Coal

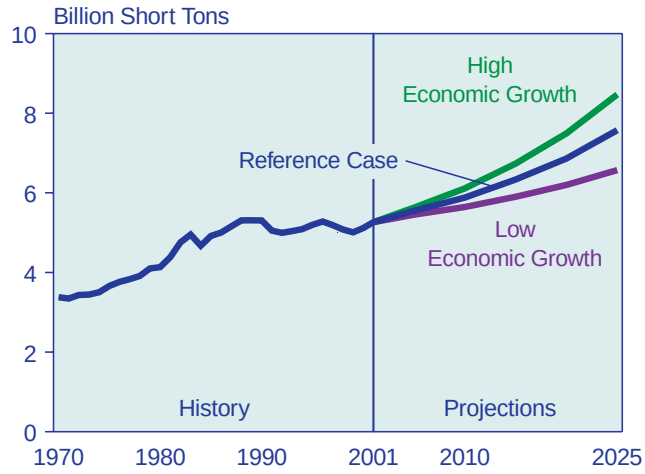
Although coal use is expected to be displaced by natural gas in some parts of the world, only a slight drop in its share of total energy consumption is projected by 2025. Coal continues to dominate fuel markets in developing Asia.

World coal consumption has been in a period of generally slow growth since the late 1980s, a trend that is projected to continue. Although total world consumption of coal in 2001, at 5.26 billion short tons,[10] was more than 27 percent higher than the total in 1980, it was 1 percent below the 1989 peak of 5.31 billion short tons (Figure 52). The *International Energy Outlook 2004* (*IEO2004*) reference case projects growth in coal use between 2001 and 2025, at an average annual rate of 1.5 percent (on a tonnage basis), but with considerable variation among regions.

Coal use is expected to increase in all regions, with the exceptions of Western Europe, Eastern Europe, and the former Soviet Union (FSU) outside Russia. In Western Europe, coal consumption declined by 30 percent between 1990 and 2001 (on a Btu basis), displaced in large part by the growing use of natural gas and, in France, nuclear power. A similar decline occurred in the countries of Eastern Europe and the former Soviet Union (EE/FSU), where coal use fell by 40 percent between 1990 and 2001, primarily as a result of the economic downturns that followed the collapse of the pro-Soviet regimes in Eastern Europe beginning in 1989 and the eventual breakup of the Soviet Union in 1991. The displacement of coal with other sources of energy, primarily natural gas, in the countries of the EE/FSU was also a contributing factor to the decline in coal use during the period. The projected slow growth in world coal use suggests that coal will account for a shrinking share of global primary energy consumption. In 2001, coal provided 24 percent of world primary energy consumption, down from 26 percent in 1990. In the *IEO2004* reference case, the coal share of total energy consumption is projected to fall to 23 percent by 2025 (Figure 53).

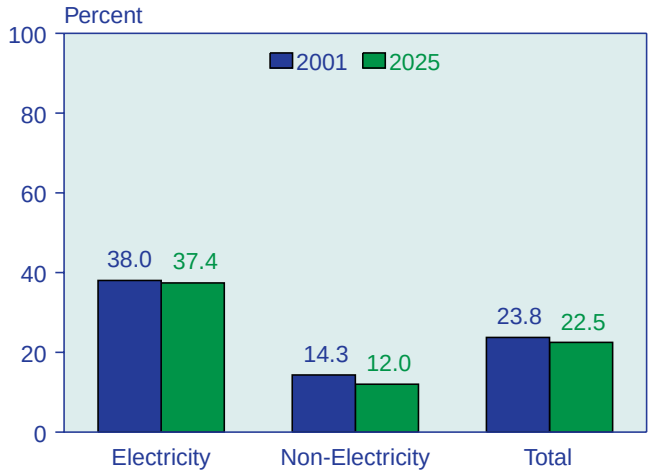
The expected decline in coal's share of energy use would be even greater were it not for large increases in energy use projected for developing Asia, where coal continues to dominate many fuel markets, especially in China and India. As very large countries in terms of both population and landmass, China and India are projected to account for 30 percent of the world's total increase in energy consumption over the forecast period. The expected increases in coal use in China and India from 2001 to 2025 account for 67 percent of the total expected increase in coal use worldwide (on a Btu basis); however, coal's share of energy use in China and India, and in developing Asia as a whole, still is projected to decline

Figure 52. World Coal Consumption, 1970-2025



Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2001*, DOE/EIA-0219(2001) (Washington, DC, February 2003), web site www.eia.doe.gov/iea/. **Projections:** EIA, System for the Analysis of Global Energy Markets (2004).

Figure 53. Coal Share of World Energy Consumption by Sector, 2001 and 2025



Sources: **2001:** Energy Information Administration (EIA), *International Energy Annual 2001*, DOE/EIA-0219(2001) (Washington, DC, February 2003), web site www.eia.doe.gov/iea/. **2025:** EIA, System for the Analysis of Global Energy Markets (2004).

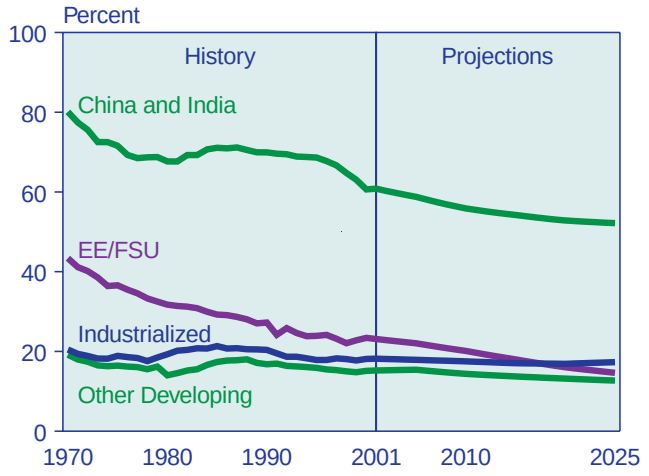
[10]Throughout this chapter, tons refers to short tons (2,000 pounds).

Figure 54). In comparison, the United States accounts for 18 percent of the increase in world energy consumption projected in *IEO2004* and 22 percent of the projected increase in world coal consumption.

Coal consumption is heavily concentrated in the electricity generation sector, although significant amounts are also used for steel production. In 2001, coal accounted for 24 percent of total world energy consumption and for 38 percent of the energy consumed worldwide for electricity production (Figure 53). Coal is also an essential input for steel production, primarily in the basic oxygen furnace process, which currently accounts for about 60 percent of world crude steel production [***1***]. Almost 64 percent of the coal consumed worldwide is used for electricity generation, and in almost every region power generation accounts for the bulk of all the projected growth in coal consumption [**2**]. Where coal is used in the industrial, residential, and commercial sectors, other energy sources—primarily natural gas—are expected to gain market share. One exception is China, where coal continues to be the main fuel in a rapidly growing industrial sector, reflecting the country's abundant coal reserves and limited access to other sources of energy. Consumption of coking coal is projected to decline slightly in most regions of the world as a result of technological advances in steelmaking, increasing output from electric arc furnaces, and continuing replacement of steel by other materials in end-use applications.

The combustion of coal produces several types of emissions that adversely affect the environment. The five principal emissions associated with coal consumption in the electricity and end-use energy sectors are sulfur dioxide (SO_2), which has been linked to acid rain and increased incidence of respiratory illnesses; nitrogen oxides (NO_x), which have been linked to the formation of acid rain and photochemical smog and to depletion of the Earth's ozone layer; particulates, which have been linked to the formation of acid rain and increased incidence of respiratory illnesses; carbon dioxide (CO_2), which has been at the center of ongoing study and debate about global climate change; and mercury, which has been linked with both neurological and developmental damage in humans and other animals. Mercury concentrations in the air usually are low and of little direct concern; however, when mercury enters water—either directly or through deposition from the air—biological processes transform it into methylmercury, a highly toxic chemical that accumulates in fish and the animals (including humans) that eat fish [*3*]. (For additional discussion of SO_2, NO_x, particulates, CO_2, and mercury emissions, see the chapter on "Environmental Issues and World Energy Use.")

Figure 54. Coal Share of Regional Energy Consumption, 1970-2025



Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2001*, DOE/EIA-0219(2001) (Washington, DC, February 2003), web site www.eia.doe.gov/iea/. **Projections:** EIA, System for the Analysis of Global Energy Markets (2004).

The *IEO2004* projections are based on current laws and regulations and do not reflect the possible future ratification of proposed policies to address environmental concerns. In particular, the forecast does not directly assume compliance with the Kyoto Protocol, which currently is not a legally binding agreement, although it does take into account the fact that some countries, such as those in Western Europe, are already taking actions to reduce greenhouse gas emissions. In effect, fuel use patterns in those countries are shifting in favor of fuels such as natural gas and renewables, which produce smaller amounts of greenhouse gas emissions per unit of energy input than do more carbon-intensive fuels, including coal and petroleum products. Similarly, regulation of mercury emissions from coal-fired power plants is not a factor in the *IEO2004* forecast, because proposed regulations in several countries, including the United States, Canada, and the European Union, are not final.

World coal trade is projected to increase from 656 million tons in 2001 to 919 million tons in 2025, accounting for between 12 and 14 percent of total world coal consumption over the period. Steam coal (including coal for pulverized coal injection at blast furnaces) accounts for most of the projected increase in world trade. Details of recent changes in international coal markets, along with a detailed assessment regarding the long-term outlook for world coal trade, are provided at the end of this chapter.

Reserves

Total recoverable reserves of coal around the world are estimated at 1,083 billion tons[11]—enough to last

[11] Recoverable reserves are those quantities of coal which geological and engineering information indicates with reasonable certainty can be extracted in the future under existing economic and operating conditions.

approximately 210 years at current consumption levels (Figure 55). Although coal deposits are widely distributed, 60 percent of the world's recoverable reserves are located in three countries: the United States (25 percent), FSU (23 percent), and China (12 percent). Another four countries—Australia, India, Germany, and South Africa—account for an additional 29 percent. In 2001, these seven countries accounted for 80 percent of total world coal production [*4*].

Quality and geological characteristics of coal deposits are other important parameters for coal reserves. Coal is a much more heterogeneous source of energy than is oil or natural gas, and its quality varies significantly from one region to the next and even within an individual coal seam. For example, Australia, the United States, and Canada are endowed with substantial reserves of premium-grade bituminous coals that can be used to manufacture coke. Together, these three countries supplied 81 percent of the coking coal traded worldwide in 2002 (see Table 13 on page 89).

At the other end of the spectrum are reserves of low-Btu lignite or "brown coal." Coal of this type is not traded to any significant extent in world markets, because of its relatively low heat content (which makes its transportation costs higher than those for bituminous coal on a Btu basis) and other problems related to transport and storage. In 2001, lignite accounted for 18 percent of total world coal production (on a tonnage basis) [*5*]. The top three producers were Germany (193 million tons), Russia (110 million tons), and the United States (84 million tons), which as a group accounted for 41 percent of the world's total lignite production in 2001.

On a Btu basis, lignite deposits show considerable variation. Estimates by the International Energy Agency, for coal produced in 2001, show that the average heat content of lignite from major producers in countries of the Organization for Economic Cooperation and Development (OECD) varied from a low of 4.55 million Btu per ton in Greece to a high of 12.25 million Btu per ton in Canada [*6*]. In comparison, bituminous coal supplied to U.S. electric utilities in 2001 had a heat content of 23.84 million Btu per ton [*7*].

Regional Consumption

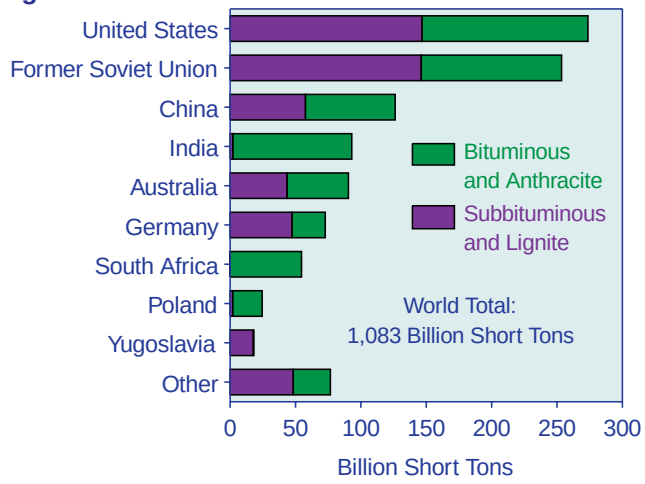
Developing Asia

The countries of developing Asia accounted for 40 percent of the world's coal consumption in 2001. Primarily as a result of substantial growth in coal consumption in China and India over the forecast period, developing Asia, taken as a whole, is projected to account for a 51-percent share of total world coal consumption by 2025.

The large increases in coal consumption projected for China and India (Figure 56) are based on an outlook for strong economic growth (6.1 percent per year in China and 5.2 percent per year in India between 2001 and 2025) and the expectation that much of the increased demand for energy will be met by coal, particularly in the industrial and electricity sectors. The *IEO2004* forecast assumes that necessary investments in the countries' mines, transportation, industrial facilities, and power plants will be made.

In China, 58 percent of the coal demand in 2001 occurred in the non-electricity sectors, for steam and direct heat

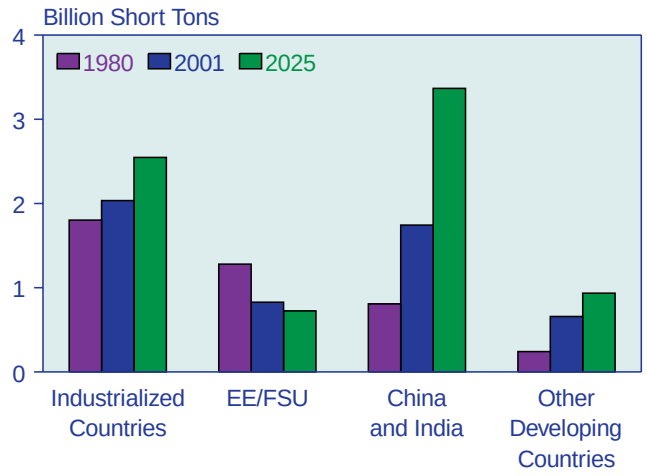
Figure 55. World Recoverable Coal Reserves



Note: Data for the U.S. represent recoverable coal estimates as of January 1, 2001. Data for other countries are as of January 1, 2000.

Source: Energy Information Administration, *International Energy Annual 2001*, DOE/EIA-0219(2001) (Washington, DC, February 2003), Table 8.2, web site www.eia.doe.gov/iea/.

Figure 56. World Coal Consumption by Region, 1980, 2001, and 2025



Sources: **1980 and 2001:** Energy Information Administration (EIA), *International Energy Annual 2001*, DOE/EIA-0219 (2001) (Washington, DC, February 2003), web site www.eia.doe.gov/iea/. **2025:** EIA, System for the Analysis of Global Energy Markets (2004).

for industrial applications (primarily in the chemical, cement, and pulp and paper industries), and for the manufacture of coal coke for input to the steelmaking process. Although coal demand in China's non-electricity sectors is expected to increase by 8 quadrillion Btu over the forecast period, the non-electricity share of total coal demand is projected to decline to 44 percent by 2025. In 2001, China was the world's leading producer of both steel and pig iron [*8*].

Coal remains the primary source of energy in China's industrial sector, primarily because China has limited reserves of oil and natural gas. In the non-electricity sectors, most of the projected increase in oil use comes from rising demand for energy for transportation. Growth in the consumption of natural gas is expected to come primarily from increased use for space heating in the residential and commercial sectors.

