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United States General Accounting Office  
Washington, DC 20548

October 28, 2003

The Honorable Ernest F. Hollings  
Ranking Member  
Committee on Commerce, Science,  
and Transportation  
United States Senate

The Honorable John F. Kerry  
Ranking Member  
Subcommittee on Oceans, Fisheries,  
and Coast Guard  
Committee on Commerce, Science,  
and Transportation  
United States Senate

Subject: *Climate Change: Trends in Greenhouse Gas Emissions and Emissions Intensity in the United States and Other High-Emitting Nations*

In February 2002, the President reaffirmed a previous U.S. commitment to stabilize atmospheric concentrations of carbon dioxide and other greenhouse gases at a level designed to prevent dangerous human interference with the earth's climate. At the same time, he announced a Global Climate Change Initiative to reduce the rate of increase of greenhouse gas emissions in the United States between 2002 and 2012. Specifically, he established the goal of reducing the "emissions intensity" of the U.S. economy by 18 percent, a reduction 4 percentage points greater than would be expected absent any new policy.

Emissions intensity is a ratio calculated by dividing emissions in a given year by economic output for that year. For example, in 2000, U.S. greenhouse gas emissions were 1,909 million metric tons of carbon equivalent,<sup>1</sup> and U.S. economic output was \$9,216 billion;<sup>2</sup> dividing these numbers yields an emissions intensity of 207 tons of emissions per million dollars of economic output. Changes in emissions intensity depend on the relative rate of change in emissions and economic output. For example, if emissions and economic output increase (or decrease) at the same rate, intensity remains constant. However, if emissions increase faster than economic

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<sup>1</sup>To allow for comparisons among greenhouse gases, which differ in terms of their effects on the atmosphere and their expected lifetimes, emissions are typically measured in million metric tons of carbon equivalent, which we refer to as million metric tons.

<sup>2</sup>Economic output (gross domestic product, or GDP) is expressed in billions of 1996 dollars, as reported in the *Economic Report of the President*, 2002.

output, intensity increases. Conversely, if economic output rises faster than emissions, intensity decreases.

You asked us to describe how U.S. emissions and emissions intensity compare to the world's other highest emitters. Specifically, as agreed with your offices, this report focuses on (1) how greenhouse gas emissions and the emissions intensity of the United States and the nine nations with the next-highest emissions changed from 1980 to 2000, (2) how such emissions and the emissions intensities of the same nations are expected to change between 2001 and 2025, and (3) how meeting the administration's goal of reducing emissions intensity by 18 percent would affect cumulative U.S. emissions between 2002 and 2012.

To accomplish these objectives, we analyzed data from the Energy Information Administration (EIA), an independent statistical and analytical agency within the U.S. Department of Energy. After the United States, the next nine nations (excluding Russia<sup>3</sup>) with the highest 2001 emissions, in declining order, are China, Japan, India, Germany, Canada, the United Kingdom, Italy, South Korea, and France. With the United States, these nations accounted for 59 percent of the world's energy-related carbon emissions in 2001 and are projected to account for the same percentage in 2025. For the first two objectives, we used data on emissions of energy-related carbon dioxide (generally, emissions from the consumption of fossil fuels) because we did not find data on the other greenhouse gas emissions for these high-emitting nations. (Energy-related carbon dioxide accounts for an estimated 85 percent of world greenhouse gas emissions, according to the International Energy Agency.<sup>4</sup>) For the third objective, we used data on U.S. emissions of all greenhouse gases. We also analyzed the administration's February 2002 Global Climate Change Initiative and supporting documentation.

## **Results in Brief**

Between 1980 and 2000, energy-related carbon dioxide emissions increased in the United States and six of the other nine highest-emitting nations. Emissions increased 22.5 percent in the United States, while the largest increase occurred in South Korea (231.4 percent). Emissions decreased in the United Kingdom (10.1 percent), France (19.9 percent), and Germany (22.3 percent). During the same period, emissions intensities fell in the United States (34.7 percent) and the other nations reviewed except India. The decrease was the smallest in Italy (19.6 percent) and the greatest in China (68.9 percent). In India, emissions intensity increased slightly but was essentially stable.

