

2. Carbon Dioxide Emissions

Overview

U.S. Anthropogenic Carbon Dioxide Emissions, 1990-2004		
	Carbon Dioxide	Carbon Equivalent
Estimated 2004 Emissions (Million Metric Tons)	5,973.0	1,629.0
Change Compared to 2003 (Million Metric Tons)	101.2	27.6
Change from 2003 (Percent)	1.7%	1.7%
Change Compared to 1990 (Million Metric Tons)	970.7	264.7
Change from 1990 (Percent)	19.4%	19.4%
Average Annual Increase, 1990-2004 (Percent)	1.3%	1.3%

Carbon dioxide emissions in the United States and its Territories were 5,973.0 million metric tons (MMT) in 2004, 101.2 MMT (1.7 percent) more than in 2003 (Table 5). The increase in emissions from 2003 to 2004 can be attributed mainly to an increase in overall U.S. economic growth in 2004 of 4.2 percent, including an increase in industrial production. As a result of the higher economic growth rate, fossil fuel consumption and carbon dioxide emissions in the transportation and industrial sectors increased (Table 6). The 1.7-percent increase in total emissions from 2003 to 2004 followed an increase of 1.1 percent, or 63.3 MMT, from 2002 to 2003 (Figure 1). Since 1990, total U.S. carbon dioxide emissions have increased by an average of about 1.3 percent per year.

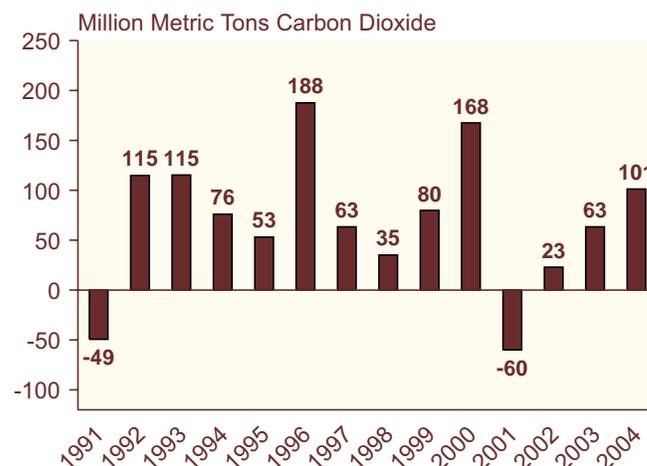
Carbon dioxide emissions represent about 84 percent of total U.S. greenhouse gas emissions. In the United States, most carbon dioxide (98 percent) is emitted as the result of the combustion of fossil fuels; consequently, carbon dioxide emissions and energy use are highly correlated. (The remaining 2 percent of carbon dioxide emissions comes from a variety of other industrial sources.) Historically, economic growth, the weather, the carbon and energy intensity of the economy, and movements in energy prices have caused year-to-year fluctuations in energy consumption and resulting carbon dioxide emissions.

In both the residential and commercial sectors, 2004 energy-related carbon dioxide emissions were virtually unchanged from 2003 levels (Table 6). In the residential sector, emissions of carbon dioxide decreased by 0.1 percent, from 1,213.2 MMT in 2003 to 1,212.0 MMT in 2004. In the commercial sector, carbon dioxide emissions increased by 0.3 percent, from 1,021.1 MMT in 2003 to 1,024.2 MMT in 2004. Growth in energy consumption, and subsequently emissions, was mitigated in both sectors, because both a warmer winter and a cooler summer than in 2003 reduced heating and cooling degree-days by 3.8 and 4.4 percent, respectively.

Industrial production rose by 4.1 percent in 2004, and industrial emissions of carbon dioxide rose by 2.6 percent, from 1,685.6 MMT in 2003 to 1,730.2 MMT in 2004 (Table 6). Trends in industrial emissions are driven in part by growth patterns in the six most energy-intensive manufacturing industries, which account for about two-thirds of total industrial emissions of carbon dioxide. In 2004, there was growth in all six energy-intensive industries. Three of those manufacturing industries grew at rates greater than the overall GDP growth rate of 4.2 percent: paper by 5.6 percent, primary metals by 5.5 percent, and nonmetallic minerals by 4.6 percent. The other three grew by less than overall GDP: the petroleum industry by 3.9 percent, the food industry by 3.2 percent, and chemicals by 2.0 percent.

Estimates for 2004 indicate that, as a result of strong growth in demand for transportation services, carbon

Figure 1. Annual Change in U.S. Carbon Dioxide Emissions, 1990-2004



Source: Estimates presented in this chapter.

dioxide emissions in the transportation sector increased by 3.1 percent, from 1,875.7 MMT in 2003 to 1,933.7 MMT in 2004 (Table 6). If these preliminary numbers prove accurate, this would be the highest growth rate in transportation-sector emissions of carbon dioxide during the 1990 to 2004 period.

Net generation of electricity increased by 1.9 percent from 2003 to 2004, although carbon dioxide emissions from the electric power sector increased by only 0.9 percent, from 2,278.8 MMT in 2003 to 2,298.6 MMT in 2004 (Table 6). Accordingly, the overall carbon intensity of U.S. electricity production fell by about 1.1 percent. The decrease in carbon intensity was driven by an increase in the use of natural gas to generate electricity, while coal use for generation was essentially flat. Natural gas has a lower carbon content than the coal it displaced and generally higher efficiency when used to produce electricity. In addition, generation from “non-carbon” nuclear and renewable fuels increased by 21 billion kilowatt-hours (2.0 percent).⁵⁴

In this report, the electric power sector is defined as all utilities, nonutilities, and combined heat and power (CHP) facilities whose primary business is the production of electric power. Carbon dioxide emissions from generators that produce electric power as part of an industrial or commercial operation—that is, businesses that produce electricity primarily for their own use—are not included in the electric power sector total but are assigned to the industrial or commercial sector according to the classification of the business. In addition, the emissions totals reported above for the energy end-use sectors (residential, commercial, industrial, and transportation) include their shares of total electric power sector emissions.

Nonfuel uses of fossil fuels, principally petroleum, both emit and sequester carbon dioxide over their life cycles. In 2004, carbon dioxide emissions from nonfuel uses of fossil fuels totaled 114.3 MMT, an 8.6-percent increase from the 2003 total of 105.2 MMT (Table 5). Nonfuel uses of fossil fuels also resulted in carbon sequestration equal to 316.6 million metric tons carbon dioxide equivalent (MMT_{CO₂e}) in 2004, a 7.7-percent increase from the 2003 level of 294 MMT_{CO₂e}.⁵⁵ The major fossil fuel products that emit and sequester carbon include liquefied petroleum gas (LPG) and feedstocks for plastics and other petrochemicals. Asphalt and road oils are a major source of sequestration, but they do not emit carbon dioxide. It is estimated that, of the amount of carbon dioxide sequestered in the form of plastic, about 11.0 MMT was emitted as carbon dioxide from the burning of

the plastic components of municipal solid waste to produce electricity in 2004. The 2003 estimate of 18.8 MMT is used in this report as an estimate for total 2004 emissions of carbon dioxide from all burning of wastes, because the 2004 estimate is not yet available.

Emissions of carbon dioxide from other sources—including cement production, industrial processes, waste combustion, carbon dioxide in natural gas, and gas flaring—increased by 2.7 percent, from 102.2 MMT in 2003 to 105.0 MMT in 2004 (Table 5).

Energy Consumption

Energy End-Use Sector Sources of U.S. Carbon Dioxide Emissions, 1990-2004

Sector	Million Metric Tons Carbon Dioxide		Percent Change	
	1990	2004	1990-2004	2003-2004
Residential	953.7	1,212.0	27.1%	-0.1%
Commercial	780.7	1,024.2	31.2%	0.3%
Industrial	1,692.2	1,730.2	2.2%	2.6%
Transportation	1,569.9	1,933.7	23.2%	3.1%

Note: Electric power sector emissions are distributed across sectors.

The consumption of energy in the form of fossil fuel combustion is the largest single contributor to greenhouse gas emissions in the United States and the world. Of total 2004 U.S. carbon dioxide emissions (adjusting for U.S. Territories and bunker fuels), about 98 percent, or 5,868.0 MMT carbon dioxide, resulted from the combustion of fossil fuels. This figure represents an increase of 1.7 percent from 2003 levels.

