



## Short-Term Energy Outlook Supplement: Understanding the Decline in Carbon Dioxide Emissions in 2009 <sup>1</sup>

EIA projects carbon dioxide (CO<sub>2</sub>) emissions from fossil fuels in 2009 to be 5.9 percent below the 2008 level in the [Short-Term Energy Outlook](#), October 2009 (STEO) (Table 1). Projected coal CO<sub>2</sub> emissions fall by 10.1 percent in 2009, primarily because of lower consumption for electricity generation. Coal accounts for 63 percent of the total decline in CO<sub>2</sub> emissions from fossil fuels this year. Forecast lower natural gas and petroleum emissions this year make up 7 percent and 30 percent of the projected total decline in CO<sub>2</sub> emissions from fossil fuels, respectively.

**Table 1. Short-Term Energy Outlook CO<sub>2</sub> Emissions (million metric tons)**

	2008	2009 forecast	Change 2008 to 2009	
			Million metric tons	Percent
Petroleum	2,413	2,311	- 102	- 4.2%
Natural Gas	1,247	1,221	- 26	- 2.1%
Coal	<u>2,130</u>	<u>1,914</u>	<u>- 216</u>	- 10.1%
Total Fossil Fuels	5,790	5,446	- 344	- 5.9%

Source: EIA, *Short-Term Energy Outlook*, October 2009.

A decline in coal, natural gas, and electricity consumption in the industrial sector, a result of the weak economy, accounts for 140 million metric tons, or about 40 percent, of the total projected reduction in CO<sub>2</sub> emissions. Industrial activity, including manufacturing, is disproportionately impacted by the economic downturn, with the index of manufacturing activity forecast to decline by 11.5 percent in 2009, considerably more than the 2.5-percent forecast decline in real gross domestic product (GDP).

Forecast coal, natural gas, and electricity consumption in the commercial and residential sectors is also lower this year because of the weak economy, a slightly warmer winter, and milder summer. We expect CO<sub>2</sub> emissions from the commercial and residential sectors to be 29 million metric tons lower in 2009, or just over 8 percent of the total projected reduction in CO<sub>2</sub> emissions this year.

<sup>1</sup> Contact: Elias Johnson (Elias.Johnson@eia.doe.gov)

Projected reductions in CO<sub>2</sub> emissions associated with changes in the electricity generation mix reflect both increases in emission-free generation from hydropower, wind, and nuclear power and, with substantially lower natural gas prices, decisions by some electricity suppliers to back out some coal generation in favor of natural gas generation. Low industrial demand for natural gas is among the factors contributing to lower natural gas prices, so part of the change in the electricity generation mix, which accounts for 73 million metric tons, or about 20 percent, of the total projected decline in CO<sub>2</sub> emissions, is indirectly related to the decline in industrial activity.

The decline in CO<sub>2</sub> emissions from petroleum consumption, which occurs primarily in economy-related reductions in jet fuel and distillate fuel consumption, accounts for the other 30 percent of the forecast reduction in CO<sub>2</sub> emissions.

Additional discussion of the forecast for CO<sub>2</sub> emissions from fossil fuels in 2009, and its composition, is provided below.

**Industrial sector energy consumption.** A key factor in the expected 5.9-percent decline in CO<sub>2</sub> emissions from fossil fuels in 2009 is the decline in economic activity. Although real GDP is forecast to fall by 2.5 percent in 2009, industrial sector production, which includes manufacturing and is energy-intensive, is projected to fall at a much faster rate. For example, the 2009 average manufacturing production index is expected to fall by 11.5 percent while raw steel production declines by 40 percent.

Projected declines in energy consumption in the industrial sector lead to substantial declines in energy-related CO<sub>2</sub> emissions (Table 2). The forecast 25-percent decline in coal consumed by the industrial sector leads to a 43-million-metric-ton fall in CO<sub>2</sub> emissions for 2009. Industrial-sector natural gas consumption, which accounts for about one-third of all natural gas consumed, is forecast to decline by 8 percent, resulting in a 31-million-metric-ton decline in CO<sub>2</sub> emissions.