With a substantial portion of the increase in China's demand for both oil and natural gas projected to be met by imports, the construction of a China's first coal liquefaction plant was recently initiated by the Shenhua Coal Liquefaction Corporation, with an expected startup in 2007 [*9*]. The facility will be located in Inner Mongolia and will be capable of converting 5.5 million tons of coal to 7.3 million barrels of petroleum products annually. By comparison, South Africa's most recently constructed coal liquefaction plant (built by SASOL at Secunda, South Africa, in 1982) is capable of producing more than 25 million barrels of coal liquids annually.

In China's electricity sector, coal use is projected to grow by 4.1 percent a year, from 10.7 quadrillion Btu in 2001 to 28.2 quadrillion Btu in 2025. In comparison, coal consumption by electricity generators in the United States is projected to rise by 1.5 percent annually, from 21.0 quadrillion Btu in 2001 to 30.3 quadrillion Btu in 2025. One of the key implications of the substantial rise in coal use for electricity generation in China is that large financial investments in new coal-fired power plants and in the associated transmission and distribution systems will be needed. The projected growth in coal demand implies that China will need to build approximately 171 gigawatts of additional coal-fired capacity by 2025.[12] At the beginning of 2001, China had 232 gigawatts of coal-fired generating capacity [*10*].

Although China is heavily dependent on coal as a source of indigenous energy supply, a number of energy projects involving other fuels are in the pipeline and will contribute significantly to domestic energy supply. Two major projects that are well underway are the Three Gorges Dam and the West-East Gas Pipeline Project. When completed in 2009, the 18.2-gigawatt Three Gorges Dam will have 26 generating turbines and be capable of producing 84.7 billion kilowatthours of electricity annually, or about 5 percent of total electricity demand projected for China in 2010 in the *IEO2004* reference case [*11*]. The first four generating turbines at the Three Gorges Dam began operating in 2003. A major new upgrade to China's electricity grid, the West-East Power Transmission Project, will facilitate the transmission of electricity from Three Gorges to load centers in eastern and southern China.

A second major energy project is the West-East Gas Pipeline Project. The 2,500-mile-long pipeline will be capable of transporting 706 billion cubic feet of natural gas annually from China's Tarim Basin in the northwest part of the country to eastern and southern provinces [*12*]. The pipeline is scheduled to be fully operational by the beginning of 2005. Annual sales are expected to reach 420 billion cubic feet by 2009, equivalent to 22 percent of total natural gas consumption projected for China in 2010 in the *IEO2004* reference case.

In India, projected growth in coal demand occurs primarily in the electricity sector, which currently accounts for a little more than three-quarters of India's total coal consumption. Coal use for electricity generation in India is projected to rise by 2.3 percent per year, from 5.0 quadrillion Btu in 2001 to 8.6 quadrillion Btu in 2025, implying that India will need to build approximately 57 gigawatts of additional coal-fired capacity.[13] At the beginning of 2001, India's total coal-fired generating capacity amounted to 66 gigawatts [*13*].

India's state-owned National Thermal Power Corporation (NTPC) is the largest thermal power generating company in India. At present, it has 17 gigawatts of coal-fired capacity and another 3 gigawatts under construction that rely almost exclusively on India's state-owned coal producer, Coal India Limited (CIL), for its supply of coal [*14*]. Later in this decade, however, demand from the power sector is expected to outstrip CIL's production target level, with the result that NTPC and the other utilities in India will begin supplementing domestic coal supplies with additional shipments from the international market [*15*].

[12]Based on the assumption that, on average, coal consumption at China's fleet of coal-fired power plants will rise to a level of 70 trillion Btu per gigawatt by 2025. Higher average utilization rates (or capacity factors) for coal plants, taken as a whole, would increase the amount of coal consumed per unit of generating capacity, while overall improvements in conversion efficiencies would have the opposite effect. In EIA's *Annual Energy Outlook 2004* reference case forecast, U.S. coal-fired power plants are projected to consume an average of 72 trillion Btu of coal per gigawatt of generating capacity in 2025, based on a projected average utilization rate of 83 percent and an average conversion efficiency of 34.6 percent. At present, similar projections of generating capacity, capacity utilization, and conversion efficiencies are not available from EIA's System for the Analysis of Global Energy Markets (SAGE).

[13]Based on the assumption that, on average, coal consumption at India's coal-fired power plants will rise to a level of 70 trillion Btu per gigawatt by 2025. See previous footnote for discussion of the factors that affect the amount of coal consumed per unit of generating capacity.

In the other areas of developing Asia, a considerably smaller rise in coal consumption is projected over the forecast period, based on expectations for growth in coal-fired electricity generation in South Korea, Taiwan, and the member countries of the Association of Southeast Asian Nations (primarily Indonesia, Malaysia, the Philippines, Thailand, and Vietnam). In the electricity sector, coal use in the other developing countries of Asia (including South Korea) is projected to increase by 2.0 percent per year, from 3.4 quadrillion Btu in 2001 to 5.4 quadrillion Btu in 2025.

The key motivation for increasing use of coal in other developing Asia is diversity of fuel supply for electricity generation [***16***]. This objective exists even in countries that have abundant reserves of natural gas, such as Thailand, Malaysia, Indonesia, and the Philippines. In the *IEO2004* forecast, coal's share of fuel consumption for electricity generation in the region (including South Korea) is projected to decrease from 33 percent in 2001 to 27 percent in 2025.

Some of the planned additions of coal-fired generating capacity in other developing Asia for 2002 and later include 8,600 megawatts of new coal-fired capacity for South Korea by 2015, 6,900 megawatts for Taiwan by 2015, 5,600 megawatts for Malaysia by 2010, 1,346 megawatts for Thailand by 2007, and 1,320 megawatts for Indonesia by 2006 [***17***]. In addition to planned capacity additions, a number of new coal-fired units have come on line in the region in 1999, 2000, and 2001, adding a combined total of almost 13,000 megawatts of electric power supply in South Korea (3,700 megawatts), Taiwan (3,700 megawatts), Indonesia (2,450 megawatts), Malaysia (1,000 megawatts), and the Philippines (2,040 megawatts) [***18***].

Because of environmental concerns and abundant natural gas reserves, there is considerable opposition to the addition of coal-fired capacity in Southeast Asia, particularly for countries such as Thailand and the Philippines. A number of individuals and environmental groups argue that reliance on local supplies of natural gas for electricity generation is a wiser and probably a more economical choice than constructing new coal-fired power plants that will rely on imported fuel and produce more pollution than gas-fired plants [***19***].

In Thailand, strong environmental opposition to coal has prevailed over the desire for diversification of fuel supply leading to the government's cancellation of two large coal-fired generation projects [***20***]. This leaves one planned independent power producer (IPP) coal project for Thailand, the 1,434-megawatt Map Ta Phut plant being built by BLCP Power (a consortium of energy companies), whose two units are scheduled to come on line in late 2006 and early 2007 [***21***]. The Electricity Generating Authority of Thailand (the state-owned electric utility) has tentative plans to construct a 600-megawatt lignite-fired plant in northern Thailand that would be fueled by indigenous lignite [***22***].

Industrialized Asia

Industrialized Asia consists of Australia, New Zealand, and Japan. Australia is the world's leading coal exporter, and Japan is the world's leading coal importer. In 2001, Australian coal producers shipped 214 million tons of coal to international consumers and consumed another 144 million tons (both hard coal and lignite) domestically, primarily for electricity generation. Coal-fired power plants accounted for 78 percent of Australia's total electricity generation in 2001 [***23***]. Over the forecast horizon, coal use in Australia is expected to increase slightly. Australia's Queensland district has recently completed three coal-fired power projects: Callide C power plant (840 megawatts of capacity brought on line in 2001), Millmerran plant (840 megawatts of capacity brought on line in 2002), and Tarong Power plant (450 megawatts of capacity brought on line in 2003) [***24***]. In addition, Australia's Griffin Group plans to construct a 350-megawatt coal-fired plant near the existing Collie A power plant in Western Australia [***25***].

Japan, which is the third largest coal user in Asia (behind China and India) and the seventh largest globally (following China, India, the United States, Russia, Germany, and South Africa), imports nearly all the coal it consumes, much of it originating from Australia [***26***]. Currently, slightly more than one-half of the coal consumed in Japan is used by the country's steel industry (Japan is the world's second largest producer of both crude steel and pig iron, behind China) [***27***]. Coal is also used heavily in the Japanese power sector, and coal-fired plants generated 23 percent of the country's electricity supply in 2001 [***28***]. Japanese power companies plan to construct an additional 16 gigawatts of new coal-fired generating capacity between 2001 and 2010 [***29***].

Western Europe

In Western Europe, environmental concerns play an important role in the competition among coal, natural gas, and nuclear power. Recently, other fuels—particularly, natural gas—have been gaining over coal in the generation market. Coal consumption in Western Europe has fallen by 36 percent since 1990, from 894 million tons to 574 million tons in 2001. The decline was smaller on a Btu basis, at 30 percent, reflecting the fact that much of it resulted from reduced consumption of low-Btu lignite in Germany.

Over the forecast period, coal consumption in Western Europe is projected to decline by an additional 19 percent (on a Btu basis), reflecting a slower rate of decline than was seen during the previous decade. Factors contributing to further cutbacks in coal

consumption include continued penetration of natural gas for electricity generation, environmental concerns, and continuing pressure on member countries of the European Union to reduce subsidies that support domestic production of hard coal (see box on page 81).

Despite a substantial decline in coal consumption since 1990, Germany continues to be the leading coal-consuming country in Western Europe, a role that it is projected to maintain over the forecast period. Coal consumption in Germany fell by 50 percent between 1990 and 2001, from 528 million tons to 265 million tons. The *IEO2004* reference case projects a more modest rate of decline in the future, to 232 million tons in 2025.

In 2001, coal-fired plants accounted for slightly more than 50 percent of Germany's total electricity output. Lignite plants accounted for 27 percent of the total and hard coal plants 24 percent [***30***]. Current plans to replace some of Germany's older lignite-fired generating capacity have been placed on hold as a result of uncertainties surrounding the development of a European strategy to allocate carbon dioxide emission allowances [***31***]. Each of the 15 member countries of the European Union is required to submit a National Allocation Plan (NAP) to the European Commission by March 31, 2004 [***32***]. In turn, the Commission plans to issue final rulings on the individual NAPs as early as summer 2004. The actions are part of an overall plan to cap emissions of the European Union countries at the total specified under the Kyoto Protocol and to create an international emissions trading market for allowances.

In the United Kingdom, coal-fired power generation is largely being displaced by generation from new natural-gas-fired combined-cycle plants. During the 1990s, new gas-fired plants in the United Kingdom benefited from declining natural gas prices and increasing conversion efficiencies [***33***]. In the *IEO2004* forecast, coal consumption in the United Kingdom is projected to decline from 71 million tons in 2001 to 49 million tons in 2025.

In Spain, coal consumption declined from 52 million tons in 1990 to 45 million tons in 2001 [***34***]. The coal share of Spain's total electricity generation is projected to decline as gas-fired plants proliferate. The owners of Spain's coal-fired generating plants, Endesa and Union Fenosa, plan to keep most of the plants in operation but acknowledge that their role is likely to shift from baseload to peaking generation.

Major projects currently underway at two of Spain's coal-fired plants will enable them to operate entirely on imported coal [***35***]. The plants, which currently burn blends of domestic lignite and imported coal, are Union Fenosa's 550-megawatt Meirama plant and Endesa's 1,400-megawatt As Pontes plant. Because the imported coal will have a higher heat content than the domestic lignite it will be replacing, the increased quantity of coal imports will be considerably less than the 9 million tons of domestic lignite currently consumed at the two plants. In 2000, the local lignite burned at the Meirama and As Pontes plants had average heat contents of approximately 6.9 and 6.6 million Btu per ton, respectively [***36***].

In France, coal consumption declined from 35 million tons in 1990 to 21 million tons in 2001. Although several coal-fired generating plants have been earmarked for retirement, the country's two main thermal generators—EDF (Électricité de France) and SNET (Société Nationale d'Électricité et de Thermique—have embarked on an investment plan to refurbish many of their existing coal plants for the purpose of extending their operating lives to at least 2015 [***37***]. While coal plants in France are typically operated as peaking capacity (the average capacity factor for France's fleet of coal-fired generating plants in 2001 was slightly under 20 percent), it is felt that coal-fired generation plays an important role in balancing out the country's nuclear-heavy generation mix [***38***]. Nuclear power plants accounted for 77 percent of total electricity generation in Frnace in 2001, with hydropower and coal adding 14 percent and 5 percent, respectively [***39***]. Nevertheless, the *IEO2004* reference case expects some additional declines in overall coal use in France, with consumption projected to fall to 11 million tons in 2025.

Coal use in other major coal-consuming countries in Western Europe is projected either to decline or to remain close to current levels. In the Scandinavian countries (Denmark, Finland, Norway, and Sweden), environmental concerns and competition from natural gas are expected to reduce coal use over the forecast period. The government of Denmark has stated that its goal is to eliminate coal-fired generation by 2030 [***40***]. In 2001, 47 percent of Denmark's electricity was supplied by coal-fired plants [***41***].

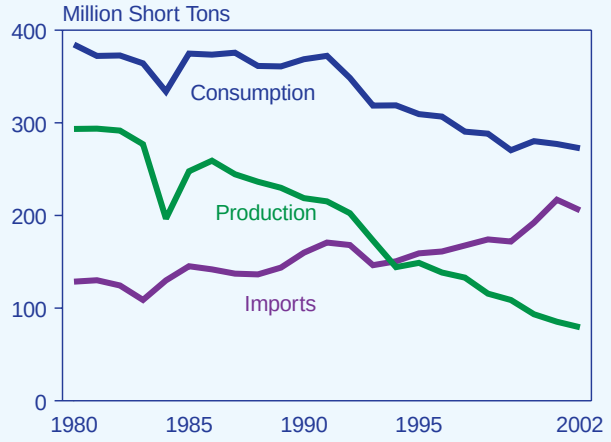
Coal consumption in Italy is projected to decline only slightly in the *IEO2004* forecast, from 22 million tons in 2001 to 20 million tons in 2025. Factors contributing to the continued use of coal in Italy over the forecast horizon include near-term plans by Enel, Italy's dominant electricity company, to switch some of its high-cost oil-fired capacity to coal, and the recent conversion of two units at Endesa Italia's Fiume Santo power station in Sardinia from Orimulsion to coal [***42***].

Partially offsetting the expected declines in coal consumption elsewhere in Europe is a projected increase in consumption of indigenous lignite for power generation in Greece. Under a burden-sharing agreement reached by the countries of the European Union in June 1998, Greece committed to capping its emissions of

Coal Production and Subsidies in Western Europe

In Western Europe, recent trends in consumption of hard coal[a] are closely correlated with trends in its production, primarily because coal imports have increased by considerably less than production has declined (see figure below). From 1980 to 2002, coal imports to Western Europe increased by 77 million tons, while hard coal production declined by 214 million tons. Following the closure of the last remaining coal mines in Belgium (in 1992) and Portugal (in 1994), only four member states of the European Union (the United Kingdom, Germany, Spain, and France) continued to produce hard coal,[b] and all have seen their output of hard coal decline since 1990. The European Union will add two additional hard coal producers, Poland and the Czech Republic, in 2004.[c] In addition to hard coal, Germany and Greece produce and consume substantial amounts of lignite, and some lignite is also produced at two mines in the northwestern area of Spain.

Production, Consumption, and Imports of Hard Coal in Western Europe, 1980-2002



Note: Data for 2002 are preliminary.
Source: International Energy Agency, Databases for *Coal Information 2003*, web site http://data.iea.org.

The governments of Germany, Spain, France, and the United Kingdom currently support domestic production of hard coal through subsidies approved by the European Commission (see table on page 82).[d] In 2001, authorized subsidies amounted to $3,668 million in Germany, $919 million in Spain, $875 million in France, and $90 million in the United Kingdom (in nominal U.S. dollars).[e] In Germany, Spain and France, the average subsidy per ton of coal produced exceeds the average value of imported coal. Hard coal production is expected to come to an end in France in 2004, but the governments in Germany and Spain plan to continue financial support for their hard coal industries, while acknowledging that future reductions in coal production are inevitable when existing mines exhaust their minable reserves.