In the short term, year-to-year changes in energy consumption and carbon dioxide emissions tend to be dominated by weather, economic fluctuations, and movements in energy prices. Over longer time spans, changes in energy consumption and emissions are also influenced by other factors, such as population shifts and energy consumers’ choice of fuels, appliances, and capital equipment (e.g., vehicles, aircraft, and industrial plant and equipment). The energy-consuming capital stock of the United States—cars and trucks, airplanes, heating and cooling plants in homes and businesses,

⁵⁴Included as non-carbon renewable fuels are hydropower, wood, solar, and wind. Both geothermal power and waste combustion produce some carbon dioxide emissions. Wood-fired generation is considered carbon-neutral so long as it does not lead to deforestation.

⁵⁵Unlike emissions of carbon that occur in the form of carbon dioxide, carbon is sequestered in combination with other chemicals. Therefore, carbon sequestration is estimated in carbon dioxide equivalent units, rather than simply as carbon dioxide.

steel mills, aluminum smelters, cement plants, and petroleum refineries—changes slowly from one year to the next, because capital stock usually is retired only when it begins to break down or becomes obsolete.

The Energy Information Administration (EIA) divides energy consumption into four general end-use categories: residential, commercial, industrial, and transportation. Emissions from electricity generators, which provide electricity to the end-use sectors, are allocated in proportion to the electricity consumed in, and losses allocated to, each sector (Table 6).

Residential Sector

At 1,212.0 MMT, residential carbon dioxide emissions represented 21 percent of U.S. energy-related carbon dioxide emissions in 2004. The residential sector's pro-rated share of electric power sector emissions, 837.3 MMT, accounts for more than two-thirds of all emissions in the residential sector (Table 7).⁵⁶ Natural gas accounted for 22 percent (265.5 MMT), and petroleum (mainly distillate fuel oil) represented 8.9 percent (108.0 MMT). Since 1990, residential electricity-related emissions have grown by 2.2 percent annually. In contrast, emissions from the direct combustion of fuels, primarily natural gas, in the residential sector have grown by 0.7 percent annually since 1990.

Total carbon dioxide emissions from the residential sector decreased by 0.1 percent in 2004. Year-to-year, residential sector emissions are strongly influenced by weather. The warmer winter in 2004, relative to 2003, was a contributor to the 2004 decrease in residential sector emissions. In addition, the 2004 summer was cooler than in 2003, leading to a drop in both heating and cooling degree-days of about 4 percent.⁵⁷

Since 1990, the growth in carbon dioxide emissions attributable to the residential sector has averaged 1.7 percent per year. Residential sector emissions in 2004 were 258.3 MMT higher than in 1990, representing 29 percent of the total increase in unadjusted U.S. energy-related carbon dioxide emissions since 1990. Long-term trends in residential carbon dioxide emissions are strongly influenced by demographic factors, living space attributes, and building shell and appliance

efficiency choices. For example, the movement of population into warmer climates tends to increase summer air conditioning consumption and promote the use of electric heat pumps, which increases emissions from electricity use (although the increase could be offset by a reduction in emissions from heating fuel combustion). Growth in the number of households, resulting from increasing population and immigration, contributes to more residential energy consumption.

Commercial Sector

Commercial sector carbon dioxide emissions, at 1,024.2 MMT, accounted for about 17 percent of total energy-related carbon dioxide emissions in 2004, of which 78 percent (795.4 MMT) is the sector's pro-rated share of electricity-related emissions (Table 8). Natural gas contributes 16 percent and petroleum 6 percent of the sector's emissions.

Commercial sector emissions largely have their origin in the lighting, space heating, and space cooling requirements of commercial structures, such as office buildings, shopping malls, schools, hospitals, and restaurants. Lighting is a significantly more important component of energy demand in the commercial sector (approximately 20 percent of total demand in 2003) than it is in the residential sector (approximately 12 percent of total demand in 2003). Heating and cooling demand accounted for approximately 41 percent of energy demand in the residential sector in 2003, and about 20 percent in the commercial sector.⁵⁸ Thus, commercial sector emissions are affected less by the weather than residential sector emissions. In the longer run, because commercial activity is a factor of the larger economy, emissions from the commercial sector are more affected by economic trends and less affected by population growth than are emissions from the residential sector.

Emissions attributable to the commercial sector's pro-rated share of electricity consumption increased by 1.5 percent in 2004, and emissions from the direct combustion of fuels (dominated by natural gas, as in the residential sector) decreased by 3.6 percent. Overall, carbon dioxide emissions related to commercial sector activity increased by 0.3 percent—from 1,021.1 to 1,024.2 MMT—between 2003 and 2004 (Table 8). Since 1990,

⁵⁶Sectoral (residential, commercial, and industrial) energy-related carbon dioxide emissions include the share of total electric power sector carbon dioxide emissions that can be attributed to each end-use sector. The share is based on the percentage of total electricity sales purchased by the sector and losses attributed to the sector. (For values used to calculate sectoral shares, see Energy Information Administration, *Monthly Energy Review*, DOE/EIA-0035, Tables 2.2, 2.3, 2.4, and 2.5, web site www.eia.doe.gov/emeu/mer/consump.html.) All carbon dioxide emissions associated with industrial or commercial enterprises whose primary business is not the production of electricity are allocated to the sectors in which they occur.

⁵⁷Energy Information Administration, *Short-Term Energy Outlook* (Washington, DC, July 2005), Appendix A, Table A2, p. 2, web site www.eia.doe.gov/emeu/steo/pub/pdf/a2tab.pdf.

⁵⁸Energy Information Administration, *Annual Energy Outlook 2005*, DOE/EIA-0383(2005) (Washington, DC, February 2005), Table A5, web site www.eia.doe.gov/oiaf/aeo/excel/aeo_base.xls.

commercial emissions growth has averaged 2.0 percent per year, the largest growth of any end-use sector. Commercial sector carbon dioxide emissions have risen by 243.4 MMT since 1990, accounting for 27 percent of the total increase in U.S. unadjusted energy-related carbon dioxide emissions.

Industrial Sector

Industrial sector emissions, at 1,730.2 MMT carbon dioxide, accounted for 29 percent of total U.S. energy-related carbon dioxide emissions in 2004. In terms of fuel shares, electricity consumption was responsible for 38 percent of total industrial sector emissions (660.9 MMT), natural gas for 26 percent (441.9 MMT), petroleum for 26 percent (440.6 MMT), and coal for 10 percent (181.0 MMT).

Estimated 2004 energy-related carbon dioxide emissions in the industrial sector, at 1,730.2 MMT (Table 9), were 2.6 percent higher than the 2003 emissions level of 1,685.6 MMT. Carbon dioxide emissions attributable to industrial sector energy consumption, while fluctuating from year to year, have increased by an average of only 0.2 percent per year since 1990. As a result, total energy-related industrial emissions in 2004 were just 2.2 percent (38.0 MMT) higher than in 1990, despite a much larger economy.

A contributing factor to the slow growth in industrial sector carbon dioxide emissions (it has the lowest growth rate of any of the end-use sectors) is the erosion of the older energy-intensive (and specifically coal-intensive) industrial base. For example, coke plants consumed 38.9 million short tons of coal in 1990, as compared with 23.7 million short tons in 2004. Other industrial coal consumption declined from 76.3 million short tons in 1990 to 61.2 million short tons in 2004. Also, the share of manufacturing activity represented by less energy-intensive industries, such as computer chip and electronic component manufacturing, has increased while the share represented by energy-intensive industries has fallen.

Transportation Sector

Carbon dioxide emissions from the transportation sector, at 1,933.7 MMT, accounted for 33 percent of total U.S. energy-related carbon dioxide emissions in 2004. Almost all (98 percent) of transportation sector emissions result from the consumption of petroleum products: motor gasoline, at 60 percent of total transportation sector emissions; middle distillates (diesel fuel) at 22 percent; jet fuel at 12 percent of the total; and residual oil (i.e., heavy fuel oil, largely for maritime use) at 2.8 percent of the sector's total emissions. Motor gasoline is used primarily in automobiles and light trucks, and middle distillates are used in heavy trucks, locomotives, and ships.