Electricity consumed by the industrial sector is expected to decline by 11 percent in 2009. To estimate the change in CO<sub>2</sub> emissions that could be attributed to the decline in electricity consumption and not to fuel switching we assume the year-over-year decline rates for coal and natural-gas-fired generation are an identical 11 percent, meeting the projected decline in electricity consumption without changing the coal-natural-gas-generation mix.

The total reduction in CO<sub>2</sub> emissions from the projected declines in coal, natural gas, and electricity consumption in the industrial sector is 140 million metric tons, about 40 percent of the total forecast decline in CO<sub>2</sub> emissions from all fossil fuel use in the United States in 2009.

**Table 2. Short-Term Energy Outlook Industrial Sector Fossil Fuel Consumption and CO<sub>2</sub> Emissions**

	2008	2009 forecast	Change 2008 to 2009
Real GDP (billion chained 2005 dollars)	13,312	12,978	-2.5%
Manufacturing Production Index (2002=100)	110.3	97.6	-11.5%
Raw steel Production (million short tons)	100.8	60.0	-41%
Industrial Sector Energy Consumption (million Btu)			
Coal	1,840	1,382	-25%
Natural Gas	8,132	7,515	-8%
Electricity	3,351	2,993	-11%
Industrial Sector CO <sub>2</sub> Emissions (million metric tons)			
Coal	174	131	-25%
Natural Gas	426	395	-7%
Electricity	619	553	-11%
Total	1,219	1,079	-12%

Source: EIA, *Short-Term Energy Outlook*, October 2009.

**Commercial and residential sector energy consumption.** The weak economy has also contributed to lower energy consumption in the commercial and residential sectors. For example, forecast commercial sector employment falls by 2.9 percent in 2009.

The projected declines in coal, natural gas, and electricity in the commercial and residential sectors are expected to reduce CO<sub>2</sub> emissions by 29 million metric tons in 2009, about 8 percent of the total forecast decline in CO<sub>2</sub> emissions from all fossil fuel use (Table 2).

**Table 3. Short-Term Energy Outlook Commercial and Residential Sectors Coal and Natural Gas Consumption and CO<sub>2</sub> Emissions**

	2008	2009 forecast	Change 2008 to 2009
Commercial Sector Employment (millions)	91.3	88.7	-2.9%
Commercial and Residential Sectors Energy Consumption (million Btu)			
Coal	75	72	-3.4%

Natural Gas	8,217	8,014	-2.5%
Electricity	9,321	9,234	-0.9%
Commercial and Residential Sectors CO <sub>2</sub> Emissions (million metric tons)			
Coal	7	7	-3.5%
Natural Gas	430	421	-2.2%
Electricity	<u>1,723</u>	<u>1,704</u>	-1.1%
Total	2,161	2,132	-1.3%

Source: EIA, *Short-Term Energy Outlook*, October 2009.

**Electricity generation switching from coal to natural gas.** The decline in economic activity in 2009 has led to lower natural gas prices. EIA expects electric power sector natural gas prices to average \$4.45 per million Btu (MMBtu) in 2009, more than 51 percent lower than last year's \$9.13 per MMBtu average. In contrast the projected average cost of coal used for electricity generation *increases* by 7 percent, from an annual average \$2.07 per MMBtu in 2008 to \$2.21 in 2009. This dramatic decline in the natural gas price relative to coal has led to significant switching from coal to natural gas for electricity generation. Despite declines in overall electricity generation, natural-gas-fired generation is projected to increase by 5.5 percent in 2009 (Table 4). Coal-fired generation is forecast to decline at a much larger rate (10.5 percent) than total electricity generation (3.5 percent)

To estimate the change in CO<sub>2</sub> emissions that could be attributed to natural-gas-coal fuel-switching, an alternative case assumes the year-over-year decline rates for coal and natural-gas-fired generation were assumed to be an identical 5.6 percent, meeting projected demand without changing the coal-natural-gas-generation mix. Generation-based CO<sub>2</sub> emissions in this case are 2,213 million metric tons in 2009, 56 million metric tons higher than the *STEO* base case, or 16 percent of the total projected decline in total U.S. CO<sub>2</sub> emissions from all fossil fuel use in 2009.

