipt of applications shall be August 2, 1993, at 2 p.m. (Eastern Time) at the address below.

APPENDIX C
COMPANIES, ASSOCIATIONS, RESEARCH FIRMS, AND GOVERNMENT CONTACTED

GOVERNMENT

Office of the United States Trade Representative
U.S. Bureau of the Mines, Department of the Interior
U.S. Department of Commerce
U.S. Department of Energy
U.S. Department of State
U.S. Environmental Protection Agency
U.S. Trade and Development Program

DOMESTIC

ABC Coke
Acme Steel
American Coke and Coal Chemical Association
American Commercial Barge Line Co.
American Iron and Steel Institute
Armco Steel
Bethlehem Steel
Citizens Gas and Coke
Coal Exporters Association of the United States, Inc.
Coke Consultants, Inc.
Consolidated Railway Corp. (Conrail)
Crown Coal and Coke Co.
CSX Transportation
East-West Center Resources Programs
Empire Coke
Geneva Steel
Gulf States Steel
Hickman & Williams Co.
Industrial Economics, Inc.
Ingram Barge Co.
Inland Steel
Koppers Industries
Krupps Wilputte
Lawrence Berkeley Lab.
LTV
McLouth
Mitsubishi International Corp.
National Steel
Navios Corp.
New Boston
Norfolk Southern Railway Co.
Ohio River Co.
Phibro Energy Inc.
PlanEcon, Inc.
Rouge Steel
Ruhrkohle Trading Corporation
Sharon Steel
Shenango Group
Sloss Industries
Southern Pacific Lines
Sun Oil Co.

Terre Haute Coke and Carbon Corp.
Tonawanda
Union Pacific Railway Co.
United Steelworkers of America
U.S. Steel
Warren Consolidated
Warrior and Gulf Navigation
Weirton Steel Corp.
Wheeling-Pittsburgh

FOREIGN

Alpha International Coal, Ltd.
Center for Economic Analysis, Office of the President, Czech Republic
Coal-Chem Engineers & Consultants, Poland
Environment Agency, Japan
Instytut Budowy Maszyn
International Energy Administration, Coal Research Division
International Iron and Steel Institute
International Legal Counsel
The Japan Aromatic Industry Association, Inc.
Japan Coke Association
The Japan Iron and Steel Federation
Ministry of Industry and Trade, Department of Industrial Policy, Poland
Ministry of Industry, Department of Metallurgy, Czech Republic
Ministry of Industry, Mexico
Ministry of International Trade and Industry, Japan
Mitsubishi Kasei Corp.
Mitsui Mining Co.
Mitsui O.S.K. Lines
Navix Lines
Organization for Economic Cooperation and Development
Steltec
Treuhandanstalt
United Nations Economic Commission for Europe, Energy Division

APPENDIX D
CALENDAR OF WITNESSES APPEARING AT THE PUBLIC HEARING

CALENDAR OF PUBLIC HEARING

Those listed below appeared as witnesses at the United States International Trade Commission's hearing:

Subject	:	METALLURGICAL COKE: BASELINE ANALYSIS OF THE U.S. INDUSTRY AND IMPORTS
Inv. No.	:	332-342
Date and Time	:	October 5, 1993 - 9:30 a.m.

Sessions were held in connection with the investigation in the Main Hearing Room 101 of the United States International Trade Commission, 500 E Street, S.W., Washington, D.C.

ORGANIZATION AND WITNESS:

Fenwick & West
Washington, D.C.
On behalf of

American Coke and Coal Chemicals Institute (ACCCI)

Andrew Aloe, Chief Executive Officer/President, Shenango Group, Inc., Pittsburgh, PA

Mark T. Engle, President, ACCCI, Washington, D.C.

Lee C. Houlditch, President, Sloss Industries Corporation Birmingham, AL

John M. Pearson, Senior Vice President and General Manager, ABC Coke, Birmingham, AL

Donald N. Sweet, Vice President and General Manager, Coke and By-Product Services, Koppers Industries, Inc. Pittsburgh, PA

Dale A. Gilbert, Vice President of Manufacturing, Sloss Industries Corporation, Birmingham, AL

ORGANIZATION AND WITNESS:

Fenwick & West (Continued)
Washington, D.C.
On behalf of

Frank J. Kiessling, Manager, Coke Marketing Planning,
Citizens Gas & Coke Utility

David C. Ailor, Director of Regulatory Affairs,
Coke Association

Roger M. Golden)--OF COUNSEL

Coke Consultants, Inc.
Wheaton, IL

Richard M. Frazier, President

United Steelworkers of America
Birmingham, AL

Michael Locker, Locker Associates,
New York City, NY

Dale A. Gilbert, Vice President of Manufacturing,
Sloss Industries Corporation, Birmingham, AL

Cleary, Gottlieb, Steen & Hamilton
Washington, D.C.
On behalf of

Mitsubishi International Corporation

Bruce Malashevich, Economic Consulting Services, Inc.