Emissions attributable to the transportation sector increased by 3.1 percent in 2004, from 1,875.7 MMT carbon dioxide in 2003 to 1,933.7 MMT in 2004 (Table 10). The fuel-use patterns and related emissions sources in the transportation sector are different from those in the other end-use sectors. By far the largest single source of emissions, motor gasoline, at 1,162.6 MMT carbon dioxide, grew by 1.9 percent. Emissions from motor gasoline were mitigated somewhat by a 24-percent increase in the consumption of ethanol. Carbon dioxide emissions from ethanol consumption are considered to be zero, because the carbon in the fuel is derived primarily from corn, and it is assumed that an equivalent amount of carbon will be sequestered during the corn-growing season.

Since 1990, carbon dioxide emissions related to the transportation sector have increased at an average annual rate of 1.5 percent. The growth since 1990 has meant that transportation emissions have increased by 363.7 MMT, representing 40 percent of the growth in unadjusted energy-related carbon dioxide emissions from all sectors. Transportation is the largest contributing end-use sector to total emissions.

Electric Power Sector

Electric Power Sector Carbon Dioxide Emissions by Fuel Input, 1990-2004

Fuel	Million Metric Tons Carbon Dioxide		Percent Change	
	1990	2004	1990- 2004	2003- 2004
Petroleum	100.9	97.4	-3.5%	0.3%
Natural Gas	176.9	295.9	67.3%	6.6%
Coal	1,519.1	1,893.9	24.7%	0.1%
Total	1,803.1	2,298.6	27.5%	0.9%

The data in Table 11 represent estimates of carbon dioxide emissions for the electric power sector. These emissions when taken as a whole account for 39 percent of total U.S. energy-related carbon dioxide emissions; in calculating sector-specific emissions, electric power sector emissions are distributed to the end-use sectors. The electric power sector includes traditional regulated utilities, as well as independent power producers whose primary business is the generation and sale of electricity. The industrial sector and, to a much lesser extent, the commercial sector also include establishments that generate electricity; however, their primary business is not electricity generation, and so their electricity-related emissions are included in the totals for those sectors, not in the electric power sector.

Energy-Related Carbon Dioxide Emissions in Manufacturing

Manufacturing is the single largest source of energy-related carbon dioxide emissions in the U.S. industrial sector, which also includes agriculture, forestry, fisheries, mining, and construction. The manufacturing subsector accounted for about 84 percent of energy-related carbon dioxide emissions and 90 percent of energy consumption in the industrial sector in 2002. The table below shows estimates of energy-related carbon dioxide emissions from manufacturing in 2002, based on end-use energy consumption statistics from EIA's Manufacturing Energy Consumption Survey (MECS), which surveys more than 15,000 manufacturing plants every 4 years. The most recent MECS data available are from the 2002 survey. The table on page 24 shows estimates of manufacturing emissions by fuel, based on statistics from the 1991, 1998, and 2002 surveys.

The 1991 MECS reported energy consumption (for fuel and nonfuel purposes) that yielded carbon dioxide emissions from the manufacturing subsector as a whole totaling 1,251.4 million metric tons. The corresponding estimate for 2002 is 1,401.2 million metric tons—an increase of 149.8 million metric tons, representing an average increase of 1.0 percent per year. Over the same interval, the demand for manufacturing products (as measured by gross output^a) increased by 1.3 percent per year. Therefore, the overall carbon intensity of U.S. manufacturing, measured as metric tons of carbon dioxide emitted per million chained 2000 dollars of gross output, was 420.4 in 1991 but had dropped to 358.4 by 2002, representing an average decrease of 1.4 percent per year.

The *overall carbon intensity* of the U.S. manufacturing subsector is the ratio of its total carbon dioxide emissions (C) to manufacturing output (Y), as measured by the gross output (in chained 2000 dollars). That ratio (C/Y) can be calculated as the product of the subsector's aggregate *carbon intensity of energy supply*—carbon dioxide emissions (C) per unit of energy consumed (E)—and its *energy intensity*—energy consumed (E) per unit of gross output (Y). That is:

$$C/Y = (C/E) \times (E/Y)$$

For the manufacturing subsector as a whole, energy intensity (the ratio E/Y) is a function primarily of the energy intensities of different production groups and their contributions to the total gross output mix in the subsector. The subsector's carbon intensity of energy supply (the ratio C/E) is determined primarily by the mix of energy fuel inputs and the mix of fuel and nonfuel (sequestering) uses of the inputs. Thus, the overall carbon intensity of manufacturing (C/Y) is a combination of the energy intensity of manufacturing gross output and the carbon intensity of the energy consumed to meet manufacturing energy demand.^b

The manufacturing C/Y ratio fell by 1.4 percent per year from 1991 to 2002; however, the reduction was largely the result of a structural shift (i.e., a change in relative market shares in the subsector). The energy intensity for the "other manufacturing" category declined by 1.0 percent per year, and at the same time its gross output grew by 3.2 percent per year, from
(continued on page 24)

Carbon Dioxide Emissions from Manufacturing by Industry Group, 2002

Industry Group	NAICS ^a Code	Carbon Dioxide Emissions (Million Metric Tons)	Share of Total Manufacturing Emissions (Percent)	Carbon Intensity of Energy Supply (Million Metric Tons per Quadrillion Btu of Energy Consumed)
Petroleum	324	304.8	21.8	43.24
Chemicals	325	311.0	22.2	41.47
Metals	331	212.8	15.2	68.72
Paper	322	102.4	7.3	43.35
Minerals	327	91.1	6.5	68.06
Other Manufacturing		379.0	27.0	54.58
Total		1,401.2	100.0	49.53

^aNorth American Industry Classification System.

Sources: Energy Information Administration, Form EIA-846, "Manufacturing Energy Consumption Survey," and Form EIA-810, "Monthly Refinery Report" (2002).

^aConsists of sales, or receipts, and other operating income, plus commodity taxes and changes in inventories.

^bThe ratios presented here are estimated as aggregations of several manufacturing industries. Specifically, 22 manufacturing industry groups were aggregated into 6 groups for calculations of industry-specified E/Y and C/Y ratios. Therefore, quantifying influences on the change in overall carbon intensity is valuable to extent that these groupings represent changes in the U.S. manufacturing sector. It should be noted, however, that these ratios are based on survey data that are subject to sampling errors and other uncertainties.

Energy-Related Carbon Dioxide Emissions in Manufacturing (Continued)

Carbon Dioxide Emissions from Manufacturing by Fuel, 1991, 1998, and 2002

Fuel Type	NAICS ^a Code					Other Mfg.	Total
	324	325	331	322	327		
1991							
Carbon Dioxide Emissions (Million Metric Tons)							
Petroleum	149.9	42.1	3.4	13.6	6.4	14.1	229.6
Natural Gas	44.2	102.3	37.4	29.1	20.1	73.4	306.6
Coal	1.4	25.2	83.2	28.3	27.9	27.2	193.2
Electricity	19.8	83.1	94.3	38.0	19.8	192.7	447.8
Other	61.0	9.7	3.0	0.2	0.0	0.5	74.3
Total	276.3	262.4	221.3	109.2	74.3	307.8	1,251.4
Share of Total Gross Output (Percent)	7.1	12.4	4.4	5.1	2.4	68.6	100.0
Share of Total Energy Use (Percent)	24.8	23.3	13.2	11.9	4.5	22.3	100.0
Share of Total Carbon Dioxide Emissions (Percent) . .	22.1	21.0	17.7	8.7	5.9	24.6	100.0
1998							
Carbon Dioxide Emissions (Million Metric Tons)							
Petroleum	174.8	56.5	3.6	15.1	6.7	13.4	270.1
Natural Gas	53.2	127.7	47.9	31.1	23.4	91.5	374.9
Coal	0.0	26.9	94.3	25.8	27.7	23.7	198.3
Electricity	22.9	103.2	101.8	45.6	24.4	263.7	561.6
Other	69.5	4.9	3.4	0.8	0.7	1.6	80.9
Total	320.4	319.2	251.0	118.4	82.9	393.9	1,485.8
Share of Total Gross Output (Percent)	5.7	11.0	4.2	4.2	2.4	72.5	100.0
Share of Total Energy Use (Percent)	25.2	24.0	7.4	10.8	4.1	28.5	100.0
Share of Total Carbon Dioxide Emissions (Percent) . .	21.6	21.5	16.9	8.0	5.6	26.5	100.0
2002							
Carbon Dioxide Emissions (Million Metric Tons)							
Petroleum	153.9	70.2	2.4	10.0	11.4	9.6	257.6
Natural Gas	46.4	106.2	37.2	26.6	22.3	87.3	325.9
Coal	19.3	32.8	72.4	22.5	30.1	25.6	202.8
Electricity	24.6	99.4	93.8	42.4	26.8	253.7	540.7
Other	60.8	2.4	7.0	0.8	0.4	2.8	74.2
Total	304.8	311.0	212.8	102.4	91.1	379.0	1,401.2
Share of Total Gross Output (Percent)	5.9	10.5	3.6	3.9	2.2	73.9	100.0
Share of Total Energy Use (Percent)	24.9	26.5	10.9	8.4	4.7	24.5	100.0
Share of Total Carbon Dioxide Emissions (Percent) . .	21.8	22.2	15.2	7.3	6.5	27.0	100.0