Between 2001 and 2025, energy-related carbon dioxide emissions are expected to increase in all 10 nations. U.S. emissions are projected to rise 43.5 percent, not

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<sup>3</sup>Although Russia was the world's third-largest emitter of energy-related carbon dioxide emissions in 2001, we did not include Russia in our study because EIA did not project emissions intensity for Russia for 2025.

<sup>4</sup>The International Energy Agency is the energy forum for the 26 member nations of the Organization for Economic Cooperation and Development.

counting any reductions from the administration's initiative. The smallest increase is expected in Germany (15.2 percent), and the largest increase is expected in China (121.6 percent). During the same period, emissions intensities are expected to decrease in all 10 nations. In the United States, the expected decrease is 30.1 percent. Decreases in intensities are expected to be smallest in Japan (20.8 percent) and largest in China (47.6 percent).

If the administration's goal of reducing U.S. emissions intensity by 18 percent between 2002 and 2012 is met, cumulative emissions for that 11-year period would be about 500 million metric tons of carbon equivalent lower than the 23,162 million metric tons that would otherwise be expected, according to an EIA projection. Specifically, achieving the administration's goal would limit emissions to no more than 22,662 million metric tons—2 percent below the level that would otherwise be expected over the period.

In commenting on a draft of this report, a senior EIA official concurred without further comment, and a senior staff economist at the Council of Economic Advisers, part of the Executive Office of the President, provided technical comments, which we incorporated where appropriate.

## **Background**

Carbon dioxide and certain other gases trap some of the sun's heat in the earth's atmosphere and prevent it from returning to space. The trapped heat warms the earth's climate, much like the process that occurs in a greenhouse. Hence, the gases that cause this effect are often referred to as greenhouse gases. The most prevalent of these gases is carbon dioxide, which results from the combustion of coal and other fossil fuels in power plants, the burning of gasoline in vehicles, and other sources. In recent decades, concentrations of these gases have built up in the atmosphere, giving rise to concerns that continuing increases might interfere with the planet's climate, for example, by increasing temperatures or changing precipitation patterns.

In 1992, the United States ratified the United Nations Framework Convention on Climate Change, which was intended to stabilize the buildup of greenhouse gases in the earth's atmosphere, but did not impose specific goals or timetables for limiting emissions. In 1997 the United States participated in drafting the Kyoto Protocol, an international agreement to specifically limit greenhouse gas emissions, and in 1998 it signed the protocol. However, the previous administration did not submit the protocol to the Senate for advice and consent, which are necessary for ratification. In March 2001, the President announced that he opposed the protocol.

Nearly a year later, in February 2002, the President announced his Global Climate Change Initiative, which focuses on reducing emissions intensity compared to what would otherwise be expected, but not necessarily on reducing the level of emissions. EIA projects that, in the absence of new policies, U.S. greenhouse gas emissions intensity will decrease from 183 metric tons of emissions per million dollars of GDP in 2002 to 158 metric tons in 2012, a decrease of 14 percent. The administration's goal is to reduce emissions intensity to 151 metric tons per million dollars of GDP—a

further reduction of 4 percentage points, bringing the total reduction to 18 percent by 2012.

According to EIA, reductions in emissions intensity can have various causes. For example, in the last half-century the U.S. energy supply has come to rely less on fuels with a high carbon content as nuclear energy, hydropower, and natural gas have been increasingly substituted for coal and oil in power generation. The use of renewable energy sources, such as ethanol, has also increased in the United States. In nations such as China and India, lower emissions intensities result primarily from rapid economic growth, rather than from a switch to less carbon-intensive fuels.

**Emissions Increased, While Intensities Decreased, in Most of the 10 Nations between 1980 and 2000**

Energy-related carbon emissions increased in the United States and six of the other nine highest emitters between 1980 and 2000. In the United States, emissions increased 22.5 percent. The increases were relatively small in Italy (17.5 percent) and Japan (18.8 percent) and relatively large in India (203.7 percent) and South Korea (231.4 percent). Emissions decreased in the United Kingdom (10.1 percent), France (19.9 percent), and Germany (22.3 percent). (See table 1.)