Richard deC Hinds)--OF COUNSEL

ORGANIZATION AND WITNESS:

United Mine Workers of America
Belle Vernon, PA

Donald D. Redman, International Executive Board Member, District No. 5, U.M.W.A.

Jim Smith, District 5 President, International Executive Board, U.M.W.A.

Andrew Aloe, Chief Executive Officer/President Shenango Group, Inc., Pittsburgh, PA

APPENDIX E
GLOSSARY

Agglomeration of iron ore
The briquetting, sintering, or pelletizing, of iron ore to improve burden permeability and gas–solid contact in the blast furnace, thereby reducing blast furnace coke rates and increasing the rate of reduction.

Anthracite coal
A hard, black, lustrous coal containing a high percentage of fixed carbon and a low percentage of volatile matter.

Ash
The inorganic residue remaining after ignition of combustible substances.

Battery
A series of adjacent coke ovens, usually 45 or more ovens, sharing coal charging and by product control equipment.

Bituminous coal
A coal which is high in carbonaceous matter, having between 15 and 50 percent volatile matter. Often termed "soft coal".

Blast furnace
A shaft furnace in which solid fuel is burned with an air blast to smelt ore in a continuous operation.

Blast furnace coke
A type of metallurgical coke used in the iron–making blast furnace.

Byproduct oven
A coke oven consisting of a series of long, narrow chambers arranged in rows, and heated by flues in which are burned a portion of the combustible gases generated by the coking of coal. All the volatile products are collected as ammonia, tar, and gas, and may be further processed into other byproducts.

Carbonization
The process of decomposing a nonvolatile carbonaceous substance, usually coal, into solid, liquid, and gaseous products, by heating in a reducing atmosphere.

Coke
Bituminous coal from which the volatile constituents have been driven off by heat, so that the fixed carbon and ash are fused together.

Coke breeze
The fine screenings from crushed coke used predominantly as a fuel source in the process of agglomerating iron ore. Usually coke breeze will pass through a 1/4 inch screen opening.

Coke rate
The amount of coke needed in the blast furnace to produce one ton of iron.

Cold idle
Coke ovens not producing coke or maintained at sufficient temperatures for further coke making. Ovens that can no longer produce coke without replacement of bricks.

Direct reduced iron (DRI)
Ore, generally in the shape of briquettes, that has gone through a reduction process that has driven off most of the oxygen so that the briquettes contain up to 97 percent natural iron.

Electric arc furnace (EAF)
A device that passes a strong electric current through steel scrap, thereby melting it and allowing it to be cast into steel shapes.

Foundry coke
A type of metallurgical coke used in furnaces that produce molten iron and steel for casting purposes. Foundry coke size is generally 3 inches and larger, and requires lower temperatures and longer residence times than blast furnace coke.

Foundry industry
The industry that produces metal castings.

Hot blast
Air forced into a blast furnace after having been heated.

Hot metal
Molten pig iron in the blast furnace.

Hot idle
Maintaining ovens during non–coking periods at a sufficient temperature to ensure integrity of brick for future coke production

Industrial coke
Other coke products not used in blast furnace or foundries.

Integrated mills
Mills that typically include all six steps of steelmaking: ore processing, cokemaking, ironmaking, steelmaking, rolling, and treating.

LAER
Lowest Achievable Emission Rate.

Lignite coal
Coal of low rank with a high inherent moisture and volatile matter.

MACT
Maximum Achievable Control Technology.

Metallurgical coke
A coke with very high compressive strength at elevated temperatures, used in metallurgical furnaces, not only as a fuel, but also to support the weight of the charge.

Offtake
Gas collecting system located on the roof at one end of coke oven designed to carry off the volatile products liberated in the coking process.

Oven
An individual coking chamber composed of silica brick walls with dimensions ranging between 4 to 14 feet in height, 30 to 45 feet in length, and 12 to 25 inches in average width.

Panamax vessels
Shipping vessels that are employed in maritime commerce and principally in trade routes utilizing the Panama Canal. The dead weight capacity for bulk product transport is approximately 60,000 to 70,000 metric tons.

Petroleum coke
The residue obtained by the distillation of petroleum. Used in metallurgical processes and in making battery carbons and carbon pencils.

Pig iron
A metallic product of the blast furnace that is generally not usefully malleable. Contains over 90 percent iron and over 2 percent carbon.

Rationalization
Company efforts to improve their competitive position, usually in response to imbalances between capacity and production and poor financial performance. Rationalization typically includes sizeable workforce reductions, plant closure, and modernization of remaining facilities.

Reduction
The process of removing oxygen from ore.

Sintering
A process in which fine iron ore is mixed with coke and ignited, the coke providing the heat to produce semifused lumps of ore.

Soft loading
Loading of coal or coke using adjustable loaders to minimize the distance between the loader and the coke pile. Soft loading helps reduce degradation during loading.

Subbituminous coal
Coal of rank intermediate between lignite and bituminous.

Tuyere
A tube or opening in a metallurgical furnace through which air is blown as part of the extraction or refining process.

Volatile matter
Those products, excluding moisture, liberated in the form of gas and vapor during the coking process.