^aNorth American Industry Classification System: 324, petroleum products; 325, chemicals; 331, primary metals; 322, paper; 327, nonmetallic minerals (includes stone, clay, and glass).

Notes: Totals may not equal sum of components due to independent rounding. To calculate intensity and consumption values, electricity was calculated as primary electricity: 10,436 Btu per kilowatthour for 1991, 10,197 for 1998, and 10,173 for 2002. These conversion factors represent the average energy input to the generation process for fossil-fired utility plants in the United States. See Energy Information Administration, *Monthly Energy Review*, DOE/EIA-0035(2003/09) (Washington, DC, September 2003), Table A6.

Sources: Energy Information Administration, Form EIA-846, "Manufacturing Energy Consumption Survey," and Form EIA-810, "Monthly Refinery Report" (1991, 1998, and 2002); and U.S. Department of Commerce, Bureau of Economic Analysis, Industry Economics Division.

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Energy-Related Carbon Dioxide Emissions in Manufacturing (Continued)

\$2.0 trillion in 1991 to \$2.9 trillion in 2002 (in chained 2000 dollars), as newer, less energy-intensive industries accounted for an increasing share of manufacturing activity. In 1991 the four most energy-intensive industries (petroleum, chemicals, primary metals, and paper) accounted for 29.0 percent of total manufacturing gross output, but by 2002 their share had fallen to 23.9 percent. For three of the six manufacturing categories, energy intensity increased from 1991 to 2002 (petroleum by 0.4 percent per year, chemicals 1.5 percent, and nonmetallic minerals 0.1 percent). For paper, primary metals, and other manufacturing, energy intensity declined by 2.0 percent, 0.9 percent, and 1.0 percent per year, respectively.

The mix and quantity of energy fuels consumed by manufacturers (for both fuel and nonfuel uses) affect the subsector's aggregate carbon intensity of energy supply. Overall, manufacturing industries had *C/E* ratios equal to 50.92 million metric tons carbon dioxide equivalent per quadrillion Btu in 1991 and 49.53 million metric tons carbon dioxide equivalent per quadrillion Btu in 2002; however, the carbon dioxide factors of the various industries differed markedly.

The petroleum and chemical industries both transform some energy products into products that sequester carbon, such as petrochemical feedstocks, asphalt, and plastics. Because of that use, both the petroleum and chemical industries have lower aggregate *C/E* ratios than the manufacturing average (45.27 and 43.24 million metric tons carbon dioxide equivalent per quadrillion Btu for the petroleum industry and 45.84 and

41.47 for the chemicals industry in 1991 and 2002, respectively).

The paper industry makes extensive use of wood byproducts as an energy source. Carbon dioxide emissions from wood consumption are considered to be zero, because the carbon that is emitted has been sequestered recently, and the regrowing of trees will again sequester an equivalent amount of carbon dioxide. Consequently, the paper industry has a relatively low *C/E* ratio, at 37.41 and 43.35 million metric tons carbon dioxide equivalent per quadrillion Btu in 1991 and 2002, respectively. In contrast, the primary metals industry, which uses large amounts of coal and other carbon-intensive fuels (e.g., electricity), has a high *C/E* ratio: 68.18 in 1991 and 68.72 in 2002.

Between 1998 and 2002, manufacturing industries had decreases in carbon dioxide emissions associated with their use of electricity (20.9 million metric tons) and natural gas (49.0 million metric tons). Even so, electricity use continues to account for the largest share of manufacturers' energy-related carbon dioxide emissions: 37.8 percent (561.6 million metric tons) in 1998 and 38.6 percent (540.7 million metric tons) in 2002.

As a result of the above changes in energy intensity, in combination with the structural shift in the subsector, the overall manufacturing energy intensity (*E/Y*) declined by 1.2 percent per year from 1991 to 2002. When the influence of the structural shift is removed, however, decomposition analysis suggests that the aggregate energy intensity of the manufacturing sector is virtually unchanged.^c

Changes in Key Measures of Carbon Intensity in Manufacturing, 1991-2002

Industry Group	NAICS ^a Code	1991			2002			Annual Percent Change, 1991-2002		
		<i>E/Y</i>	<i>C/E</i>	<i>C/Y</i>	<i>E/Y</i>	<i>C/E</i>	<i>C/Y</i>	<i>E/Y</i>	<i>C/E</i>	<i>C/Y</i>
Petroleum	324	29	45.27	1,310.6	30	43.24	1,312.2	0.4	-0.4	0.0
Chemicals	325	15	45.84	708.0	18	41.47	758.0	1.5	-0.9	0.6
Metals	331	25	68.18	1,688.3	22	68.72	1,532.2	-0.9	0.1	-0.9
Paper	322	19	37.41	717.9	15	43.35	668.2	-2.0	1.3	-0.6
Minerals	327	15	67.76	1,048.2	16	68.06	1,058.7	0.1	0.0	0.1
Other Manufacturing	3	56.12	150.8		2	54.58	131.2	-1.0	-0.3	-1.3
Total		8	50.92	420.4	7	49.53	358.4	-1.2	-0.3	-1.4
Total Without Structural Shift . .		8	NA	NA	8	NA	NA	-0.1	NA	NA

^aNorth American Industry Classification System.

Notes: *E/Y* = energy consumed (thousand Btu) per chained 2000 dollar value of gross output. *C/E* = million metric tons carbon dioxide emitted per quadrillion Btu of energy consumed. *C/Y* = metric tons carbon dioxide emitted per million chained 2000 dollars of gross output. NA = not applicable. Annual percent change for *E/Y* is not statistically significant.

Sources: Energy Information Administration, Form EIA-846, "Manufacturing Energy Consumption Survey," and Form EIA-810, "Monthly Refinery Report" (1991 and 2002).

^cThere are several approaches that, based on index number theory, can be used to decompose aggregate values. The values reported here are based on a Laspeyres index.

Preliminary estimates indicate that carbon dioxide emissions from the electric power sector increased by 0.9 percent (19.7 MMT), from 2,278.8 MMT in 2003 to 2,298.6 MMT in 2004 (Table 11). Emissions from natural-gas-fired generation increased by 6.6 percent, from coal-fired generation by 0.1 percent, and from petroleum-fired generation by 0.3 percent. Carbon dioxide emissions from the electric power sector have grown by 28 percent since 1990, while total unadjusted energy-related carbon dioxide emissions have grown by 18 percent. Of the total growth in energy-related carbon dioxide emissions from 1990 to 2004, 55 percent is attributable to the electric power sector.

Nonfuel Use of Energy Inputs

Nonfuel uses of energy fuels, principally petroleum products, both emit and sequester carbon dioxide over their life cycles. In 2004, nonfuel uses of fossil fuels resulted in emissions of 114.3 MMT carbon dioxide, an increase of 9.1 MMT (8.6 percent) over the 2003 level of 105.2 MMT (Table 12). Carbon dioxide emissions from nonfuel uses, which represent about 2 percent of total U.S. carbon dioxide emissions, have grown by an average of 1.1 percent annually from their 1990 level of 98.1 MMT. Emissions from nonfuel uses of petroleum products in 2004 were 89.0 MMT in the industrial sector and 5.6 MMT in the transportation sector. Within the industrial petroleum products category, the leading carbon dioxide emission sources were petrochemical feedstocks at 41.4 MMT and LPG at 19.3 MMT. Nonfuel uses of natural gas resulted in emissions of 19.2 MMT carbon dioxide in 2004.