After 50 years in force, the European Coal and Steel Community treaty expired in July 2002. The European Commission has proposed a new state aid program for coal, establishing the continuation of subsidies for hard coal production in member states through December 31, 2010.[f] The Commission wants to establish measures that will promote the development of renewable energy sources while maintaining a minimum level of subsidized coal production in the European Union as an "indigenous primary energy base." The guiding principle will be that subsidized coal production will be limited to the minimum necessary for energy security—maintaining access to coal reserves, keeping equipment in an operational state, preserving the professional qualifications of a nucleus of coal miners, and safeguarding technological expertise.

In the United Kingdom, hard coal production fell from 104 million tons in 1990 to 35 million tons in 2001.[g] Of the 2001 total, 19 million tons was from underground operations and 16 million tons from surface mines.[h] The United Kingdom's remaining hard coal mines are by far the most productive in Western Europe, and

(continued on page 82)

[a]Internationally, the term "hard coal" is used to describe anthracite and bituminous coal. In data published by the International Energy Agency, coal of subbituminous rank is classified as hard coal for some countries and as brown coal (with lignite) for others.
[b]Directorate-General XVII—Energy, European Commission, *The Market for Solid Fuels in the Community in 1996 and the Outlook for 1997* (Brussels, Belgium, June 6, 1997), web site www.europa.eu.int.
[c]Commission of the European Communities, *Proposal for a Council Regulation on State Aid to the Coal Industry* (Brussels, Belgium, July 25, 2001), p. 17, web site www.europa.int.
[d]In Spain, subsidies support the production of both hard coal and subbituminous coal.
[e]Commission of the European Communities, *Report From the Commission On the Application of the Community Rules For State Aid To The Coal Industry In 2001* (Brussels, Belgium, October 4, 2002), p. 10, web site www.europa.eu.int.
[f]Commission of the European Communities, *Proposal for a Council Regulation on State Aid to the Coal Industry* (Brussels, Belgium, July 25, 2001), web site www.europa.eu.int.
[g]Energy Information Administration, *International Energy Annual 2001*, DOE/EIA-0219 (2001) (Washington, DC, February 2003), Tables 2.5 and 5.4.
[h]UK Department of Trade and Industry, "Energy Statistics: Coal," Table 2.7, web site www.dti.gov.uk.

Coal Production and Subsidies in Western Europe (Continued)

improvements in mining operations in recent years have increased average labor productivity (tons produced per miner per year) from 1,272 in 1990 to 2,929 in 2001.[i] The price of coal from domestic mines is essentially at parity with the price of coal imports, and it is likely that U.K. coal production will fluctuate with changes in international coal prices.[j] When international coal prices fell between 1998 and 2000, the government reinstated coal production subsidies for 2000 through 2002 in an effort to protect the country's remaining coal operations.[k]

At 2001 production levels, recent and impending mine closures in the United Kingdom will remove approximately 6 million tons of underground coal production by the end of 2007.[l] Mines closed or scheduled for closure include Clipstone and Betws (both closed in 2003), Ricall, Stillingfleet, and Wistow (all part of the Selby Complex and to be closed in June 2004), and Ellington (to be closed in 2007).[m] A recent report by the U.K. government indicates that underground mining operations will continue to be closed as they reach the end of their geologic and economic lives, and production at most of the country's deep mines is likely to end within the next 10 years.[n] In 2003, some additional state aid was made available to a number of underground mines, based on the premise that the resulting capital investments would provide access to additional reserves of coal.[o]

Germany's hard coal production dropped from 86 million tons in 1990 to 32 million tons in 2001.[p] Currently, all of its hard coal production comes from 10 underground mines operated by Deutsche Steinkohle.[q] Recent negotiations and political decisions by the German government, the European Commission, the miners' trade union, and Deutsche Steinkohle point to the probable closure of 5 of those mines between 2006 and 2012, reducing output to an estimated 18 million tons.[r]

(continued on page 83)

Western European Coal Industry Subsidies, Production, and Import Prices, 2001

Country	Coal Industry Subsidies (Million 2001 U.S. Dollars)	Hard Coal Production (Million Tons)	Average Subsidy per Ton of Coal Produced (2001 U.S. Dollars)	Average Price per Ton of Coal Imported (2001 U.S. Dollars)
Germany	3,668	32.4	113	39
Spain	919	15.9	58	36
France	875	2.2	403	42
United Kingdom	90	34.7	3	43

Sources: **Coal Production Subsidies:** Commission of the European Communities, *State Aid Scorecard—Statistical Tables*, web site www.europa.eu.int; and U.S. Federal Reserve Bank, "Foreign Exchange Rates (Annual)," web site www.federalreserve.gov (January 6, 2004). **Production:** Energy Information Administration, *International Energy Annual 2001*, DOE/EIA-0219(2001) (Washington, DC, February 2003), web site www.eia.doe.gov/iea/. **Average Price of Coal Imports:** International Energy Agency, *Coal Information 2003* (Paris, France, November 2003).

[i]International Energy Agency, *Coal Information 2003* (Paris, France, November 2003), Table 6.4.

[j]Commission of the European Communities, *Proposal for a Council Regulation on State Aid to the Coal Industry* (Brussels, Belgium, July 25, 2001), pp. 24-25, web site www.europa.eu.int.

[k]"Coal Industry Receives Additional Funds as EU Drafts New Aid Plan," *Financial Times: International Coal Report*, No. 530 (July 31, 2001), pp. 8-9.

[l]"Britain's Coal Industry," UK Coal, web site www.rjb.co.uk (accessed: February 8, 2004).

[m]UK Department of Trade and Industry, "Energy Statistics: Coal," Table 2.10, web site www.dti.gov.uk; "100 Jobs to Go as Pit Shuts," BBC News (July 23, 2003), web site news.bbc.co.uk; and "End Predicted for Lone Coal Mine," BBC News (March 27, 2003), web site news.bbc.co.uk.

[n]UK Department of Trade and Industry, *Energy White Paper: Our Energy Future—Creating a Low Carbon Economy*, Cm 5761 (February 2003), pp. 93-94.

[o]UK Department of Trade and Industry, *Energy White Paper: Our Energy Future—Creating a Low Carbon Economy*, Cm 5761 (February 2003), pp. 93-94; and "UK Coal PLC (UKC.L) Investment Aid," *Regulatory News Service* (December 18, 2003).

[p]Energy Information Administration, *International Energy Annual 2001*, DOE/EIA-0219(2001) (Washington, DC, February 2003), Tables 2.5 and 5.4.

[q]International Energy Agency, *Coal Information 2003* (Paris, France, November 2003), Tables 6.1; and "New German Import Surge on the Horizon," *McCloskey's Coal Report*, No 65 (July 25, 2003), p. 8.

[r]"New German Import Surge on the Horizon," *McCloskey's Coal Report*, No 65 (July 25, 2003), p. 8.

Coal Production and Subsidies in Western Europe (Continued)

Germany continues to be the world's top producer of lignite, despite substantial reductions over the past decade. Between 1990 and 2001, German lignite production fell by 55 percent, from 427 to 193 million tons, primarily because natural gas has displaced both lignite and lignite-based "town gas"[s] in the eastern states since reunification in 1990.[t] The collapse of industrial output in the eastern states was a contributing factor.

In Spain, hard coal production fell from 22 million tons in 1990 to 16 million tons in 2001.[u] Spain has adopted a restructuring plan for 1998 through 2005 that includes a gradual decline to 12 million tons of production.[v] In addition to hard coal, two lignite mines in Spain produced 9 million tons in 2001. Both mines, however, are scheduled to close in the near future.[w]

In France, production of hard coal declined from 12 million tons in 1990 to 2 million tons in 2001.[x] The closure of the country's three remaining coal mines in 2003 (Gardanne and Merlebach) and 2004 (La Houve) will bring an end to the country's 200-year history of coal production.[y]

Greece is another major producer of coal in Western Europe, but its reserves and production consist of lower-ranked lignite. Lignite production in Greece increased from 57 million tons in 1990 to 74 million tons in 2001,[z] virtually all used for electricity generation. The heat content of lignite reserves in Greece is low, even in comparison with lignite reserves in other countries, and substantial amounts are required per unit of electricity generated.

[s]"Town gas" (or "coal gas"), a substitute for natural gas, is produced synthetically by the chemical reduction of coal at a coal gasification facility.

[t]Directorate-General XVII—Energy, European Commission, *Energy in Europe: European Union Energy Outlook to 2020* (Brussels, Belgium, November 1999), p. 47.

[u]Energy Information Administration, *International Energy Annual 2001*, DOE/EIA-0219 (2001) (Washington, DC, February 2003), Tables 2.5 and 5.4.

[v]Commission of the European Communities, *Proposal for a Council Regulation on State Aid to the Coal Industry* (Brussels, Belgium, July 25, 2001), p. 25, web site www.europa.eu.int.

[w]"Spain Promises Import Bonanza," *McCloskey Coal Report, No. 19* (September 21, 2001), pp. 21-22.

[x]Energy Information Administration, *International Energy Annual 2001*, DOE/EIA-0219 (2001) (Washington, DC, February 2003), Tables 2.5 and 5.4.

[y]"French Gardanne Coal Mine to be Shut, Miners Protest," *Platts Commodity News* (February 4, 2003); and R. Tieman, "France Puts an End to Its Mining Industry," *The Business* (January 12, 2003).

[z]Energy Information Administration, *International Energy Annual 2001*, DOE/EIA-0219(2001) (Washington, DC, February 2003), Table 5.4.

greenhouse gases by 2010 at 25 percent above their 1990 level—a target that is substantially less severe than the emissions target for the European Union as a whole, which caps emissions at 8 percent below 1990 levels by 2010 [***43***]. The European Union's burden-sharing agreement permitted higher emission targets for several member countries—including Greece, Spain, Portugal, and Ireland—primarily on the basis of economic conditions and the fact that greenhouse gas emissions for those countries are low in comparison with most of the other member countries.

Virtually all the coal produced in Greece is lignite that is used for electricity generation. In 2001, lignite-fired power plants (4,516 megawatts of capacity) accounted for 66 percent of the country's total electricity output [***44***]. A new 330-megawatt lignite-fired power plant came on line in northern Greece in mid-2003, and another unit of the same size is scheduled to be built soon at the same site [***45***].

Eastern Europe and the Former Soviet Union

In the EE/FSU countries, the process of economic reform continues as the transition to a market-oriented economy replaces centrally planned economic systems. The dislocations associated with institutional changes in the region have contributed substantially to declines in both coal production and consumption. Coal consumption in the EE/FSU region has fallen by 40 percent, from 1,376 million tons in 1990 to 828 million tons in 2001. In the future, total energy consumption in the EE/FSU is expected to rise, primarily as the result of increasing production and consumption of natural gas. In the *IEO2004* reference case, coal's share of total EE/FSU energy consumption is projected to decline from 23 percent in 2001 to 15 percent in 2025, and the natural gas share is projected to increase from 45 percent in 2001 to 52 percent in 2025.

Of the 15 FSU countries, Russia, Ukraine, and Kazakhstan together accounted for 98 percent of the region's total coal consumption and 99 percent of its coal production in 2001 [***46***]. Intraregional coal trade in the FSU has been substantial over the years, and the region as a whole is relatively self-sufficient in terms of coal supply. Coal imports from non-FSU countries in 2001 (including both seaborne and other shipments) was less than 2 million tons [***47***].

In addition to substantial declines in economic output and energy demand that followed the breakup of the Soviet Union in 1991, the transition of coal production from state-run enterprises to private companies in the three major coal-producing FSU countries has reduced their coal output. From 1990 to 2001, total energy consumption in the FSU declined by 18.8 quadrillion Btu, or 31 percent, and coal consumption fell by 5.4 quadrillion Btu, or 41 percent.

Both Kazakhstan and Russia have shown considerable progress in terms of closing uneconomical mining operations and selling government-run mining operations to the private sector, but Ukraine has made considerably less progress in its restructuring efforts. In Kazakhstan, many high-cost underground coal mines have been closed, and its more competitive surface mines are now owned and operated by international energy companies [***48***]. In Russia, the World Bank estimated that 77 percent of the country's coal production in 2001 would originate from mines not owned by the government, and that percentage was expected to increase to more than 90 percent by the end of 2002 [***49***].

Privatization of the coal industry in Ukraine faces a variety of challenges, including financial instability (many of the country's coal operations are involved in bankruptcy proceedings), lack of funds for addressing the social and environmental problems associated with mine closures, and harsh geologic conditions at many of the underground coal mines [***50***]. Geologic factors affecting Ukraine's underground mining operations include thin, steeply sloping coal seams, very deep mines, and high concentrations of methane gas. As a result, Ukraine's coal mines rank among the least productive operations in the world. In 2002, average coal mining productivity in Ukraine was approximately 320 tons per miner per year [***51***], as compared with Poland at 800 tons per miner, United Kingdom at 3,110 tons per miner, South Africa at 5,225 tons per miner, the United States at 14,110 tons per miner, and Australia at 14,220 tons per miner [***52***].

Recent data indicate a slight resurgence in coal production in the FSU region since 1998, particularly in Russia and Kazakhstan, and the governments of the three coal-producing countries have indicated that further increases in coal consumption and production are expected [***53***]. The *IEO2004* outlook for FSU coal consumption, however, is for a fairly flat trend over time. Natural gas and oil are expected to fuel most of the projected increase in the region's energy consumption.

In Eastern Europe, Poland is the largest producer and consumer of coal; in fact, it is the second largest coal producer and consumer in all of Europe, outranked only by Germany [***54***]. In 2001, coal consumption in Poland totaled 151 million tons—47 percent of Eastern Europe's total coal consumption for the year [***55***]. Poland's hard coal industry produced 113 million tons in 2001, and lignite producers added 66 million tons [***56***].

Coal consumption in other Eastern European countries is dominated by the use of low-Btu subbituminous coal and lignite produced from local reserves. The region, taken as a whole, relies heavily on local production, with seaborne imports of coal to the region totaling only 3 million tons in 2001 [***57***]. Like the FSU, Eastern Europe also experienced substantial declines in both overall energy and coal consumption during the 1990s, as national economies in the region moved from a Soviet-era emphasis on heavy industry to less energy-intensive industries. As a result, coal consumption in Eastern Europe has declined by 28 percent, from 528 million tons in 1990 to 382 million tons in 2001.

In Poland, coal is by far the most important energy source for electricity generation. Coal-fired power plants provided 93 percent of the country's total generation in 2001 [***58***]. Notwithstanding the importance of coal to Poland's economy, however, its hard coal industry faces significant challenges. Over the past several years, the Polish government has issued a number of draft plans for coal industry restructuring, aimed at moving the hard coal industry to a position of positive earnings and eliminating government subsidies. Each plan proposes the closing of a number of the country's least productive mines, which could reduce hard coal production from the 113 million tons mined in 2001 to as little as 77 million tons in 2020 [***59***]. Nevertheless, the government anticipates that coal will continue to play an important role in Poland's overall energy mix, particularly in the electricity sector, where upgrades of existing coal-fired plants are being emphasized for both environmental and efficiency reasons [***60***].

The Czech Republic, which consumed 68 million tons of coal in 2001, is the second leading coal consumer in Eastern Europe [***61***]. Coal-fired plants in the Czech Republic accounted for 70 percent of the country's total electricity generation in 2001 [***62***]. In the near term, the commissioning of the Czech Republic's second nuclear power plant, the 2,000-megawatt Temelin plant, in 2003 is expected to reduce slightly the use of coal in the country's electricity sector [***63***]. In the longer term, however, a recently approved energy policy developed by the Czech Industry Ministry calls for increased dependence on domestic supplies of energy, especially lignite [***64***].