**Table 4. Short-Term Energy Outlook Electricity Generation and CO<sub>2</sub> Emissions**

	2008	2009 forecast	Change 2008 to 2009
Electricity Generation (billion kilowatthours)			
Coal	1,994	1,784	-10.5%
Natural Gas	877	925	5.5%
Zero-emission Sources:			
Hydropower	248	261	5.4%
Nuclear	806	806	0.0%
Wind	52	62	18.9%
Solar	1	1	-4.4%
Wood and Wood Waste	39	38	-3.2%
Total Generation from Zero-emissions Sources	<u>1,146</u>	<u>1,167</u>	1.9%

Total Electricity Generation	4,017	3,877	-3.5%
Fuel Consumed for Electricity Generation			
Coal (million short tons)	1,044	948	-9.2%
Natural Gas (billion cubic feet)	6,833	7,166	4.9%
CO <sub>2</sub> Emissions from Coal and Natural Gas Consumption in the Electric Power Sector (million metric tons)			
Coal	1,950	1,769	-9.3%
Natural Gas	<u>373</u>	<u>389</u>	4.5%
Total from Electricity Generation	2,322	2,158	-7.1%

Note: Differences will occur in the annual percentage changes in electricity generation from coal and natural gas and the actual volumes of these fuels consumed because of changes in heat rates (Btu of fuel consumed per kilowatthour of electricity generated) resulting from the mix of plants utilized and generator operating rates. Differences in the volumes of fuel consumed and emissions result from changes in the average heat contents of the fuels consumed.

Source: EIA, *Short-Term Energy Outlook*, October 2009.

**Increases in electricity generation from zero-emission sources.** Electricity generation accounts for approximately 40 percent of U.S. energy-related CO<sub>2</sub> emissions. Some sources of electricity generation are classified as zero-emission sources, such as hydropower, nuclear, wind, solar, wood and wood waste. Projected total generation from zero-emission sources increases by 1.9 percent in 2009 (Table 4).

To estimate the change in CO<sub>2</sub> emissions attributed to the increase in zero-emission generation, an alternative case assumes no growth in generation from these sources over the forecast period and replaces the difference (base case minus no-growth) by proportional increases from coal and natural gas. The calculated increase in electric-power-sector CO<sub>2</sub> emissions between the base case and the zero-emission generation no-growth case is 17 million metric tons, or 5 percent of the total projected decline in total U.S. CO<sub>2</sub> emissions from all fossil fuel use in 2009.

**Petroleum consumption.** EIA expects CO<sub>2</sub> emissions from petroleum to fall by 102 million metric tons in 2009, with over two-thirds of the decline attributable to reductions in consumption of jet fuel and distillate fuel oil. The data are not yet available to reliably allocate consumption to end-use sectors or the decline in jet fuel, distillate fuel, and other transportation fuel consumption between economy-related declines in demand for transportation services and increases in fuel efficiency, which may be permanent due to technology-related improvements in equipment or transitory because of higher load factors.

**Conclusion.** A convergence of several factors contributes to the projected decline in CO<sub>2</sub> emissions in 2009. Taken together, the decline in industrial, commercial,

and residential energy consumption of coal and natural gas, the substitution of natural gas for coal in the electric power sector, and the increase in non-CO<sub>2</sub>-emitting generation combine to reduce CO<sub>2</sub> emissions in 2009 by an estimated 242 million metric tons, or 70 percent of the projected decline in total U.S. CO<sub>2</sub> emissions from all fossil fuel use. Projected CO<sub>2</sub> emissions from petroleum fall by 102 million metric tons in 2009, with over two-thirds of the decline attributable to economy-related reductions in consumption of jet fuel and distillate fuel oil, including diesel fuel and heating oil. This decline in CO<sub>2</sub> emissions from petroleum consumption accounts for the other 30 percent of the forecast reduction in CO<sub>2</sub> emissions.