In 2004, carbon sequestration through nonfuel uses of fossil fuels totaled 316.6 MMTCO₂e (Table 13). The vast majority was sequestered in petroleum-based products, including 287.7 MMTCO₂e in the industrial sector and 5.6 MMTCO₂e in the transportation sector sequestered through the use of petroleum-based lubricants. Smaller amounts of carbon were sequestered in natural-gas-based products (21.8 MMTCO₂e) and coal-based products (1.5 MMTCO₂e). The main products that sequester carbon include asphalt and road oil (98.6 MMTCO₂e), LPG (77.7 MMTCO₂e), and feedstocks for plastics and other petrochemicals (69.2 MMTCO₂e). The amount sequestered in 2004 was 7.7 percent more than in 2003, when 294.0 MMTCO₂e was sequestered. Since 1990, the annual sequestration of carbon in this manner has increased by 65.4 MMTCO₂e or 26 percent. This translates to an average annual growth rate of 1.7 percent.

Adjustments to Energy Consumption

Total energy consumption and the carbon dioxide emissions upon which they are based correspond to EIA's coverage of energy consumption, which includes the 50 States and the District of Columbia. Under the United Nations Framework Convention on Climate Change (UNFCCC), however, the United States is also responsible for counting emissions emanating from its Territories, and their emissions are added to the U.S. total. Conversely, because the Intergovernmental Panel on Climate Change (IPCC) definition of energy consumption excludes international bunker fuels from the statistics of all countries, emissions from international bunker fuels are subtracted from the U.S. total. Additionally, military bunker fuels are subtracted because they are also excluded by the IPCC from the national total. These sources and subtractions are enumerated and described as "adjustments to energy."

U.S. Territories

Energy-related carbon dioxide emissions for the U.S. Territories are added as an adjustment in keeping with IPCC guidelines for national emissions inventories. The Territories included are Puerto Rico, the U.S. Virgin Islands, American Samoa, Guam, the U.S. Pacific Islands, and Wake Island. Most of these emissions are from petroleum products; however, Puerto Rico and the Virgin Islands consume coal in addition to petroleum products. For 2004, total energy-related carbon dioxide emissions from the U.S. Territories are estimated at 61.7 MMT (Table 5).

International Bunker Fuels

In keeping with the IPCC guidelines for estimating national greenhouse gas emissions, carbon dioxide emissions from international bunker fuels are subtracted from the estimate of total U.S. energy-related emissions of carbon dioxide. Purchases of distillate and residual fuels by foreign-bound ships at U.S. seaports, as well as jet fuel purchases by international air carriers at U.S. airports, form the basis of the estimate for bunker fuels. Additionally, U.S. military operations for which fuel was originally purchased in the United States but consumed in international waters or airspace are subtracted from the total, because they are also considered international bunker fuels under this definition.

For 2003, the carbon dioxide emissions estimate for military bunker fuels was 9.2 MMT.⁵⁹ In 2004, approximately 93.6 MMT carbon dioxide was emitted in total from international bunker fuels, including 84.4 MMT attributed to civilian consumption of bunker fuels. The total amount is subtracted from the U.S. total in Table 5. Just over one-half of the carbon dioxide emissions associated with international bunker fuels comes from the combustion of jet fuels; residual and distillate fuels account for the other half, with most coming from residual fuel.

Other Carbon Dioxide Emissions

U.S. Carbon Dioxide Emissions from Other Sources, 1990-2004

Estimated 2004 Emissions (Million Metric Tons Carbon Dioxide)	105.0
Change Compared to 2003 (Million Metric Tons Carbon Dioxide)	2.8
Change from 2003 (Percent)	2.8%
Change Compared to 1990 (Million Metric Tons Carbon Dioxide)	16.7
Change from 1990 (Percent)	18.9%

Energy Production

In addition to emissions resulting from fossil energy consumed, oil and gas production leads to emissions of carbon dioxide from sources other than the combustion of those marketed fossil fuels. The two energy production sources estimated for this report are:

- Flared natural gas (gas burned at the production site), which is flared either because the cost of bringing the gas to market is prohibitive or because the gas is of insufficient quality to sell
- Carbon dioxide scrubbed from natural gas to improve its heat content and quality and subsequently vented to the atmosphere.

Because many States require flaring of natural gas, EIA assumes that all gas reported under the category “Vented and Flared” is actually flared and therefore

should be counted as carbon dioxide emissions rather than methane emissions. In 2004, about 5.9 MMT carbon dioxide was emitted in this way (Table 5).

By computing the difference between the estimated carbon dioxide content of raw gas and the carbon dioxide content of pipeline gas, the amount of carbon dioxide that has been removed (scrubbed) in order to improve the heat content and quality of natural gas can be calculated. This amount was about 17.8 MMT in 2004 (Table 5).

Information on energy production sources that are excluded from this report because of insufficient data are available in Energy Information Administration, *Documentation for Emissions of Greenhouse Gases in the United States 2003*.⁶⁰

Industrial Process Emissions

Industrial emissions of carbon dioxide not caused by the combustion of fossil fuels accounted for only 1.2 percent (73.5 MMT) of total U.S. carbon dioxide emissions in 2004 (Table 14). Process-related emissions from industrial sources depend largely on the level of activity in the construction industries and on production at oil and gas wells. These sources include limestone and dolomite calcination, soda ash manufacture and consumption, carbon dioxide manufacture, cement manufacture, and aluminum production.

Estimated industrial process emissions of carbon dioxide in 2004 totaled 73.5 MMT, 13.4 MMT (22 percent) higher than in 1990 and 2.7 MMT (3.9 percent) higher than in 2003 (Table 14). Of the total estimate for carbon dioxide emissions from industrial processes in 2004, 61 percent is attributed to cement manufacture. When calcium carbonate is heated (calcined) in a kiln, it is converted to lime and carbon dioxide. The lime is combined with other materials to produce clinker (an intermediate product from which cement is made), and the carbon dioxide is released to the atmosphere. In 2004, the United States produced an estimated 95.0 million metric tons of cement,⁶¹ resulting in the direct release of 44.8 MMT into the atmosphere. This calculation is independent of the carbon dioxide released by the combustion of energy fuels consumed in making cement. The estimate for 2004 represents an increase in carbon dioxide emissions of 11.5 MMT (34 percent) compared with 1990 and an increase of about 1.6 MMT (3.8 percent) compared with 2003.

⁵⁹Data for 2004 military bunker fuels were not available at the time of publication. It should also be noted that only bunker fuels purchased in the United States are subject to adjustment.

⁶⁰Energy Information Administration, *Documentation for Emissions of Greenhouse Gases in the United States 2003*, DOE/EIA-0638(2003) (Washington, DC, January 2004), web site [www.eia.doe.gov/oiaf/1605/ggrpt/documentation/pdf/0638\(2003\).pdf](http://www.eia.doe.gov/oiaf/1605/ggrpt/documentation/pdf/0638(2003).pdf). See also Energy Information Administration, *Documentation for Emissions of Greenhouse Gases in the United States 2004* (to be published).

⁶¹U.S. Department of the Interior, U.S. Geological Service, “Cement,” *Mineral Commodity Summary*, web site <http://minerals.usgs.gov/minerals/pubs/commodity/cement/cemenmcs04.pdf>.

Collectively, in 2004, industrial processes other than cement manufacture emitted 28.7 MMT carbon dioxide. Limestone manufacture and consumption emitted 19.1 MMT, soda ash manufacture 3.8 MMT, aluminum manufacture 3.7 MMT, carbon dioxide manufacture 1.5 MMT, and soda ash consumption 0.6 MMT.