CEZ, the Czech Republic's largest power generator, has announced that it plans to reopen an idled coal-fired power plant in Tusimice and build several new ones over the next 10 years to replace old plants in north Bohemia [***65***]. It is expected that most of the coal to fuel the plants will be produced domestically from mines in the North Bohemian region, and that the new plants will

be equipped with state-of-the-art scrubbers that will help manage the pollution caused by burning lignite.

North America

Coal use in North America is dominated by U.S. consumption. In 2001, the United States consumed 1,060 million tons, accounting for 92 percent of the regional total. U.S. consumption is projected to rise to 1,567 million tons in 2025. The United States has substantial supplies of coal reserves and has come to rely heavily on coal for electricity generation, a trend that continues in the forecast. Coal provided 51 percent of total U.S. electricity generation in 2001 and is projected to provide 52 percent in 2025 [***66***].

To a large extent, the projections of increasing prices for natural gas, combined with projected declines in both minemouth coal prices and coal transportation rates, are the basis for the expectation that coal will continue to compete as a fuel for U.S. power generation. Increases in coal-fired generation are projected to result from both greater utilization of U.S. coal-fired generating capacity and an additional 112 gigawatts of new coal-fired capacity by 2025 (10 gigawatts of older coal-fired capacity is projected to be retired). The average utilization rate of coal-fired generating capacity is projected to rise from 69 percent in 2001 to 83 percent in 2025.

In Canada, coal consumption accounted for approximately 14 percent of total energy consumption in 2001 and is projected to decline slightly over the forecast period. In the near term, the restart of six of Canada's nuclear generating units over the next few years is expected to restrain the need for coal in eastern Canada. Between September 2003 and January 2004, three of the six units, representing 2,000 megawatts of generating capacity, were returned to service. The units returned to service included Unit 4 (500 megawatts) at Ontario Power Generation's (OPG's) Pickering A plant and Units 3 and 4 (each 750 megawatts) at Bruce Power's Bruce A plant [***67***]. OPG plans to make an announcement in early 2004 regarding a startup schedule for the three remaining 500-megawatt units at its Pickering A station [***68***]. In the *IEO2004* forecast, the three remaining Pickering A units are projected to return to service by 2006.

Ontario's Liberal Party, which was victorious in the province's parliamentary elections held on October 2, 2003, has announced its intention to shut down all of the province's 7,560 megawatts of coal-fired generating capacity by 2007 [***69***]. The decision is based primarily on the premise that the health and environmental impacts of the plants' operation are unacceptable. Currently, the government is looking to energy conservation and the construction of new gas-fired power plants to assure adequate electricity supply during the planned phaseout of coal-fired generation. In 2003, coal-fired generation accounted for approximately 23 percent of Ontario's electricity supply [***70***].

Although the shut down of OPG's 1,140-megawatt Lakeview coal-fired power plant by April 30, 2005, appears to be definite, in that the action was stipulated as part of a provincial regulation issued by the previous administration, a firm closure plan has not been established yet for OPG's four remaining coal plants [***71***]. The Lakeview plant represents 15 percent of Ontario's coal-fired generating capacity, but it typically is operated as an intermediate to peaking plant and, thus, accounted for less than 7 percent of the province's coal-fired generation in 2002.

In western Canada, increased demand for electricity is expected to result in the need for some additional coal-fired generation [***72***]. Canada's lead exporter of metallurgical grade coal, Fording, is currently in the process of building two 500-megawatt coal-fired generation units in the Province of Alberta, approximately 110 miles southeast of Calgary [***73***]. The first unit is expected to be on line at the end of 2005 and the second in 2006. Additional coal-fired capacity in Alberta is being added by joint EPCOR-TransAlta investments at TransAlta's Keephills coal facility (900 megawatts), scheduled for operation in 2005, and at EPCOR's Genesee Phase 3 project (450 megawatts), scheduled for operation in winter 2004-2005 [***74***]. In late 2003, SaskPower rebuilt its 300-megawatt coal-fired Boundary Dam Unit 6 at Estevan, extending its life by an additional 20 to 25 years. The rebuild included boiler work, turbine and generator refurbishment, and a precipitator upgrade to reduce sulfur dioxide emissions. In the process, SaskPower installed a new control system and upgraded the coal pulverizer, feedwater heaters, and related components [***75***].

Mexico consumed 15 million tons of coal in 2001. Two coal-fired generating plants, Rio Escondido and Carbon II, operated by the state-owned utility Comisión Federal de Electricidad (CFE), consume approximately 10 million tons of coal annually, most of which originates from domestic mines [***76***]. In addition, CFE has recently switched its six-unit, 2,100-megawatt Petacalco plant, located on the Pacific coast, from oil to coal. The utility estimates that the plant will require more than 5 million tons of imported coal annually. Late in 2002, CFE awarded a contract for 2.5 million tons to a supplier of Australian coal, after encountering problems with a Chinese coal supplier [***77***]. A coal import facility adjacent to the plant, with an annual throughput capacity of more than 9 million tons, serves both the power plant and a nearby integrated steel mill [***78***].

Although natural gas is expected to fuel most new generating capacity to be built in Mexico over the *IEO2004* forecast period, some new coal-fired generation is also

expected. In addition, based on authorization granted by the government's energy authority in 2001, CFE is in the process of soliciting bids for the 2,100-megawatt Pacifico II coal-fired power plant in the Michoacan state and is in the early planning stages of constructing a new coal-fired plant on Mexico's Gulf Coast. The Pacifico II plant, expected to come on line by 2009, will involve three 700-megawatt units in the first stage, with two additional 700-megawatt units to be added at a later date [*79*]. If constructed, the new plants would likely use imported coal.

Africa

Africa's coal production and consumption are concentrated heavily in South Africa. In 2001, South Africa produced 250 million tons of coal, representing 97 percent of Africa's total coal production for the year. Approximately three-quarters of South Africa's coal production went to domestic markets and the remainder to exports [*80*]. Ranked third in the world in coal exports since the mid-1980s (behind Australia and the United States), South Africa moved up a notch in 1999 when its exports exceeded those from the United States, then slipped back to third in 2001 when its export total was surpassed by China's. South Africa is also the world's largest producer of coal-based synthetic liquid fuels. In 1998, about 17 percent of the coal consumed in South Africa (on a Btu basis) was used to produce coal-based synthetic oil, which in turn accounted for more than one-fourth of all liquid fuels consumed in South Africa [*81*].

For Africa as a whole, coal consumption is projected to increase by 78 million tons between 2001 and 2025, primarily to meet increased demand for electricity, which is projected to increase at a rate of 2.7 percent per year. Some of the increase in coal consumption is expected outside South Africa, particularly as other countries in the region seek to develop and use domestic resources and more varied, less expensive sources of energy.

The Ministry of Energy in Kenya has begun prospecting for coal in promising basins in the hope of diversifying the fuels available to the country's power sector [*82*]. In Nigeria, several initiatives to increase the use of coal for electricity generation have been proposed, including the possible rehabilitation of the Oji River and Markurdi coal-fired power stations and tentative plans to construct a large new coal-fired power plant in southeastern Nigeria [*83*]. Also, Tanzania may move ahead with plans to construct a large coal-fired power plant. The new plant would help to improve the reliability of the country's power supply, which at present relies heavily on hydroelectric generation, and would promote increased use of the country's indigenous coal supply [*84*].

A recently completed coal project in Africa was marked by the commissioning of a fourth coal-fired unit at Morocco's Jorf Lasfar plant in 2001. With a total generating capacity of 1,356 megawatts, the plant accounts for more than one-half of Morocco's total electricity supply and is the largest independent power project in Africa and the Middle East [*85*].

Central and South America

Historically, coal has not been a major source of energy in Central and South America. In 2001, coal accounted for about 4 percent of the region's total energy consumption, and in past years its share has never exceeded 5 percent. In the electricity sector, hydroelectric power has met much of the region's electricity demand, and new power plants are now being built to use natural gas produced in the region. Natural gas is expected to fuel much of the projected increase in electricity generation over the forecast period.

Brazil, with the ninth largest steel industry worldwide in 2001, accounted for more than 65 percent of the region's coal demand (on a tonnage basis), with Colombia, Chile, Argentina, and to a lesser extent Peru accounting for much of the remainder [*86*]. The steel industry in Brazil accounts for more than 75 percent of the country's total coal consumption, relying on imports of coking coal to produce coke for use in blast furnaces [*87*].

In the forecast, Brazil accounts for most of the growth in coal consumption projected for the region, with increased use of coal expected for both steelmaking (both coking coal and coal for pulverized coal injection) and electricity production. With demand for electricity approaching the capacity of Brazil's hydroelectric plants, the government recently introduced a program aimed at increasing the share of fossil-fired electricity generation in the country, primarily promoting the construction of new natural-gas-fired capacity. The plan also includes several new coal-fired plants to be built near domestic coal deposits [*88*]. In addition, serious consideration is being given to the construction of a large coal-fired power plant at the port of Sepetiba, to be fueled by imported coal [*89*].

In November 2002, the construction of Puerto Rico's first coal-fired power plant was completed as part of a long-range plan to reduce the Commonwealth's dependence on oil for electricity generation [*90*]. The 454-megawatt circulating fluidized bed (CFB) Aurora plant, located in Guayama, will require approximately 1.5 million tons of imported coal annually [*91*]. Currently, most of the coal purchased by the Aurora plant originates from Colombia.

Middle East

Turkey accounts for more than 86 percent of the coal consumed in the Middle East. In 2001, Turkish coal consumption reached 81 million tons, most of it low-Btu

(approximately 6.8 million Btu per ton), locally produced lignite [*92*]. Over the forecast period, coal consumption in Turkey (both lignite and hard coal) is projected to increase by 41 million tons, primarily to fuel additional coal-fired generating capacity. Projects currently in the construction phase include a 1,300-megawatt hard-coal-fired plant being built on the southern coast of Turkey near Iskenderun, to be fueled by imported coal, and a 1,440-megawatt lignite-fired plant (Afsin-Elbistan B plant) being built in the lignite-rich Afsin-Elbistan region in southern Turkey [*93*]. When completed between 2003 and 2005, the two plants are expected to increase Turkey's annual coal consumption by approximately 23 million tons (19 million tons of indigenous lignite and 3.5 million tons of imported bituminous coal) [*94*]. Substantial amounts of lignite are required for the Afsin-Elbistan B plant because of the extremely low heat content of the indigenous lignite feedstock, estimated at approximately 4.00 million Btu per short ton.

Israel, which consumed 11 million tons of coal in 2001, accounts for most of the remaining coal use in the Middle East. In the near term, Israel's coal consumption is projected to rise by approximately 3 million tons per year following the completion of two 575-megawatt coal-fired units at Israel Electric Corporation's Rutenberg plant in 2000 and 2001 [*95*]. Israel obtains most of its coal from South Africa, Australia, and Colombia and has, in the past, also obtained coal from the United States. Recently approved plans for an additional 1,200 megawatts of coal-fired generating capacity near the Rutenberg site in 2007 should result in another increase in consumption of approximately 3 million tons of coal per year [*96*].

Trade

Overview

The amount of coal traded in international markets is small compared with total world consumption. In 2002, world imports of coal amounted to 656 million tons (Figure 57 and Table 13), representing 13 percent of total consumption [*97*]. In 2025, coal imports worldwide are projected to total 919 million tons, accounting for a 12-percent share of world coal consumption. Although coal trade has made up a relatively constant share of world coal consumption over time and should continue to do so in future years, the geographical composition of trade is shifting.

In recent years, international coal trade has been characterized by strong growth in imports in Asia (Figure 58) and moderate growth in Western Europe. Rising production costs in the indigenous coal industries of Western Europe, combined with continuing pressure to reduce industry subsidies, have led to substantial declines in production there and significant increases in coal imports (see box on page 81). In Asia, strong growth in coal demand in Japan, South Korea, and Taiwan in recent years has contributed to a substantial rise in the region's coal imports.

In 2002 and 2003, international coal markets have undergone significant changes in both supply and demand. Although 2002 was a fairly stable year for international coal markets in terms of prices, freight rates, and demand, 2003 was marked by substantial changes in almost every facet of the market.

World coal trade reached 656 million tons in 2002, reflecting an increase of less than 1 percent over the 650 million tons recorded during 2001. The market in 2002 was characterized by a continuation of low ocean freight rates through the first half of the year and declining coal export prices through much of the year [*98*]. During the latter half of 2002, however, both freight rates and coal export prices were on the rise. Higher freight rates toward the end of 2002 were attributable primarily to increasing international demand for iron ore and coal, and higher coal export prices were primarily due to increasing coal import demand. A continuation of favorable exchange rates against the U.S. dollar continued to benefit several key exporting countries in 2002, including Australia, South Africa, and Russia [*99*].[14]

Another key highlight for 2002 was the emergence of China as a significant importer of coal. Total coal imports by China reached almost 14 million tons during 2002, which was substantially higher than the annual levels of between 2 and 4 million tons from 1980 through 2001 [*100*]. Rising domestic coal prices in 2001 persuaded a number of electricity producers located on China's southern coast to turn to imported coal, which they could purchase at lower cost than domestic coal [*101*].

Although final coal trade data for 2003 were not available as of the publication date of this report, preliminary data indicate that world coal trade rose to approximately 700 million tons for the year, an increase of more than 6 percent over 2002 [*102*]. The major highlights for the international coal market in 2003 included phenomenal increases in ocean freight rates, substantial increases in coal export prices during the final quarter of the year, a weakening U.S. dollar, a curtailment of coal exports from China in late 2003, and a sharp rise in the international price of coal coke.

[14]The exchange rate for the Australian dollar was US$0.56 in December 2002, 29 percent below its recent historical peak of US$0.80 in May 1996. The exchange rate for the South African rand was US$0.11 in December 2002, 59 percent below its recent historical peak of US$0.27 in January 1996. Between August 1998 and December 2002, the Russian ruble lost 79 percent of its value compared with the U.S. dollar.

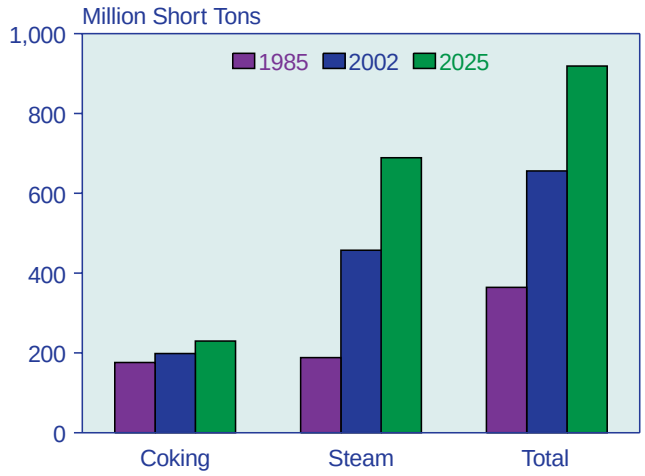
Ocean freight rates for coal rose to near all-time record highs during 2003. Much of the rise was attributable to a substantial increase in imports of iron ore by Chinese steel producers, which in turn created a shortage of ocean vessels for transporting other dry bulk products such as coal [***103***]. China's imports of iron ore in 2003 were estimated at 160 million tons, up 30 percent from 2002 [***104***]. Freight rates for major coal export routes in late 2003 were more than double the rates paid in late 2002. For example, shipments from the Richards Bay Coal Terminal in South Africa to the Rotterdam coal import terminal in the Netherlands were approximately $23.50 per ton (nominal dollars) in mid-December 2003, as compared with just over $9.00 per ton a year earlier [***105***] With projections of continuing strong growth in imports of iron ore by Chinese steel producers and little in the way of additional new shipping capacity in the pipeline, high freight rates appear to be assured for at least the next 2 to 3 years [***106***].

In addition to higher freight rates, coal importers were also hit by a substantial increase in coal export prices in 2003, adding to the delivered price of coal. The key factors underlying the higher coal export prices were increased demand for coal imports and sudden curtailments of exports from China late in the year. The free-on-board (f.o.b.) spot market price for steam coal shipped from the Richards Bay Coal Terminal in South Africa, as reported by McCloskey Coal Information Services, was $35.82 per ton in December 2003, considerably higher than the December 2002 price of $24.56 per ton [***107***]. A similar price estimate for coal originating from Newcastle, Australia, indicated an f.o.b. spot market price of $33.57 per ton in December 2003, compared with $22.52 per ton in December 2002 (all prices in U.S. dollars).

Additional information about future coal export prices is provided by the annual contract price negotiations between Japanese electric utilities and steelmakers and Australian coal producers. Price negotiations underway in late 2003 into early 2004 for Japan's 2004 fiscal year (April 1, 2004, through March 31, 2005) indicated price increases of between 20 and 25 percent for coking coal and as much as 50 percent for thermal coal [***108***]. For Japan's 2003 fiscal year, the benchmark price for coking coal was $41.91 per ton FOB port of exit (nominal dollars), and the reference price for steam coal was $24.27 per ton FOB port of exit (nominal dollars) [***109***]. For Australian coal producers, however, the expected benefits of higher prices will be attenuated due to a considerably stronger Australian currency against the U.S. dollar. In December 2003, the Australian dollar was valued at 0.74 U.S. dollar, 31 percent higher than in December 2002 [***110***].

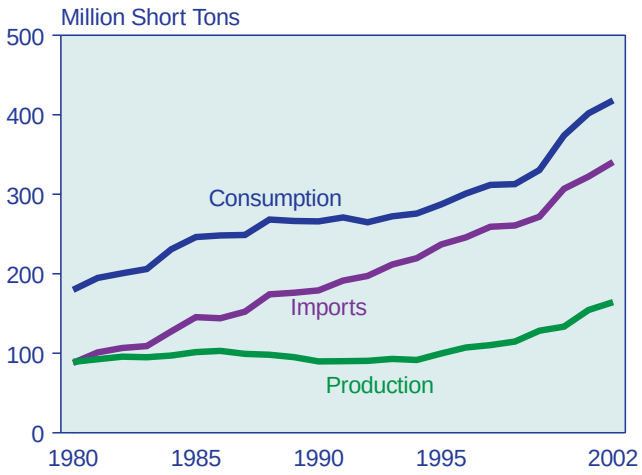
Another event affecting the world coal market in late 2003 was the sudden curtailment of coal exports from China. Although the Chinese government has taken actions to expand coal exports in recent years, the shortages of coal for the electricity generation, steel, and chemical industries, which became critical in late 2003, led to some revisions in government policies, including a reduction in tax rebates for export coal and the request that coal producers give top priority to domestic shipments over exports [***111***]. Beginning on January 1, 2004,

Figure 57. World Coal Trade, 1985, 2002, and 2025



Sources: **1985:** Energy Information Administration (EIA), *Annual Prospects for World Coal Trade 1987*, DOE/EIA-0363(87) (Washington, DC, May 1987). **2001:** SSY Consultancy and Research, Ltd., *SSY's Coal Trade Forecast*, Vol. 12, No. 3 (London, UK, June 2003); and Energy Information Administration, *Quarterly Coal Report*, October-December 2002, DOE/EIA-0121(2002/4Q) (Washington, DC, March 2003). **2025:** Energy Information Administration, National Energy Modeling System run IEO2004.D022304A (February 2004).

Figure 58. Production, Consumption, and Imports of Hard Coal in Asia, 1980-2002



Note: Data for 2002 are preliminary. Data for Australia, China, India, and New Zealand are excluded.

Source: International Energy Agency, Databases for *Coal Information 2003*, web site data.iea.org.

Table 13. World Coal Flows by Importing and Exporting Regions, Reference Case, 2002, 2010, and 2025
(Million Short Tons)

Exporters	Importers											
	Steam				Coking				Total			
	Europe[a]	Asia	America	Total[b]	Europe[a]	Asia[c]	America	Total[b]	Europe[a]	Asia	America	Total[b]
	2002											
Australia	11.5	94.7	3.4	**110.1**	29.5	79.7	5.8	**115.0**	41.0	174.4	9.2	**225.0**
United States	4.2	1.6	12.9	**18.8**	12.4	0.0	8.4	**20.8**	16.6	1.6	21.3	**39.6**
South Africa	64.3	8.2	0.7	**75.0**	0.6	0.0	0.6	**1.3**	64.9	8.2	1.3	**76.3**
Former Soviet Union	20.2	10.6	0.0	**30.8**	0.6	3.1	0.0	**3.7**	20.8	13.7	0.0	**34.5**
Poland	18.4	0.0	0.0	**18.7**	2.3	0.0	0.3	**2.6**	20.7	0.0	0.3	**21.4**
Canada	0.2	2.0	1.5	**3.7**	7.3	14.9	3.6	**25.8**	7.5	16.9	5.1	**29.6**
China	2.0	72.0	3.7	**77.7**	0.3	12.7	1.7	**14.6**	2.3	84.7	5.4	**92.3**
South America[d]	29.2	0.0	18.4	**47.5**	0.0	0.0	0.0	**0.0**	29.2	0.0	18.4	**47.5**
Indonesia[e]	12.5	60.3	2.4	**75.2**	0.1	14.3	0.1	**14.6**	12.6	74.6	2.5	**89.8**
Total	**162.4**	**249.3**	**43.0**	**457.4**	**53.0**	**124.7**	**20.5**	**198.5**	**215.4**	**374.0**	**63.5**	**656.0**
	2010											
Australia	8.4	121.6	0.8	**130.8**	33.3	90.4	9.7	**133.5**	41.7	211.9	10.6	**264.2**
United States	6.4	0.7	13.6	**20.7**	9.6	1.2	10.6	**21.5**	16.0	1.9	24.3	**42.2**
South Africa	75.4	3.4	4.2	**83.0**	1.1	0.5	0.0	**1.7**	76.6	3.9	4.2	**84.7**
Former Soviet Union	25.4	15.1	0.0	**40.5**	0.8	4.3	0.0	**5.1**	26.1	19.4	0.0	**45.5**
Poland	9.1	0.0	0.0	**9.1**	1.1	0.0	0.0	**1.1**	10.3	0.0	0.0	**10.3**
Canada	1.5	0.0	0.0	**1.5**	12.3	9.0	7.3	**28.6**	13.9	9.0	7.3	**30.2**
China	0.0	108.0	0.0	**108.0**	0.0	16.0	0.0	**16.0**	0.0	124.1	0.0	**124.1**
South America[d]	46.1	0.0	41.6	**87.7**	0.0	0.0	0.0	**0.0**	46.1	0.0	41.6	**87.7**
Indonesia[e]	10.2	92.7	0.0	**102.8**	0.0	12.9	0.0	**12.9**	10.2	105.6	0.0	**115.7**
Total	**182.5**	**341.5**	**60.3**	**584.3**	**58.3**	**134.3**	**27.7**	**220.3**	**240.9**	**475.7**	**87.9**	**804.6**
	2025											
Australia	0.0	158.7	1.9	**160.6**	32.0	98.1	13.3	**143.4**	32.0	256.8	15.2	**304.0**
United States	0.0	0.6	11.6	**12.2**	7.3	1.4	5.5	**14.2**	7.3	2.0	17.1	**26.4**
South Africa	67.1	19.0	6.2	**92.3**	0.8	0.3	0.0	**1.1**	67.8	19.3	6.2	**93.4**
Former Soviet Union	28.7	22.0	0.0	**50.7**	0.8	5.0	0.0	**5.7**	29.4	27.0	0.0	**56.4**
Poland	4.4	0.0	0.0	**4.4**	0.6	0.0	0.0	**0.6**	5.0	0.0	0.0	**5.0**
Canada	1.5	0.0	0.0	**1.5**	8.1	9.7	9.9	**27.7**	9.7	9.7	9.9	**29.2**
China	0.0	115.8	0.0	**115.8**	5.2	16.4	2.6	**24.3**	5.2	132.1	2.6	**140.0**
South America[d]	69.1	0.0	59.4	**128.4**	0.0	0.0	0.0	**0.0**	69.1	0.0	59.4	**128.4**
Indonesia[e]	0.0	123.1	0.0	**123.1**	0.0	12.9	0.0	**12.9**	0.0	136.0	0.0	**136.0**
Total	**170.7**	**439.1**	**79.1**	**689.0**	**54.8**	**143.7**	**31.3**	**229.8**	**225.5**	**582.9**	**110.4**	**918.8**

[a]Coal flows to Europe include shipments to the Middle East and Africa.

[b]In 2002, total world coal flows include a balancing item used by the International Energy Agency to reconcile discrepancies between reported exports and imports. The 2002 balancing items by coal type were 2.5 million tons (steam coal), 0.3 million tons (coking coal), and 2.8 million tons (total).

[c]Includes 12.9 million tons of coal for pulverized coal injection at blast furnaces shipped to Japanese steelmakers in 2002.

[d]Coal exports from South America are projected to originate from mines in Colombia and Venezuela.

[e]In 2002, coal exports from Indonesia include shipments from other countries not modeled for the forecast period. The 2002 non-Indonesian exports by coal type were 7.4 million tons (steam coal), 1.7 million tons (coking coal), and 9.0 million tons (total).

Notes: Data exclude non-seaborne shipments of coal to Europe and Asia. Totals may not equal sum of components due to independent rounding. The sum of the columns may not equal the total, because the total includes a balancing item between importers' and exporters' data.

Sources: **2002:** SSY Consultancy and Research, Ltd., *SSY's Coal Trade Forecast*, Vol. 12, No. 3 (London, UK, June 2003); and Energy Information Administration, *Quarterly Coal Report*, October-December 2002, DOE/EIA-0121(2002/4Q) (Washington, DC, March 2003). **2010 and 2025:** Energy Information Administration, National Energy Modeling System run IEO2004.D022304A (February 2004).

coal export tax rebates were reduced from 13 percent to 11 percent for steam coal, from 15 percent to 5 percent for semi-soft coking coal, and from 13 percent to 5 percent for hard coking coal [***112***].

On the import side, coal buyers in countries such as Japan, South Korea, Taiwan, and the Philippines scrambled to replace tonnages originally to have been supplied from coal producers in China. For 2004, continuing shortages of coal in China's domestic market could lead to a significant reduction in coal exports. The Chinese government has indicated that coal exports in 2004 could be as much as 20 percent below the estimated 99 million tons of coal exported in 2003 [***113***].

In addition to a recent increase in international steam and coking coal prices, the cost of imported coal coke rose substantially in 2003, affecting the production costs of steelmaking in a number of countries [***114***]. China, which has emerged as a major exporter of coal coke, accounted for nearly 50 percent of the 31 million tons of coal coke traded worldwide in 2001 [***115***]. Shortages of coal coke in international markets in 2003 led to an increase in the price of Chinese coal coke from approximately $54 per ton FOB port of exit (nominal dollars) in early 2002 to nearly $218 per ton at the end of 2003 [***116***]. At a blast furnace without pulverized coal injection equipment, approximately 0.7 ton of coal coke is required to produce 1 ton of pig iron [***117***].

Major coke-importing countries include Germany, the United States, France, Turkey, India, and Brazil. Although Japanese steelmakers do not currently rely on imports of coal coke, recent events in the market have heightened their awareness that their coke-making capacity is aging and has actually declined during the past few years. In late 2003, Japanese steelmakers began considering such actions as extending the life of existing coke ovens, further reducing the use of coal coke for steelmaking, and building new coke-making capacity [***118***].

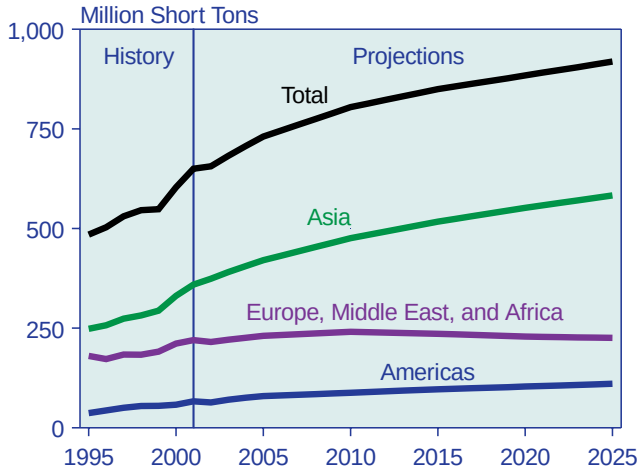
Along with strong growth in world coal trade in recent years, the geographical composition of coal supply for international markets has changed. While emerging coal exporting countries such as China, Colombia, and Indonesia have increased their output substantially over the past few years, several of the more established coal exporting countries such as the United States, South Africa, Canada, and Poland have seen their exports remain relatively constant or decline. Between 1998 and 2001, coal exports from China expanded by a remarkable 178 percent, from 36 million tons to 100 million tons [***119***]. Although its coal exports slipped to 92 million tons during 2002, China maintained its position as the second leading coal exporter in the world, ahead of Indonesia and South Africa (Table 13). The United States, which was the world's second largest coal exporter from 1984 through 1998, was surpassed by South Africa and Indonesia in 1999 and by China in 2000 [***120***].

Asia

Based primarily on strong growth in electricity demand, Asia's demand for imported coal remains poised for additional increases over the forecast period (Figure 59). Continuing the recent historical trend, Japan, South Korea, and Taiwan are projected to account for much of the regional growth in coal imports over the forecast period.

Japan continues to be the world's leading importer of coal and is projected to account for 22 percent of total world imports in 2025, less than its 2002 share of 26 percent [***121***]. In 2002, Japan produced approximately 1 million tons of coal for domestic consumption and imported 172 million tons [***122***]. Although playing a less dominant role than in the past, Japanese industries, primarily steel mills and electric utilities, continue to exert considerable influence in the Asian coal market through their annual price negotiations with coal producers in Australia and Canada. Japan's share of total Asian coal imports has fallen from 85 percent in 1980 to 60 percent in 1990 and to 46 percent in 2002, primarily as a result of increases in coal imports by South Korea, Taiwan, Malaysia, and the Philippines [***123***].

Figure 59. Coal Imports by Major Importing Region, 1995-2025



Note: Data exclude non-seaborne shipments of coal to Europe and Asia.

Sources: **History:** SSY Consultancy and Research, Ltd., *SSY's Coal Trade Forecast*, Vol. 12, No. 3 (London, UK, June 2003); International Energy Agency, *Coal Information 2001* (Paris, France, September 2001), and previous issues; Energy Information Administration, *Quarterly Coal Report*, October-December 2002, DOE/EIA-0121(2002/4Q) (Washington, DC, March 2003), and previous issues. **Projections:** Energy Information Administration, National Energy Modeling System run IEO2004.D022304A (February 2004).

China and India, which import relatively small quantities of coal at present, are expected to account for a significant portion of the remaining increase in coal imports projected for Asia. Imports by China and India have the potential to be even higher than projected, but it is assumed in the forecast that domestic coal will be given first priority in meeting the large projected increase (1.6 billion tons) in coal demand.

Elsewhere in Asia, recent and planned additions of coal-fired capacity have increased and will continue to add to coal import demand in the region. In Malaysia, coal imports are projected to rise substantially over the forecast period to fuel new coal-fired power plants. Diversification of fuel supply for electricity generation is the key factor underlying Malaysia's plans for additional coal-fired generating capacity [***124***]. In Thailand, the 1,434-megawatt Map Ta Phut plant is scheduled to be fully operational in early 2007 [***125***]. In the Philippines, the completion of several large coal-fired power projects in recent years has lead to a substantial increase in coal imports there, from about 1 million tons in 1994 to a peak of 9 million tons in 2001 [***126***]. More recently, the Philippines is moving toward increased use of indigenous energy sources such as natural gas, hydropower, and geothermal to reduce the share of generation from import-based petroleum- and coal-fired generation [***127***].