Waste Combustion

Waste that is combusted contains, on average, a portion that is composed of plastics, synthetic rubber, synthetic fibers, and carbon black. The carbon in these plastics has normally been accounted for as sequestered carbon, as

reported in Table 13; however, according to the IPCC, emissions from the plastics contained in municipal solid waste must be counted in total national emissions inventories. The U.S. Environmental Protection Agency (EPA) estimates that plastics and other non-biogenic materials in combusted waste produced emissions of about 18.8 MMT carbon dioxide in 2003 (about 11 MMT from grid-connected power generation).⁶² The EPA's 2003 value is used in this report as an estimate for 2004. The difference between the estimated total and EIA's estimate for the electric power sector is reported in Table 5. For 2004, the difference is 7.8 MMT carbon dioxide.

⁶²U.S. Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2003*, EPA 430-R-05-003 (Washington, DC, April 2005), web site <http://yosemite.epa.gov/oar/globalwarming.nsf/content/ResourceCenterPublicationsGHGEmissionsUSEmissionsInventory2005.html>.

Table 5. U.S. Carbon Dioxide Emissions from Energy and Industry, 1990 and 1996-2004
(Million Metric Tons Carbon Dioxide)

Fuel Type or Process	1990	1996	1997	1998	1999	2000	2001	2002	2003	P2004
Energy Consumption										
Petroleum	2,179.6	2,278.6	2,296.6	2,348.7	2,416.3	2,438.5	2,475.6	2,457.5	2,497.5	2,595.2
Coal	1,783.5	1,960.8	2,005.5	2,023.0	2,024.2	2,115.7	2,055.6	2,049.8	2,090.2	2,090.0
Natural Gas	1,027.2	1,206.8	1,212.3	1,189.3	1,191.9	1,237.5	1,186.0	1,225.7	1,196.1	1,203.4
Renewables ^a	6.2	10.3	10.9	10.6	10.8	10.5	11.2	13.0	11.7	11.4
Energy Subtotal	4,996.6	5,456.5	5,525.2	5,571.6	5,643.2	5,802.3	5,728.4	5,746.0	5,795.5	5,899.9
Nonfuel Use Emissions^b	98.1	105.6	110.5	118.6	124.1	110.0	104.9	107.0	105.2	114.3
Nonfuel Use Sequestration^c	251.2	291.2	303.4	314.7	325.8	308.1	293.9	298.3	294.0	316.6
Adjustments to Energy										
U.S. Territories (+)	31.1	37.7	39.0	41.3	40.7	42.2	53.6	52.2	58.4	61.7
Military Bunker Fuels (-)	13.6	8.9	9.6	10.0	9.8	7.8	8.2	8.1	9.2	9.2
International Bunker Fuels (-)	100.1	93.3	100.1	104.9	97.4	93.5	89.6	81.2	75.0	84.4
Total Energy Adjustments	-82.6	-64.5	-70.7	-73.6	-66.5	-59.1	-44.2	-37.1	-25.9	-31.9
Adjusted Energy Subtotal	4,914.0	5,392.0	5,454.6	5,498.0	5,576.8	5,743.1	5,684.2	5,709.0	5,769.6	5,868.0
Other Sources										
Natural Gas Flaring	9.1	16.5	15.5	6.2	6.7	5.5	5.9	6.0	5.9	5.9
Carbon Dioxide in Natural Gas	14.0	17.8	18.0	18.0	17.8	18.2	18.6	17.9	18.0	17.8
Cement Production	33.3	37.2	38.4	39.3	40.1	41.3	41.5	43.0	43.2	44.8
Other Industrial	26.8	29.0	29.2	29.7	29.3	29.4	27.4	26.4	27.6	28.7
Waste Combustion	5.1	7.3	7.3	6.9	7.2	7.9	8.0	6.2	7.5	7.8
Total Other Sources	88.3	107.7	108.5	100.1	101.2	102.3	101.3	99.5	102.2	105.0
Total	5,002.3	5,499.7	5,563.0	5,598.1	5,677.9	5,845.5	5,785.5	5,808.5	5,871.8	5,973.0

^aIncludes emissions from electricity generation using municipal solid waste and geothermal energy.

^bEmissions from nonfuel use are included in the fuel categories above. See Table 12 for details by fuel category.

^cSee Table 13 for details by fuel.

P = preliminary data.

Notes: Data in this table are revised from the data contained in the previous EIA report, *Emissions of Greenhouse Gases in the United States 2003*, DOE/EIA-0573(2003) (Washington, DC, December 2004). Totals may not equal sum of components due to independent rounding. Adjusted energy total includes U.S. Territories.

Sources: EIA estimates presented in this chapter.

Table 6. U.S. Carbon Dioxide Emissions from Energy Consumption by End-Use Sector, 1990 and 1996-2004
(Million Metric Tons Carbon Dioxide)

End-Use Sector	1990	1996	1997	1998	1999	2000	2001	2002	2003	P2004
Residential	953.7	1,090.2	1,082.0	1,088.5	1,110.9	1,171.8	1,168.3	1,190.4	1,213.2	1,212.0
Commercial	780.7	872.1	916.1	934.1	947.3	1,005.9	1,026.2	1,019.8	1,021.1	1,024.2
Industrial	1,692.2	1,788.8	1,804.4	1,791.2	1,779.1	1,780.3	1,698.4	1,671.0	1,685.6	1,730.2
Transportation	1,569.9	1,705.3	1,722.7	1,757.9	1,806.0	1,844.2	1,835.5	1,864.9	1,875.7	1,933.7
Total^a	4,996.6	5,456.5	5,525.2	5,571.6	5,643.2	5,802.3	5,728.4	5,746.0	5,795.5	5,899.9
Electric Power	1,803.1	2,007.1	2,076.3	2,164.9	2,175.8	2,279.3	2,248.2	2,250.6	2,278.8	2,298.6

^aP = preliminary data.

^aIncludes emissions from nonfuel uses of fossil fuels. See Table 12 for details by fuel category.

Notes: Data in this table are revised from the data contained in the previous EIA report, *Emissions of Greenhouse Gases in the United States 2003*, DOE/EIA-0573(2003) (Washington, DC, December 2004). Totals may not equal sum of components due to independent rounding. Electric power sector emissions are distributed across the end-use sectors. Emissions allocated to sectors are unadjusted. Adjustments are made to total emissions only (Table 5).

Sources: EIA estimates presented in this chapter.

Table 7. U.S. Carbon Dioxide Emissions from Residential Sector Energy Consumption, 1990 and 1996-2004
(Million Metric Tons Carbon Dioxide)

Fuel	1990	1996	1997	1998	1999	2000	2001	2002	2003	P2004
Petroleum										
Liquefied Petroleum Gas . .	22.6	29.3	28.6	26.9	33.1	34.9	33.2	33.6	32.4	33.3
Distillate Fuel	70.8	67.1	63.3	55.9	59.9	65.5	65.8	62.3	65.5	68.4
Kerosene	4.6	6.4	6.6	7.8	8.0	6.8	6.8	4.3	5.4	6.4
Petroleum Subtotal	98.0	102.7	98.5	90.5	101.0	107.2	105.8	100.2	103.3	108.0
Coal	2.9	1.5	1.5	1.2	1.3	1.0	1.1	1.0	0.9	1.0
Natural Gas	238.6	284.6	270.6	246.6	256.4	269.2	259.0	265.6	276.9	265.5
Electricity ^a	614.2	701.3	711.4	750.2	752.2	794.4	802.5	823.5	832.0	837.3
Total	953.7	1,090.2	1,082.0	1,088.5	1,110.9	1,171.8	1,168.3	1,190.4	1,213.2	1,212.0

^aShare of total electric power sector carbon dioxide emissions weighted by sales to the residential sector.

P = preliminary data.

Notes: Data in this table are revised from the data contained in the previous EIA report, *Emissions of Greenhouse Gases in the United States 2003*, DOE/EIA-0573(2003) (Washington, DC, December 2004). Totals may not equal sum of components due to independent rounding.

Sources: EIA estimates presented in this chapter.