During the 1980s, Australia became the leading coal exporter in the world, primarily by meeting increased demand for steam coal in Asia. Exports of Australian coking coal also increased, as countries such as Japan began using some of Australia's semi-soft or weak coking coals in their coke oven blends. As a result, imports of hard coking coals from other countries, including the United States, were displaced. Australia's share of total world coal trade, which increased from 17 percent in 1980 to 34 percent in 2002, is projected to remain relatively steady over the forecast period, accounting for 33 percent in 2025 [***128***]. Australia is expected to continue as the major exporter to Asia, with its share of the region's total coal import demand projected to decline only slightly from 46 percent in 2002 to 44 percent in 2025 (Table 13).

Recently, coal from China has been displacing some Australian tonnage in several of Asia's major coal-importing countries, such as South Korea, Japan, and Taiwan [***129***]. Factors contributing to China's expanding coal export position in Asia since 1998 include recent improvements in rail and coal port infrastructure, continuing tax rebates for China's coal export industry, and the relatively short transport distances from China's coal-exporting ports to Asia's major coal-importing countries [***130***]. Over the forecast period, China is expected to maintain its current share of Asia's overall coal import market; however, the shortages of coal for China's domestic market that developed in late 2003 are expected to continue through at least 2004 and to curtail Chinese coal exports in the near term.

The United States, once a major supplier of coal to Asia, is currently only a minor participant in the Asian market. The U.S. share of Asia's coal imports declined from 28 percent in 1980 to less than 1 percent in 2002 [***131***]. Additional setbacks in U.S. coal exports to this region occurred as the result of two recent events: a reduction in coal exports from Alaska and a decision to close permanently a major coal export facility located on the U.S. West Coast.

In late 2002, Alaska's Usibelli coal mine was unable to renegotiate a long-term sales contract for coal export shipments to South Korea. In essence, other coal export suppliers, primarily Indonesian producers, were able to provide coal at a lower delivered cost to Korean electricity suppliers [***132***]. Under the contract, which dated back to 1984, the Usibelli mine typically exported between 700,000 and 800,000 tons of subbituminous coal annually to South Korea for use at the Honam coal-fired power station [***133***]. The contract was renegotiated on an annual basis, with Usibelli Coal executives hashing out the terms of the contract with their counterparts at Hyundai Merchant Marine, a Korean-based shipping company. In turn, Hyundai sold the coal to Korea East-West Power Company, Ltd. (a subsidiary of the Korea Electric Power Company). Although only partially successful, Usibelli Coal was able in September 2003 to negotiate a new 2-year contract with Hyundai Merchant Marine that specifies annual shipments of 400,000 tons of coal [***134***]. A spokesman for the Alaskan Railroad, which transports the coal from the mine to the Seward coal export terminal, described the new contract as a placeholder, enabling Alaska to remain active in the coal export market.

In early 2003, the coal export facility at the Los Angeles Export Terminal (LAXT) was permanently closed [***135***]. The decision was based on the fact that U.S. coal exports had lost their competitiveness in the Asian market that the terminal was built to serve. Consequently, the quantities of annual coal exports from LAXT were insufficient to provide a positive return to the investors who financed and operated the terminal. Although there are other coal export facilities on the West Coast, the LAXT terminal, with a capability of handling 10 million tons of coal annually, had become the primary facility for U.S. coal exports originating from mines in Utah and Colorado. The coal and petroleum coke export facilities at LAXT came on line in November 1997. Over its 5.5 years of operation, approximately 13 million tons of coal were exported from LAXT, primarily to customers in Japan [***136***]. Coal export shipments out of LAXT peaked at approximately 3.5 million tons in 2000.

Most recently, the combination of rapidly rising international coal prices and the declining value of the U.S. dollar in late 2003 led to renewed interest by foreign coal consumers in coal from the U.S. West Coast [*137*]. Unfortunately, because it is no longer possible to export large quantities of coal out of either of the Los Angeles area ports (LAXT and Long Beach), coal producers in Utah and Colorado have, in effect, been cut off from the international coal market. Other ports on the West Coast with bulk-handling terminals include the Port of Stockton near San Francisco, the Levin-Richmond Terminal in Richmond, California, and the Westshore Terminals at the Port of Vancouver. Some small shipments of coal originating from mines in Wyoming and Montana were reportedly shipped to Asian customers in early 2004 from the Westshore Terminals [*138*], despite the 1,200-mile rail haul from the mines in Wyoming and Montana to the Port of Vancouver.

Limited supplies of coking coal in the international market combined with a weakening U.S. dollar have led to some renewal of interest in Appalachian coking coal. In early 2004, Japanese steel mills reportedly booked more than 1.5 million tons of U.S. coking coal (mostly a high-volatility product) for delivery in 2004, with additional purchases for the year a distinct possibility [*139*]. U.S. coking coal exports to Asia declined from a peak of more than 24 million tons in 1982 to less than 0.5 million tons in 2001 and were virtually nonexistent in 2002 [*140*].

Although Australian coking coal producers have some new mines coming on line for export, strong demand for steel worldwide, reduced exports of coal coke from China, and the emergence of China as a major importer of coking coal are expected to keep world coking coal supplies tight in 2004 [*141*]. Some supplies of high-volatility U.S. coking coal are available for export, but higher quality, lower volatility coking coal probably will not be available from U.S. mines. In 2003, the temporary closure of PinnOak's 3.5-million-ton Pinnacle mine in West Virginia, due to a fire and methane problems, created enough of a domestic shortage of low-volatility coking coal that several U.S. coke-making facilities, and subsequently steel mills, were forced to scale back their operations temporarily [*142*]. With demand for U.S. coking coal, both domestic and for export, declining in recent years, many U.S. coking coal mines have either closed or diverted their output to the domestic steam coal market [*143*].

Europe, Middle East, and Africa

Coal imports to Europe, the Middle East, and Africa, taken as a whole, are projected to increase slightly over the forecast period, from 215 million tons in 2002 to 241 million tons in 2010, then decline to 226 million tons in 2025 (Figure 59 and Table 13). In the *IEO2004* forecast, projected declines in overall imports to the countries of Western Europe are more than offset by increases projected for Turkey, Romania, Bulgaria, and Israel.

In Western Europe, environmental pressures and competition from natural gas are expected gradually to reduce the reliance on steam coal for electricity generation, and further improvements in the steelmaking process will continue to reduce the amount of coal required for steel production. Strict environmental standards are expected to result in the closure of some of Western Europe's older coke batteries and will make it difficult to get approvals for new coke plants, thus increasing import requirements for coal coke but reducing imports of coking coal. Projected reductions in indigenous coal production in the United Kingdom, Germany, Spain, and France are not expected to be replaced by equivalent volumes of coal imports. Rather, increased use of natural gas, renewable energy, and nuclear power (primarily in France) is expected to fill much of the reduction in domestic energy supply projected to result from continuing declines in the region's indigenous coal production.

In 2002, the leading suppliers of imported coal to the region represented by the countries of Europe, the Middle East, and Africa were South Africa (30 percent), Australia (19 percent), South America (14 percent), and the former Soviet Union and Poland (each accounting for a 10-percent share). Over the forecast period, low-cost coal from South America (primarily from Colombia and Venezuela) is projected to meet an increasing share of European coal import demand, displacing some coal from such higher cost suppliers as the United States and Poland.

Despite South America's current foothold and expected gains in Europe, South Africa is projected to maintain its position as the leading supplier of coal to Europe throughout most of the forecast period. Currently, plans call for a 15-million-ton expansion of South Africa's Richards Bay Coal Terminal by the end of 2006, increasing the facility's annual throughput capacity to 95 million tons [*144*].

The Americas

Compared with European and Asian coal markets, imports of coal to North and South America are relatively small, amounting to only 64 million tons in 2002 (Table 13). Canada imported 30 percent of the 2002 total, followed by the United States (27 percent) and Brazil (22 percent) [*145*]. Most (80 percent) of the imports to Brazil were coking coal, and a majority of the remaining import tonnage was steam coal used for pulverized coal injection at steel mills [*146*].

Over the *IEO2004* forecast period, coal imports to the Americas are projected to increase by 47 million tons, with most of the additional tonnage going to the United

States, Brazil, and Mexico. Coal imports to the United States are projected to increase from 17 million tons in 2002 to 46 million tons in 2025 [***147***], based on the capability and plans of existing coal-fired generating plants to import coal (primarily plants located on the eastern seaboard and in the southeastern part of the country) and announced plans to expand coal import infrastructure. Brazil and Mexico are projected to import additional quantities of coal for both electricity generation and steelmaking.

Partly offsetting the projected growth in coal imports elsewhere in the Americas, Canadian imports are expected to decline slightly over the next few years as six nuclear generating units at the Pickering and Bruce plants gradually are returned to service [***148***]. While generation from some of these units is crucial for averting expected near-term shortages in the Province's electricity supply [***149***], increasing nuclear generation over the next few years should ultimately displace some of the electricity output from Ontario's coal-fired power plants. Ontario imported 17 million tons of coal in 2002, primarily from U.S. coal mines located in Central Appalachia and the Powder River Basin [***150***].

After Ontario, Nova Scotia and New Brunswick account for most of Canada's remaining import tonnage. In 2002, Nova Scotia imported 1.9 million tons of coal and New Brunswick imported 1.2 million tons [***151***]. With the closure of the Phalen and Prince underground coal mines in 2000 and 2001, Nova Scotia Power's reliance on coal imports increased considerably in 2002. Nova Scotia Power operates four coal-fired power plants [***152***].

Historically, most of the coal imported by Canada has originated from U.S. coal mines, although South America has emerged recently as a supplier of coal to electricity producers in Nova Scotia and New Brunswick. In recent years, the importance of the Canadian market for U.S. coal exporters has increased substantially as Ontario's reliance on coal-fired generation has been stepped up to supply generation lost to reduced output from nuclear plants and as shipments of U.S. coal to overseas customers has declined. In 2002, U.S. producers exported 17 million tons of coal to Canadian consumers, corresponding to 42 percent of total U.S. exports [***153***]. As recently as 1995, U.S. coal exports to Canada, at 9 million tons, represented only 11 percent of the total amount exported [***154***].

Coking Coal

Historically, coking coal has dominated world coal trade, but its share has steadily declined, from 55 percent in 1980 to 30 percent in 2002 [***155***]. In the forecast, its share of world coal trade continues to shrink, to 25 percent in 2025. In absolute terms, despite a projected decline in imports by the industrialized countries, the total world trade in coking coal is projected to increase slightly over the forecast period as a result of increased demand for steel in the developing countries. Increased imports of coking coal are projected for South Korea, Taiwan, India, Brazil, and Mexico, where expansions in blast-furnace-based steel production are expected.

Factors that contribute to the projected decline in coking coal imports in the industrialized countries are continuing increases in steel production from electric arc furnaces (which do not use coal coke as an input) and technological improvements at blast furnaces, including greater use of pulverized coal injection and higher average injection rates per ton of hot metal produced. Each ton of pulverized coal (categorized as steam coal) used in steel production displaces approximately a ton of coking coal [***156***].[15] In 2001, the direct use of pulverized coal at blast furnaces accounted for 17 percent and 14 percent of the coal consumed for steelmaking in the European Union and Japan, respectively [***157***].

References

1. Web site www.worldsteel.org.
2. Energy Information Administration, System for the Analysis of Global Energy Markets (2004).
3. U.S. Environmental Protection Agency, "Fact Sheet: EPA To Regulate Mercury And Other Air Toxics Emissions From Coal- And Oil-Fired Power Plants" (Washington, DC, December 14, 2000), web site www.epa.gov.
4. Energy Information Administration, *International Energy Annual 2001*, DOE/EIA-0219 (2001) (Washington, DC, February 2003), Table 2.5.
5. Energy Information Administration, *International Energy Annual 2001*, DOE/EIA-0219 (2001) (Washington, DC, February 2003), Tables 2.5 and 5.4.
6. International Energy Agency, *Coal Information 2001* (Paris, France, September 2001), pp. II.21-II.23.
7. Energy Information Administration, *Annual Energy Review 2002*, DOE/EIA-0384 (2002) (Washington, DC, October 2003), Table A5.
8. Web site www.worldsteel.org.
9. "Shell Technology Will Be Used in China's Coal-to-Oil Project in Inner Mongolia," *Interfax* (March 30, 2004), web site www.interfax.com.

[15] Approximately 1.4 ton of coking coal is required to produce 1 ton of coal coke; however, according to information provided by the World Coal Institute, each ton of coal injected to the blast furnace through pulverized coal injection (PCI) equipment displaces only about 0.6 to 0.7 tons of coal coke. As a result, each ton of PCI coal displaces approximately 1 ton of coking coal. Steel companies are able to reduce their operating costs, however, because coal used for pulverized coal injection is typically less expensive than the higher quality coals required for the manufacture of coal coke.