Table 8. U.S. Carbon Dioxide Emissions from Commercial Sector Energy Consumption, 1990 and 1996-2004
(Million Metric Tons Carbon Dioxide)

Fuel	1990	1996	1997	1998	1999	2000	2001	2002	2003	P2004
Petroleum										
Motor Gasoline	7.8	1.9	3.0	2.7	2.0	3.1	2.6	3.2	3.2	3.3
Liquefied Petroleum Gas . .	4.0	5.2	5.0	4.7	5.8	6.2	5.9	5.9	5.7	5.9
Distillate Fuel	38.8	35.0	32.1	31.1	31.8	35.6	36.8	32.2	34.9	36.4
Residual Fuel	17.9	10.7	8.7	6.6	5.7	6.6	6.5	6.2	8.7	10.6
Kerosene	0.8	1.5	1.8	2.2	1.9	2.1	2.2	1.1	1.4	1.7
Petroleum Subtotal	69.4	54.2	50.6	47.4	47.2	53.6	54.0	48.7	53.9	57.9
Coal	11.6	11.3	12.2	9.5	9.6	8.1	8.6	8.6	7.9	8.2
Natural Gas	142.4	171.6	174.5	163.6	165.3	171.8	164.9	170.8	175.4	162.7
Electricity ^a	557.2	635.0	678.8	713.6	725.1	772.4	798.6	791.8	783.8	795.4
Total	780.7	872.1	916.1	934.1	947.3	1,005.9	1,026.2	1,019.8	1,021.1	1,024.2

^aShare of total electric power sector carbon dioxide emissions weighted by sales to the commercial sector.

P = preliminary data.

Notes: Data in this table are revised from the data contained in the previous EIA report, *Emissions of Greenhouse Gases in the United States 2003*, DOE/EIA-0573(2003) (Washington, DC, December 2004). Totals may not equal sum of components due to independent rounding.

Sources: EIA estimates presented in this chapter.

Table 9. U.S. Carbon Dioxide Emissions from Industrial Sector Energy Consumption, 1990 and 1996-2004
(Million Metric Tons Carbon Dioxide)

Fuel	1990	1996	1997	1998	1999	2000	2001	2002	2003	P2004
Petroleum										
Motor Gasoline	13.0	14.0	14.9	14.0	10.6	10.5	20.7	21.7	21.9	22.4
Liquefied Petroleum Gas . .	39.9	47.4	49.3	40.3	49.3	57.9	50.1	55.8	54.6	56.6
Distillate Fuel	83.1	85.6	86.7	87.3	85.5	86.5	93.7	86.8	81.9	85.4
Residual Fuel	30.3	24.1	20.5	15.7	14.0	15.4	16.6	12.6	15.0	18.9
Asphalt and Road Oil	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lubricants	6.8	6.3	6.7	7.0	7.1	7.0	6.4	6.3	5.8	5.9
Kerosene	0.9	1.3	1.3	1.6	0.9	1.1	1.7	1.0	1.2	1.5
Petroleum Coke	81.2	84.0	79.5	97.6	109.0	87.6	97.2	94.8	91.6	110.0
Other Petroleum	125.1	130.5	135.9	123.6	128.0	115.5	130.0	127.3	137.3	139.8
Petroleum Subtotal	380.3	393.2	394.9	387.1	404.4	381.6	416.4	406.3	409.4	440.6
Coal	249.5	219.0	215.3	203.8	199.2	202.9	195.9	180.3	183.2	181.0
Coal Coke Net Imports	0.5	3.2	5.3	7.4	6.5	7.2	4.0	5.8	5.8	5.8
Natural Gas	433.5	505.7	506.1	495.0	473.6	479.7	438.7	446.6	428.8	441.9
Electricity^a	628.5	667.6	682.9	697.8	695.3	709.0	643.4	631.9	658.5	660.9
Total^b	1,692.2	1,788.8	1,804.4	1,791.2	1,779.1	1,780.3	1,698.4	1,671.0	1,685.6	1,730.2

^aShare of total electric power sector carbon dioxide emissions weighted by sales to the industrial sector.

^bIncludes emissions from nonfuel uses of fossil fuels. See Table 12 for details by fuel category.

P = preliminary data.

Notes: Data in this table are revised from the data contained in the previous EIA report, *Emissions of Greenhouse Gases in the United States 2003*, DOE/EIA-0573(2003) (Washington, DC, December 2004). Totals may not equal sum of components due to independent rounding.

Sources: EIA estimates presented in this chapter.

Table 10. U.S. Carbon Dioxide Emissions from Transportation Sector Energy Consumption, 1990 and 1996-2004
(Million Metric Tons Carbon Dioxide)

Fuel	1990	1996	1997	1998	1999	2000	2001	2002	2003	P2004
Petroleum										
Motor Gasoline	955.2	1,034.0	1,042.5	1,072.9	1,099.9	1,106.0	1,110.9	1,137.6	1,141.4	1,162.6
Liquefied Petroleum Gas . .	1.3	0.9	0.8	1.0	0.8	0.7	0.8	0.8	0.8	0.8
Jet Fuel	220.4	229.8	232.1	235.6	242.9	251.2	240.4	234.4	229.1	237.4
Distillate Fuel	265.1	323.7	338.4	348.4	362.2	374.0	383.2	390.5	410.3	428.2
Residual Fuel	79.3	66.4	55.5	52.6	51.9	64.2	54.2	52.8	44.5	54.6
Lubricants ^a	6.5	6.0	6.3	6.6	6.7	6.6	6.0	6.0	5.5	5.6
Aviation Gasoline	3.1	2.6	2.7	2.4	2.7	2.5	2.4	2.3	2.1	2.1
Petroleum Subtotal	1,530.9	1,663.3	1,678.4	1,719.5	1,767.1	1,805.2	1,797.9	1,824.5	1,833.8	1,891.3
Coal	0.0									
Natural Gas	35.9	38.9	41.1	35.1	35.6	35.5	33.9	37.1	37.3	37.4
Electricity^b	3.2	3.2	3.2	3.3	3.2	3.6	3.7	3.4	4.6	5.0
Total	1,569.9	1,705.3	1,722.7	1,757.9	1,806.0	1,844.2	1,835.5	1,864.9	1,875.7	1,933.7

^aIncludes emissions from nonfuel uses of fossil fuels. See Table 12 for details by fuel category.

^bShare of total electric power sector carbon dioxide emissions weighted by sales to the transportation sector.

P = preliminary data.

Notes: Data in this table are revised from the data contained in the previous EIA report, *Emissions of Greenhouse Gases in the United States 2003*, DOE/EIA-0573(2003) (Washington, DC, December 2004). Totals may not equal sum of components due to independent rounding.

Sources: EIA estimates presented in this chapter.

Table 11. U.S. Carbon Dioxide Emissions from Electric Power Sector Energy Consumption, 1990 and 1996-2004
(Million Metric Tons Carbon Dioxide)

Fuel	1990	1996	1997	1998	1999	2000	2001	2002	2003	P2004
Petroleum										
Heavy Fuel Oil	91.0	49.5	56.4	82.7	75.7	68.8	79.3	51.7	68.3	69.1
Light Fuel Oil.	7.0	7.9	8.0	9.8	10.1	12.6	12.3	9.2	11.6	8.0
Petroleum Coke	2.9	7.6	9.7	11.7	10.7	9.5	9.9	16.4	16.4	19.4
Petroleum Subtotal^a . .	100.9	65.1	74.2	104.1	96.5	90.9	101.5	77.9	97.1	97.4
Coal	1,519.1	1,725.8	1,771.3	1,801.1	1,807.6	1,896.6	1,846.0	1,854.1	1,892.4	1,893.9
Natural Gas	176.9	206.0	220.0	249.1	260.9	281.4	289.5	305.6	277.6	295.9
Municipal Solid Waste . .	5.8	9.9	10.5	10.2	10.4	10.1	10.8	12.6	11.3	11.0
Geothermal	0.4									
Total	1,803.1	2,007.1	2,076.3	2,164.9	2,175.8	2,279.3	2,248.2	2,250.6	2,278.8	2,298.6

P = preliminary data.

^aIncludes small amounts of other petroleum liquids, such as jet fuel and waste oil.

Notes: Data in this table are revised from the data contained in the previous EIA report, *Emissions of Greenhouse Gases in the United States 2003*, DOE/EIA-0573(2003) (Washington, DC, December 2004). Emissions for total fuel consumption are allocated to end-use sectors in proportion to electricity sales. Totals may not equal sum of components due to independent rounding.