10. DRI-WEFA, Inc., *Asia/Pacific World Energy Global Energy Market Research & Analysis 2001* (Lexington, MA, 2002), p. 75, Table 28.
11. "China's Three Gorges Generates 32 pct More Electricity Than Planned-Report," *AFX Asia* (December 30, 2003); "Three Gorges to Change China's Power Supply Patterns-Experts," *Asia Pulse* (September 16, 2003); and "Integrated National Power Grid in China to Take Shape," *Asia Pulse* (November 20, 2003).
12. "China's East-West Gas Pipeline Ready for Trial Run," *China Chemical Reporter* (September 26, 2003); and "Natural Gas Reaches East China in Trial Run of Largest Pipeline," BBC Monitoring Asia Pacific (December 18, 2003).
13. DRI-WEFA, Inc., *Asia/Pacific World Energy Global Energy Market Research & Analysis 2001* (Lexington, MA, 2001), p. 105, Table 28.
14. Web site www.ntpc.co.in.
15. "India's NTPC: Could It Become an Importer In the Future?" *International Coal Trade*, No. 1378 (April 15, 2002), p. 5.
16. "Asia Won't Yet Kick the Coal Habit," *Petroleum Intelligence Weekly* (July 9, 2001), p. 4; S. Johari, "Tenaga Seeks To Delay Two Coal-Fired Plant Projects," *Business Times* (Malaysia) (July 4, 2001), p. 4; Z. Abdullah, "TNB To Rely More on Coal," *The New Straits Times* (August 25, 2001), Section 2, p. 21; Y. Praiwan, "Plants Essential To Avoid Serious Fall in Reserves," *Bangkok Post* (September 28, 2001).
17. "Korea: 5th Long-Term Power Development Plan," *International Market Insight Reports* (February 10, 2001); "Malaysia To Raise Coal Generation Despite Gas Deposits, Says TNB Head," *Coal Week International* (January 8, 2001), p. 8; D. A. Bakar, "TNB Gives Approval for Relocation of Coal-Fired Plant," *The New Straits Times* (August 25, 2001), Section 2, p. 1; "Coal Imports To Grow as Thailand Brings on New Power Plants," *Coal Week International* (March 12, 2001), p. 5; "BLCP To Begin Work on Thai Coal Plant Next Year," *Coal Week International* (August 20, 2001), p. 3; Y. Praiwan, "Plants Essential To Avoid Serious Fall in Reserves," *Bangkok Post* (September 28, 2001).
18. "Korea: 5th Long-Term Power Development Plan," *International Market Insight Reports* (February 10, 2001); "Formosa Plastic Says Tender Filled 9 Million MT Coal Needed for 2001," *Coal Week International* (January 22, 2001), p. 8; "Taiwan's Ho-Ping Power To Start Test Runs in 1st Unit Wednesday," *Dow Jones Newswires* (July 31, 2001); "S Korea Posco to Liquidate Posenergy Unit," *Dow Jones International News* (May 27, 2001).
19. "Asia Won't Yet Kick the Coal Habit," *Petroleum Intelligence Weekly* (July 9, 2001), p. 4; N.B. Srinivasan, "Gas Versus Coal: It's No Contest," *The Bangkok Post* (October 25, 2001), p. 1; "Thai New Power Development Plan To Focus on Natural Gas," *Dow Jones Newswires* (March 15, 2001).
20. "Prime Minister Rules Out Coal for Controversial Power Plants," *Organization of Asia-Pacific News Agencies* (March 15, 2003); "Order for Coal-Fired Power Plant from BLCP Power of Thailand," *News Release—Mitsubishi Heavy Industries, Ltd* (September 19, 2003), web site www.mhi.co.jp; "EGAT Approves Construction of Two 1,400 MW Power Plants," *Thai News Service* (February 25, 2003); B. Treerapongpichit, "Banpu Unit Gets Nod for Coal-Fired Plant," *Bangkok Post* (June 26, 2002), p. 12.
21. "Order for Coal-Fired Power Plant from BLCP Power of Thailand," *News Release—Mitsubishi Heavy Industries, Ltd* (September 19, 2003), web site www.mhi.co.jp; "EGAT Approves Construction of Two 1,400 MW Power Plants," *Thai News Service* (February 25, 2003); B. Treerapongpichit, "Banpu Unit Gets Nod for Coal-Fired Plant," *Bangkok Post* (June 26, 2002), p. 12.
22. "EGAT Plans Gas and Coal Plants," *Power in Asia*, No. 387 (October 2, 2003), p. 14.
23. International Energy Agency, *Coal Information 2003* (Paris, France, November 2003), Table 3.3a.
24. "Queensland Premier Opens First of Three New Coal-Fired Stations," Coal *Week International* (July 9, 2001), p. 3.
25. "Griffin Group Will Build Coal-Fired Plant in Australia," *International Coal Trade*, No. 1383 (May 20, 2002), p. 6.
26. Energy Information Administration, *International Energy Annual 2001*, DOE/EIA-0219 (2001) (Washington, DC, February 2003), Table 1.4.
27. Web site www.worldsteel.org; and International Energy Agency, *Coal Information 2001* (Paris, France, September 2001), Tables 3.9 and 3.10.
28. International Energy Agency, *Coal Information 2003* (Paris, France, November 2003), Table 3.3d.
29. H. Tagawa, Manager, Coal Fuel Department, Tokyo Electric Power Company, "Coal-Fired Power Generation in Japan and Expectations Toward U.S. Western Coal." Paper presented at the Western Coal Council's 2001 Spring Pacific Coal Forum (Park City, UT, June 4-6, 2001).
30. International Energy Agency, "Databases for the Electricity Information 2003," web site http://data.iea.org.

31. "German RWE Says It Will Replace Up to 10% of Its Power Plants From 2008," *European Daily Electricity Markets* (November 21, 2003); and "RWE Shelves Plans for New Lignite Power Plant for Now," *Dow Jones International News* (February 26, 2004).
32. "EU States Yet to Submit Any Emissions Quota Data," *Reuters News* (March 4, 2004).
33. UK Department of Trade and Industry, *Energy Paper 68: Energy projections for the UK* (London, UK: March 2000), pp. 32-44.
34. Energy Information Administration, *International Energy Annual 2001*, DOE/EIA-0219(2001) (Washington, DC, February 2003), Table 1.4.
35. "Spain's Fenosa Presses on With Meirama Power Plant Refit," *Platts Commodity News* (March 20, 2002); "Endesa Prepares Plant for Imports," *Platts International Coal Report*, No. 606 (March 31, 2003), p. 11; and "Endesa to Invest Euro 274 Million to Transform As Pontes 1,400 MW Coal Power Plant and Extend 20 Years Its Useful Life," *ENDESA Press Release* (March 26, 2003), web site www.endesa.com.
36. N. Ballisoy and H. W. Schiffer, RWE Rheinbraun, *Lignite in Europe, Edition 2001* (September 2001), pp. 15-16.
37. "Coal-Fired Competition Hots up in France; Endesa's Overpayment in SNET May Have Let Others Into the French Coal Picture," *Power in Europe*, No. 411 (October 13, 2003), p. 8.
38. International Energy Agency, *Coal Information 2003* (Paris, France, November 2003), Tables 3.2 and 3.3b; and "Coal-Fired Competition Hots up in France; Endesa's Overpayment in SNET May Have Let Others Into the French Coal Picture," *Power in Europe*, No. 411 (October 13, 2003), p. 8.
39. International Energy Agency, *Coal Information 2003* (Paris, France, November 2003), Table 3.3b.
40. E. Ewart and R. Marston, "Marketwatch: World Coal Trade and the Impact of Global Environmental Regulation," *Coal Age* (September 1, 2001).
41. International Energy Agency, *Coal Information 2002* (Paris, France, September 2002), Table 3.3a.
42. "Enel to Switch From Oil to Coal," *McCloskey Coal Report, No. 42* (August 23, 2002), p. 1; "Enel's CEO Wants More Coal," *International Coal Trade, No. 1397* (August 26, 2002), p. 8; "Endesa Continues Fiume Santo Conversion," *McCloskey Coal Report, No. 69* (September 19, 2003), p. 18; and "Fiume Santo Fires Up Early," *McCloskey Coal Report, No. 71* (October 17, 2003), p. 24.
43. United Nations Framework Convention on Climate Change, Report of the Conference of Parties on Its Third Session, Held at Kyoto from 1 to 10 December 1997, Kyoto Protocol to the United Nations Framework Convention on Climate Change, FCCC/CP/1997/L.7/ Add.1 (December 10, 1997), web site www.unfccc.de.
44. International Energy Agency, "Databases for the Electricity Information 2003," web site http://data.iea.org.
45. "Kapros: Greek Pool to Boost IPPs," *Power in Europe*, No. 413 (November 10, 2003), p. 4; and "A New Power Plant is to Begin Operations in the North, Near Florina," *Athens News Agency* (July 29, 2003).
46. Energy Information Administration, *International Energy Annual 2001*, DOE/EIA-0219(2001) (Washington, DC, February 2003), Table 2.5.
47. SSY Consultancy and Research Ltd, *SSY's Coal Trade Forecast*, Vol. 12, No. 4 (September 2003).
48. J. Chadwick, "CIS Coal," *The Mining Journal* (June 1998); PlanEcon, Inc., *Energy Outlook for Eastern Europe and the Former Soviet Republics* (Washington, DC, October 1999), pp. 13-14.
49. I. Artimiev and M. Haney, *The Privatization of the Russian Coal Industry: Policies and Processes in the Transformation of a Major Industry*, World Bank Working Paper 2820 (Washington, DC, April 2002), web site www.worldbank.org; "World Bank Approves Coal-Privatization Loan to Russia," *BBC Monitoring Former Soviet Union—Economic* (November 23, 2001).
50. "'Reform Or Perish' Message to Coal Operators," *McCloskey Coal Report*, No. 56 (March 21, 2003), p. 11; "Ukraine—An Industry Defying Reality," *McCloskey Coal Report*, No. 58 (April 18, 2003), p. 13.
51. "Ukraine—An Industry Defying Reality," *McCloskey Coal Report*, No. 58 (April 18, 2003), p. 13.
52. International Energy Agency, *Coal Information 2003* (Paris, France, November 2003), Table 6.4.
53. "Country Report: Russia (Energy)," *World Markets Analysis Online*, web site www.worldmarketsanalysis.com (February 24, 2004); "Country Report: Kazakhstan (Energy)," *World Markets Analysis Online*, web site www.worldmarketsanalysis.com (February 25, 2004); and "Country Report: Ukraine (Energy)," *World Markets Analysis Online*, web site www.worldmarketsanalysis.com (January 15, 2004).
54. Energy Information Administration, *International Energy Annual 2001*, DOE/EIA-0219(2001) (Washington, DC, February 2003), Tables 1.4 and 2.5.
55. Energy Information Administration, *International Energy Annual 2001*, DOE/EIA-0219(2001) (Washington, DC, February 2003), Table 1.4.
56. Energy Information Administration, *International Energy Annual 2001*, DOE/EIA-0219(2001) (Washington, DC, February 2003), Tables 2.5 and 5.4.

57. SSY Consultancy and Research, Ltd., *SSY's Coal Trade Forecast*, Vol. 12, No. 4 (September 2003).
58. International Energy Agency, "Databases for the Electricity Information 2003," web site http://data.iea.org.
59. "Polish Exports Threatened by Closures," *McCloskey Coal Report*, No. 68 (September 5, 2003), pp. 1-4; "World Bank Won't Lend Poland $300 Million, Says Restructuring Too Slow," *International Coal Report*, No. 640 (November 24, 2003), p. 7; "Polish Expert Group Reportedly Backs Closing of 12 out of 33 Total Coal Mines by 2020," *Interfax Poland Business News Service* (May 7, 2003); "New Polish Coal-Overhaul Plan Would Involve Pln 14 Bln in Debt Restructuring, Lay Offs of 28,000," *Interfax Poland Weekly Business Report* (August 11, 2003); and "Poland Threatens Unions With a Withdrawal of Coal Subsidies," *Platts International Coal Report,* No. 618 (June 23, 2003), p. 8.
60. "Poland: Energy and Electricity Forecast," *Economist Intelligence Unit: Executive Briefing*, No. 310 (January 13, 2004), p. 4.
61. Energy Information Administration, *International Energy Annual 2001*, DOE/EIA-0219(2001) (Washington, DC, February 2003), Table 1.4.
62. International Energy Agency, "Databases for the Electricity Information 2003," web site http://data.iea.org.
63. "Czech Republic Industry: Too Little, Too Late for Coal Mines," *Economist Intelligence Unit: ViewsWire*, No. 301 (June 25, 2003); and "CEZ Sees Electricity Output Rise 13% in 2003 to All-Time High," *Interfax Czech Republic & Slovakia Weekly Business Report* (February 6, 2004); and "Finns Push on With Europe's First Nuke in Decade," *Energy Compass* (December 18, 2003).
64. "Government Approves Country's Long-Term Energy Policy," *Interfax Czech Republic Business News Service* (March 10, 2004); and "CEA Embraces State Energy Expansion Plan But Is in No Rush To Build N-Plant," *European Spot Gas Markets* (March 11, 2004).
65. "Czech Republic Will Add New Coal-Fired Capability," *Coal Americas*, No. 15 (April 21, 2003), p. 8; "Czech Republic To Rebuild Coal-Fired Power Plants," *Coal Americas*, No. 17 (May 19, 2003), p. 17.
66. Energy Information Administration, *Annual Energy Outlook 2004*, DOE/EIA-0383(2004) (Washington, DC, January 2004), Table A8.
67. "Bruce Nuclear Back Online After Months of Delays in Time for Cold Snap," *The Canadian Press* (January 9, 2004); "Bruce unit 3 resumes electricity production; Lengthy retrofit adds 6-8 years to reactor's life Province not 'out of the woods,' Energy Probe says," *The Toronto Star* (January 10, 2004), p. D5; and "OPG Officers Ousted; Coal Could Get Boost," *Platts Coal Outlook*, Vol. 27, No. 49 (December 8, 2003), p. 1.
68. "Nuclear Fallout," The Toronto Star (September 27, 2003), p. D1.
69. "Ontario Liberal Leader Threatens to Shut Coal Plants by 2007," *Platts International Coal Report*, No. 635 (October 20, 2003), p. 9.
70. Canada's Electricity Conservation and Supply Task Force, *Tough Choices: Addressing Ontario's Power Needs, Final Report to the Minister* (January 2004), Figure 2.F, web site www.energy.gov.on.ca.
71. A. Lindgren, "Liberals Begin to Phase Out Coal Plants," *CanWest News Service* (January 21, 2004); and Ontario Power Generation Inc., *Annual Information Form for the Year Ended December 31, 2002* (March 31, 2003), web site www.opg.com.
72. "Ontario's IMO Forecasts Province's Electricity Supply Secure for Next 10 Years," *Foster Electric Report* (September 5, 2001); M. Mittelstaedt, "New Life for Old Reactors Fans Fears for Safety," *The* Globe and Mail (May 28, 2001), p. A1; Energy Information Administration, *Nuclear Power Generation and Fuel Cycle Report 1997*, DOE/EIA-0436 (97) (Washington, DC, September 1997), Table D1.
73. "Brooks Power Project Makes It Official With Alberta Govt," *International Coal Trade*, No. 1350 (October 1, 2001), p. 10; "Fording Inc. Lays Groundwork for Coal-Fired Units in Alberta," *Coal Week International* (October 1, 2001), p. 4.
74. "TransAlta Receives Green Light For Plant Expansion," *International Coal Trade*, No. 1370 (February 18, 2002), p. 7; S. Thomas, "TransAlta Buys Half Of EPCOR Genesee Phase 3 Proj," *Dow Jones Newswires* (January 13, 2003).
75. "SaskPower To Rebuild Coal-Fired Plant," *Coal Americas*, No. 1 (October 7, 2002), p. 15; "McCloskey's News Round-up," *McCloskey Coal Report*, No. 45 (October 4, 2002), p. 25; SaskPower, "Upgrades at Boundary Dam Power Station Worth $80 Million," News Release (Regina, Saskatchewan, Canada, October 1, 2002), web site www.saskpower.com.
76. F.G. Jáuregui D., "Steam Coal Requirements of CFE." Paper presented at the Western Coal Council's Pacific Coal Forum (Park City, UT, June 23-26, 1997).
77. R. Brindal, "Xstrata Coal Australia Wins US$75M Mexico Supply Contract," *Dow Jones Newswires* (December 4, 2002).
78. "International Market Report," *King's International Coal Trade*, No. 1194 (September 11, 1998), pp. 2-3.

79. "Another Coal-Fired Power Plant Is On the Drawing Board In Mexico," *Coal Americas*, No. 19 (June 16, 2003), p. 18; A. Harrup, "Mexico's State Utility Plans New Coal-Fired Power Plant," *Dow Jones Newswires* (July 3, 2001).
80. International Energy Agency, *Coal Information 2001* (Paris, France, September 2001), pp. III.37-III.38.
81. International Energy Agency, *Coal Information 2001* (Paris, France, September 2001), pp. III.36; Energy Information Administration, "Country Analysis Brief: South Africa," web site www.eia.doe.gov (December 2000).
82. "Kenya: Energy Ministry Sets Aside Money for Coal Prospecting," *BBC Monitoring Africa—Political* (November 20, 2000).
83. C. Akunna, "Ezeife Urges Igbo To Produce Coal-Fired Electricity," *Africa News Service* (December 14, 2001); K.U. Kalu, "Future of Coal Industry," *Africa* News Service (October 5, 2001); E. Imisim, "Government Gets $100m World Bank Credit for NEPA Reforms," *Africa News Service* (August 2, 2001).
84. "Tanzania: Government Plans To Develop Coal-Fired Power Station," *BBC Monitoring Africa—Political* (September 7, 2000).
85. "Largest IPP in Africa, Middle East Is Completed," *Power*, Vol. 145, No. 5 (September/October 2001), p. 16.
86. Web site www.worldsteel.org.
87. International Energy Agency, *Coal Information 2001* (Paris, France, September 2001), pp. I.88 and I.97; AME Research, web site www.ame.com.au.
88. "Tractabel's Gerasul Advances 350-MW Jacui; Will Boost Capital by $65-Million," *Global Power Report* (July 20, 2001), p. 12; D. Clifford, "Brazil—A Modern Mining Giant," *Mining Magazine* (July 1, 2001), p. 6.
89. "Brazil's Inepar To Exit Distributor's Celpa, Cemat, and Maybe Generation," *Electric Utility Week* (May 7, 2001), p. 21.
90. "AES 454MW Guayama Project Starts Commercial Operations," *Dow Jones Newswires* (December 2, 2002).
91. "AES Looks for 3-Year Supply," *McCloskey Coal Report*, No. 19 (October 4, 2001), p. 18; B.K. Schimmoller, "Fuel and Materials Handling: Moving It Without Losing It," *Power Engineering* (March 1, 2001), pp. 44-48.
92. Energy Information Administration, *International Energy Annual 2001*, DOE/EIA-0219 (2001) (Washington, DC, February 2003), Tables 2.5 and 5.4; International Energy Agency, *Coal Information 2001* (Paris, France, September 2001), p. II.23.
93. U.S. Department of Energy, Office of Fossil Energy, Energy Overview of Turkey, web site www.fe.doe.gov (accessed January 21, 2004); IEA Coal Research, CoalPower 4 Database (October 2001); "Steag Markets New Coal Station Design," McCloskey's Coal Report, No 73 (November 14, 2003), pp. 16-17; and S. Atalay, "Turkish Govt Signs $1.62 Bln Loan for 1400MW Power Project," *Dow Jones Newswires* (October 15, 1999).
94. M. Ersoy, Turkish Coal Enterprises, "Current Status of Turkish Lignite Sector," presentation at the United Nation's Economic Commission for Europe (UNECE) Ad Hoc Meeting of Experts on Coal in Sustainable Development, Geneva, Switzerland (November 17-18, 2003), web site www.unece.org; "EUAS Modifies Afsin-Elbistan B Lignite Project," *IBS Research & Consultancy Energy Line* (December 2, 2002) web site www.ibsresearch.com; and "Steag Opens 1,210 MW Coal Plant in Turkey," *European Daily Electricity Markets* (November 24, 2003).
95. "New Plant On Line," *Coal Week International* (February 26, 2001), p. 9; "Israel Looking to Asia, U.S., To Meet Growing Steam Coal Need," *Coal Week International* (November 13, 2000), p. 4.
96. "1,200-MW Ashkelon Plant On Line in 2007," *International Coal Report*, No. 594 (January 6, 2003), pp. 1,6; T. Muscal, "Gov't Okays New Coal Power Plant," *The Jerusalem Post* (December 30, 2002).
97. International Energy Agency, *Coal Information 2003* (Paris, France, November 2003), Tables 3.1b and 3.1c.
98. *Monthly Shipping Review SSY* (December 6, 2002), p. 5; "Coal Price Lows," Monthly *Shipping Review SSY* (August 12, 2002), p. 4; "2002—The Year of the Bear," *Platts International Coal Report*, No. 594 (January 6, 2003), pp. 2-3; A. Roberts, "Price Volatility Persists," *Petroleum Economist* (October 2, 2002).
99. U.S. Federal Reserve Bank, "Foreign Exchange Rates (Monthly)," web site www.federalreserve.gov; International Monetary Fund, *International Financial Statistics Yearbook* (Washington, DC, various issues).
100. SSY Consultancy and Research Ltd, *SSY's Coal Trade Forecast*, Vol. 12, No. 4 (London, United Kingdom, September 2003); and International Energy Agency, *Databases for the Coal Information 2003*, web site data.iea.org.
101. "Chinese 2002 Thermal Imports Likely to Reach 10 Million mt," *Platts International Coal Report*, No. 593 (December 23, 2002), p. 3.
102. "Seaborne Coal Trade Matrix," *Monthly Shipping Review SSY* (December 15, 2003), p. 5; and Bureau of the Census, U.S. Department of Commerce, "Monthly Report EM 522."

103. "Ocean Freight Rates Continue to Soar, Little Relief in Sight," *Coal Americas, Energy Publishing LLC*, No. 29 (November 3, 2003), p. 1.
104. "Steel/Iron Ore: Iron Ore Imports, Iron Ore Exports and Steel Production," *Monthly Shipping Review SSY* (December 15, 2003), p. 7.
105. "Freights Set in for the Long Run," *McCloskey's Coal Report*, No. 75 (December 12, 2003), pp. 20-21.
106. "Freights Set in for the Long Run," *McCloskey's Coal Report*, No. 75 (December 12, 2003), pp. 20-21.
107. "McCloskey Coal Information Services (MCIS) Key Physical Prices," *McCloskey's Coal Report*, No. 75 (December 12, 2003), p. 1; and "McCloskey Coal Information Services (MCIS) Key Physical Prices," *McCloskey's Coal Report*, No. 77 (January 23, 2004), p. 1.
108. J. Chessell, "Coalminers Sitting Pretty in Price Talks," *The Sydney Morning Herald* (January 21, 2004); and N. Todd, "Slow Burn for Thermal Coal Talks," *Herald Sun* (January 22, 2004).
109. International Energy Agency, *Coal Information 2003* (Paris, France, November 2003), Tables 2.6 and 2.11.
110. U.S. Federal Reserve Bank, "Foreign Exchange Rates (Monthly)," web site www.federalreserve.gov.
111. "Coal Exports Decrease in Year 2004," *China Coal Newsletter*, AAA Minerals International, Vol. 1, No. 2 (January 20, 2004); X. Yie, "Coal Exports Decrease to Satisfy High Domestic Demand," *China Daily* (January 5, 2004); and "China's Output Growth Seen Slowing in 2004 Despite Soaring Demand," *AFX Asia* (December 29, 2003).
112. "Coal Export Tax is Reduced in 2004," *China Coal Newsletter*, AAA Minerals International, Vol. 1, No. 1 (January 5, 2004).
113. "Coal Exports Decrease in Year 2004," *China Coal Newsletter*, AAA Minerals International, Vol. 1, No. 2 (January 20, 2004); and "Beijing to Regulate Prices," *McCloskey's Coal Report*, No. 75 (December 12, 2003), p. 18.
114. "Met Coke Prices Soar as High as the Sky," *Coal Americas, Energy Publishing LLC*, No. 30 (November 17, 2003), p. 10.
115. International Energy Agency, *Databases for the Coal Information 2003*, web site data.iea.org.
116. "Japanese Discuss New Coke Ovens as Demand Increases, Ovens Age," *Platts International Coal Report*, No. 634 (October 13, 2003), p. 9; and "Hill's Met Coke Price Indicator," *Coal Americas, Energy Publishing LLC*, No. 35 (January 26, 2004), p. 1; and "Chinese Coke Licenses for 2.3 Million mt Issued, Buyers Disappointed," *Platts International Coal Report*, No. 646 (January 12, 2004), p. 9.
117. World Coal Institute, "Coal in the Steel Industry," in *Coal: Power for Progress, Fourth Edition*, web site www.wci-coal.com (March 2000).
118. "Japanese Discuss New Coke Ovens as Demand Increases, Ovens Age," *Platts International Coal Report*, No. 634 (October 13, 2003), p. 9.
119. SSY Consultancy and Research Ltd, *SSY's Coal Trade Forecast*, Vol. 12, No. 4 (London, United Kingdom, September 2003).
120. SSY Consultancy and Research Ltd, *SSY's Coal Trade Forecast*, Vol. 12, No. 4 (London, United Kingdom, September 2003); and Energy Information Administration, *Annual Energy Review 2002*, DOE/EIA-0384(2002) (Washington, DC, October 2003), Table 7.4.
121. SSY Consultancy and Research Ltd, *SSY's Coal Trade Forecast*, Vol. 12, No. 4 (London, United Kingdom, September 2003); Energy Information Administration, National Energy Modeling System run IEO2004.D022304A.
122. International Energy Agency, *Coal Information 2003* (Paris, France, November 2003), p. I.191; and SSY Consultancy and Research Ltd, *SSY's Coal Trade Forecast*, Vol. 12, No. 4 (London, United Kingdom, September 2003).
123. SSY Consultancy and Research Ltd, *SSY's Coal Trade Forecast*, Vol. 12, No. 4 (London, United Kingdom, September 2003.
124. "Malaysian Coal Project Advances," *Power in Asia* (June 12, 2003), p. 4; "TNB to Set Ceiling on Coal Prices," *Coal Americas, Energy Publishing LLC*, No. 16 (May 5, 2003), p. 20.
125. "Order for Coal-Fired Power Plant from BLCP Power of Thailand," *News Release—Mitsubishi Heavy Industries, Ltd* (September 19, 2003), web site www.mhi.co.jp; "EGAT Approves Construction of Two 1,400 MW Power Plants," *Thai News Service* (February 25, 2003); B. Treerapongpichit, "Banpu Unit Gets Nod for Coal-Fired Plant," *Bangkok Post* (June 26, 2002), p. 12.
126. SSY Consultancy and Research Ltd, *SSY's Coal Trade Forecast*, Vol. 12, No. 4 (London, United Kingdom, September 2003).
127. "Gas-Fired Power Generation Up at 11% in Philippines Energy Mix," *Platts Commodity News* (December 15, 2003); "Philippines Power Cost in Control Despite Oil Price Rise," *Platts Commodity News* (September 26, 2002); and "Philippines to Slash Oil Use for Power to 7% by End-2002," *Platts Commodity News* (August 6, 2002).
128. Energy Information Administration, *Annual Prospects for World Coal Trade 1991*, DOE/EIA-0363 (91) (Washington, DC, June 1991), Table 1.

129. "Negative Influence From Tonne-Miles," *Monthly Shipping Review SSY* (September 10, 2001), p. 4.

130. S. Wyatt, "China Stakes Claim As Asia's Coal King," *Australian Financial Review* (May 16, 2001), p. 22; "China Rampant," *Monthly Shipping Review*, Vol. 554 (June 8, 2001), p. 4; "Increased Competition Forecast by ABARE," *Coal Week International* (June 25, 2001), p. 6.

131. SSY Consultancy and Research Ltd, *SSY's Coal Trade Forecast*, Vol. 12, No. 4 (London, United Kingdom, September 2003).

132. J. MacPherson, "Mine, Railroad Workers Hurt by End of Coal Shipments," *Alaska Journal of Commerce*, Vol. 26, No. 37 (September 15, 2002), p. 8; "Alaskan Plans Move Slowly," *International Coal Report* (September 30, 1996); and Korea East-West Power Co., Ltd., web site www.kewp.com.

133. Bureau of the Census, U.S. Department of Commerce, "Monthly Report EM 522."

134. "Usibelli to Send Coal to Korea," *Fairbanks Daily News-Miner* (September 18, 2003); and P. Dobbyn, "Contract Means Healy Coal in Korea," *Anchorage Daily News* (September 18, 2003).

135. "After Only Six Years of Operation, LAXT Shuts Its Gates," *Platts Coal Outlook*, Vol. 27, No. 20 (May 19, 2003), pp. 1 and 11.

136. "Western Export Market Revival a Shock," Coal Transportation Report (February 16, 2004), pp. 4-5; J. Gellici, "Coal Ports Struggle to Gain Advantage," Dry Cargo International, No. 5 (June 1999), pp. 42-46; and Bureau of the Census, U.S. Department of Commerce, "Monthly Report EM 522."

137. "Eastern Coal Burners Turn to Colorado/Utah for Tons: Prices Soar," *Platts Coal Outlook*, Vol. 27, No. 51 (December 22, 2003), p. 1.

138. "Western Export Market Revival a Shock," *Coal Transportation Report* (February 16, 2004), pp. 4-5.

139. "U.S. Met Coal Reenters the Japanese Market in a Big Way," *Coal Americas*, No. 35 (January 26, 2004), pp 1 and 3; and "U.S. Returns to Japan," *McCloskey's Coal Report*, No. 77 (January 23, 2004), p. 1.

140. Bureau of the Census, U.S. Department of Commerce, "Monthly Report EM 522."

141. "U.S. Coking Coal Breaks $70 Barrier," *McCloskey's Coal Report*, No. 75 (December 12, 2003), pp. 10-14; and "Met Coal: Get it While You Can at Higher Prices," Coal Americas, No. 31 (December 1, 2003), pp. 1, 4.

142. "Pinnacle workers may not be able to return until February," *Platts Coal Outlook*, Vol. 27, No. 51 (December 22, 2003), p. 7; and C. Davis, "Rise in Global Steel Demand May Impact Coke Shortage," Pittsburgh Business Times (January 26, 2004), web site www.bizjournals.com.

143. "Coking Coal Market Seeks Reunification With Once-Forgotten Partner," *Platts Coal Outlook*, Vol. 27, No. 43 (October 27, 2003), pp. 1 and 15-16; and "Will U.S. Met Exporters in Central Appalachia Continue to Feel the Squeeze," *Coal Americas*, No. 19 (June 16, 2003), pp. 8-9.

144. "Agreement Clears Way for Richards Bay Coal Terminal's R1.75bn Expansion," *Business Report* (January 14, 2004), web site www.busrep.co.za.

145. K. Stone, Natural Resources Canada, *Canadian Minerals Yearbook, 2002: Coal* (Ottawa, Canada, November 2003), web site www.nrcan.gc.ca; SSY Consultancy and Research Ltd, *SSY's Coal Trade Forecast*, Vol. 12, No. 4 (London, United Kingdom, September 2003); Energy Information Administration, *Quarterly Coal Report, October-December 2002*, DOE/EIA-0121 (2002/4Q) (Washington, DC, March 2003).

146. SSY Consultancy and Research Ltd, *SSY's Coal Trade Forecast*, Vol. 12, No. 4 (London, United Kingdom, September 2003); "Brazilian Steel Mills Look to China to Boost Coking Coal Supplies," *Platts International Coal Report*, No. 547 (February 4, 2002), p. 11.

147. Energy Information Administration, National Energy Modeling System run IEO2004.D022304A.

148. S. Brissette, "Bruce Power Begins Refueling Unit 4," *Bruce Power* (January 15, 2003), web site www.brucepower.com; C. Perkel, "Bruce Power Wins Key Approval to Refuel Two Nuclear Reactors," *The Canadian Press* (January 14, 2003); "Ontario on Track to Return Four Pickering Nukes," *Reuters News* (September 13, 2002).

149. J. Spears, "Power Problems Loom, Agency Warns," *The Toronto Star* (December 24, 2002), web site www.thestar.com.

150. Energy Information Administration, *Quarterly Coal Report, October-December 2002*, DOE/EIA-0121 (2002/4Q) (Washington, DC, March 2003), Table 10.

151. K. Stone, Natural Resources Canada, *Canadian Minerals Yearbook, 2002: Coal* (Ottawa, Canada, November 2003), web site www.nrcan.gc.ca.

152. IEA Coal Research, *CoalPower 4 Database* (October 2001).

153. Energy Information Administration, *Quarterly Coal Report, October-December 2002*, DOE/EIA-0121 (2002/4Q) (Washington, DC, March 2003), Table 10; SSY Consultancy and Research Ltd, *SSY's Coal Trade Forecast*, Vol. 12, No. 4 (London, United Kingdom, September 2003); and K. Stone, Natural Resources Canada, *Canadian Minerals Yearbook, 2002: Coal* (Ottawa, Canada, November 2003), web site www.nrcan.gc.ca.

154. Energy Information Administration, *Annual Energy Review 2002*, DOE/EIA-0384(2002) (Washington, DC, October 2003), Table 7.4.

155. Energy Information Administration, *Annual Prospects for World Coal Trade 1987*, DOE/EIA-0363(87) (Washington, DC, May 1987), Tables A2 and A3.

156. Energy Information Administration, *Coal Data: A Reference*, DOE/EIA-0064 (93) (Washington, DC, February 1995), pp. 33-35; World Coal Institute, "Coal in the Steel Industry," in *Coal: Power for Progress, Fourth Edition*, web site www.wci-coal.com (March 2000).

157. International Energy Agency, *Databases for the Coal Information 2003*, web site data.iea.org.