Sources: EIA estimates presented in this chapter.

Table 12. U.S. Carbon Dioxide Emissions from Nonfuel Use of Energy Fuels, 1990 and 1996-2004
(Million Metric Tons Carbon Dioxide)

End Use and Type	1990	1996	1997	1998	1999	2000	2001	2002	2003	P2004
Industrial										
Petroleum										
Liquefied Petroleum Gases . . .	14.8	20.3	20.6	21.5	22.4	20.4	19.1	19.9	19.0	19.3
Distillate Fuel	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Residual Fuel	1.8	2.1	2.1	2.2	2.2	2.2	2.2	2.2	2.2	2.2
Asphalt and Road Oil	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lubricants	6.8	6.3	6.7	7.0	7.1	7.0	6.4	6.3	5.8	5.9
Other (Subtotal)	51.2	51.4	55.2	60.6	66.2	53.7	51.4	52.7	52.5	61.1
Pentanes Plus	1.1	4.2	4.0	2.7	3.5	3.1	2.7	2.3	2.2	2.3
Petrochemical Feed	33.3	34.3	40.0	39.3	37.8	36.4	32.6	33.2	36.2	41.4
Petroleum Coke	9.0	7.5	5.9	10.8	14.4	7.1	10.5	9.7	8.3	13.8
Special Naphtha	7.8	5.4	5.3	7.8	10.6	7.1	5.7	7.5	5.9	3.7
Waxes and Miscellaneous . .	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Petroleum Subtotal	74.9	80.5	85.0	91.7	98.3	83.8	79.5	81.5	80.0	89.0
Coal	0.5	0.7	0.6	0.6	0.6	0.6	0.6	0.5	0.5	0.5
Natural Gas	16.2	18.5	18.5	19.7	18.5	19.0	18.8	19.1	19.2	19.2
Industrial Subtotal	91.6	99.6	104.1	112.0	117.4	103.4	98.9	101.1	99.7	108.7
Transportation										
Lubricants	6.5	6.0	6.3	6.6	6.7	6.6	6.0	6.0	5.5	5.6
Total	98.1	105.6	110.5	118.6	124.1	110.0	104.9	107.0	105.2	114.3

P = preliminary data.

Notes: Emissions from nonfuel use of energy fuels are included in the energy consumption tables in this chapter. Data in this table are revised from unpublished data used to produce the previous EIA report, *Emissions of Greenhouse Gases in the United States 2003*, DOE/EIA-0573(2003) (Washington, DC, December 2004). Totals may not equal sum of components due to independent rounding.

Sources: EIA estimates presented in this chapter.

Table 13. U.S. Carbon Sequestered by Nonfuel Use of Energy Fuels, 1990 and 1996-2004
(Million Metric Tons Carbon Dioxide Equivalent)

End Use and Type	1990	1996	1997	1998	1999	2000	2001	2002	2003	P2004
Industrial										
Petroleum										
Liquefied Petroleum Gases . . .	59.3	81.7	82.7	86.4	89.9	82.1	76.7	79.9	76.3	77.7
Distillate Fuel	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Residual Fuel	1.9	2.1	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2
Asphalt and Road Oil	88.5	88.9	92.5	95.5	100.1	96.4	95.0	93.7	92.2	98.6
Lubricants	6.9	6.4	6.8	7.1	7.2	7.0	6.5	6.4	5.9	6.0
Other (Subtotal)	72.0	85.2	90.7	92.7	94.9	88.7	83.9	86.4	88.1	102.8
Pentanes Plus	4.4	16.9	16.0	10.9	14.0	12.7	10.8	9.2	9.0	9.1
Petrochemical Feed	46.0	50.6	58.4	59.1	55.5	57.7	50.7	55.1	59.2	69.2
Petroleum Coke	9.1	7.6	6.0	10.9	14.5	7.2	10.6	9.8	8.3	13.9
Special Naphtha	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Waxes and Miscellaneous . .	12.5	10.1	10.4	11.8	10.9	11.2	11.8	12.2	11.5	10.6
Petroleum Subtotal	228.8	264.6	275.2	284.3	294.8	277.0	264.7	269.1	265.2	287.7
Coal	1.4	2.0	1.9	1.8	1.8	1.8	1.7	1.5	1.5	1.5
Natural Gas	14.4	18.5	19.8	21.9	22.5	22.7	21.3	21.7	21.8	21.8
Industrial Subtotal	244.7	285.2	297.0	308.0	319.1	301.5	287.8	292.3	288.5	311.0
Transportation										
Lubricants	6.5	6.0	6.4	6.7	6.8	6.7	6.1	6.0	5.6	5.6
Total	251.2	291.2	303.4	314.7	325.8	308.1	293.9	298.3	294.0	316.6

P = preliminary data.

Notes: Emissions from nonfuel use of energy fuels are included in the energy consumption tables in this chapter. Data in this table are revised from the data contained in the previous EIA report, *Emissions of Greenhouse Gases in the United States 2003*, DOE/EIA-0573(2003) (Washington, DC, December 2004). Totals may not equal sum of components due to independent rounding.

Sources: EIA estimates presented in this chapter.

Table 14. U.S. Carbon Dioxide Emissions from Industrial Processes, 1990 and 1996-2004
(Million Metric Tons Carbon Dioxide)

Source	1990	1996	1997	1998	1999	2000	2001	2002	2003	P2004
Cement Manufacture										
Clinker Production	32.6	36.3	37.6	38.4	39.2	40.4	40.5	42.0	42.2	43.8
Masonry Cement	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Cement Kiln Dust	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9
Cement Subtotal	33.3	37.2	38.4	39.3	40.1	41.3	41.5	43.0	43.2	44.8
Other Industrial										
<i>Limestone Consumption</i>										
Lime Manufacture	12.4	15.1	15.5	15.8	15.5	15.4	14.8	14.1	15.1	16.0
Iron Smelting	1.7	1.1	1.1	1.1	1.0	1.1	1.0	0.9	0.9	0.9
Steelmaking	0.3	0.4	0.3	0.4	0.3	0.5	0.6	0.5	0.4	0.4
Copper Refining	0.1	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1
Glass Manufacture	0.1	0.2	0.1	0.0	0.2	0.2	0.1	0.1	0.2	0.2
Flue Gas Desulfurization	0.7	0.9	1.0	1.0	1.1	1.2	1.4	1.4	1.3	1.4
Dolomite Manufacture	0.5	0.3	0.0	0.3	0.1	0.1	0.1	0.1	0.1	0.1
Limestone Subtotal	15.9	18.3	18.3	18.7	18.3	18.6	18.1	17.1	18.0	19.1
Soda Ash Manufacture	3.4	3.8	3.9	3.8	3.7	3.6	3.6	3.5	3.6	3.8
<i>Soda Ash Consumption</i>										
Glass Manufacture	0.1	0.2	0.1	0.0	0.2	0.2	0.1	0.1	0.2	0.2
Flue Gas Desulfurization	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1
Sodium Silicate	0.2	0.2	0.3	0.3	0.2	0.2	0.3	0.2	0.3	0.3
Sodium Tripolyphosphate	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Soda Ash Subtotal	0.5	0.6	0.6	0.5	0.6	0.6	0.5	0.4	0.6	0.6
Carbon Dioxide Manufacture	0.9	1.1	1.1	1.2	1.2	1.3	1.3	1.4	1.5	1.5
Aluminum Manufacture	5.9	5.2	5.3	5.4	5.5	5.4	3.9	4.0	4.0	3.7
Shale Oil Production	0.2	*	*	*	*	*	*	*	*	*
Other Industrial Subtotal	26.8	29.0	29.2	29.7	29.3	29.4	27.4	26.4	27.6	28.7
Total	60.1	66.1	67.6	69.0	69.4	70.7	68.9	69.4	70.8	73.5

*Less than 50,000 metric tons carbon equivalent.

P = preliminary data.

Notes: Data in this table are revised from the data contained in the previous EIA report, *Emissions of Greenhouse Gases in the United States 2003*, DOE/EIA-0573(2003) (Washington, DC, December 2004). Totals may not equal sum of components due to independent rounding.

Sources: EIA estimates presented in this chapter.