**Table 1: Emissions in 10 Nations, 1980 and 2000 (ranked by 2000 emissions levels)**

Nation	Emissions (million metric tons)		Percent change	
	1980	2000	Cumulative	Average annual rate
United States	1,288	1,578	22.5	1.0
China	394	780	98	3.4
Japan	261	310	18.8	0.9
India	82	249	203.7	5.6
Germany	291	226	-22.3	-1.3
Canada	125	158	26.4	1.2
United Kingdom	168	151	-10.1	-0.5
Italy	103	121	17.5	0.8
South Korea	35	116	231.4	6.0
France	136	109	-19.9	-1.1

Sources: EIA (data); GAO (calculations).

Emissions intensity decreased 34.7 percent in the United States and also decreased in eight of the other nine nations between 1980 and 2000. The decreases were the smallest in Italy (19.6 percent) and South Korea (20.8 percent) and the largest in France (47.2 percent) and China (68.9 percent). In contrast, intensity increased 1.3 percent in India. (See table 2.)

**Table 2: Emissions Intensities in 10 Nations, 1980 and 2000 (ranked by 2000 emissions levels)**

Nation	Emissions intensity (metric tons of carbon equivalent per million dollars of economic output)		Percent change	
	1980	2000	Cumulative	Average annual rate
United States	269	176	-34.7	-2.1
China	2,407	749	-68.9	-5.8
Japan	79	55	-30.5	-1.8
India	514	520	1.3	0.1
Germany <sup>a</sup>	108	84	-22.0	-2.8
Canada	308	226	-26.7	-1.5
United Kingdom	210	116	-44.9	-3.0
Italy	125	100	-19.6	-1.1
South Korea	236	187	-20.8	-1.2
France	116	61	-47.2	-3.2

Sources: EIA (data); GAO (calculations).

<sup>a</sup>Intensity data are for 1991 (the first year for which an intensity figure is available for all the territory comprising unified Germany) and 2000; the percentage changes are calculated accordingly.

### **Emissions Are Projected to Increase and Intensities to Decrease in All 10 Nations between 2001 and 2025**

Energy-related carbon dioxide emissions levels of the United States and the nine other high-emitting nations are projected to increase through 2025, while their emissions intensities are expected to decrease over the same period, according to EIA.<sup>5</sup> U.S. emissions are projected to increase 43.5 percent.<sup>6</sup> Smaller increases are expected in Germany (15.2 percent) and the United Kingdom (19 percent). Larger increases are expected in India (102.4 percent) and China (121.6 percent). (See table 3.)

<sup>5</sup>EIA cautions that its projections present plausible paths or trends for the future based on current laws and regulations; do not anticipate volatile social, political, or economic events; and are not intended as precise predictions of future events. In its most recent *International Energy Outlook*, EIA reported on the accuracy of its past projections; see the Scope and Methodology section for additional details.

<sup>6</sup>This projection for the United States does not include the administration's initiative.

**Table 3: Projected Emissions in 10 Nations, 2001 and 2025 (ranked by 2025 level of emissions)**

Nation	Emissions (million metric tons)		Percent change	
	2001	2025	Cumulative	Average annual rate
United States	1,559	2,237	43.5	1.5
China	832	1,844	121.6	3.3
India	250	506	102.4	2.9
Japan	316	382	20.9	0.8
Germany	223	257	15.2	0.6
Canada	155	206	32.9	1.2
South Korea	121	206	70.2	2.2
United Kingdom	153	182	19	0.7
Italy	121	146	20.7	0.8
France	108	135	25	0.9

Sources: EIA (data); GAO (calculations).

During the same time period, emissions intensities are projected to decrease in all 10 nations. The decrease in the United States is projected to be 30.1 percent. The smallest decreases are expected in Japan (20.8 percent) and France (29.4 percent), and the largest decreases are expected in India (40.6 percent) and China (47.6 percent). (See table 4.)

**Table 4: Projected Emissions Intensities in 10 Nations, 2001 and 2025 (ranked by 2025 level of emissions)**

Nation	Emissions intensities (metric tons of carbon equivalent per million dollars of economic output)		Percent change	
	2001	2025	Cumulative	Average annual rate
United States	166	116	-30.1	-1.5
China	693	363	-47.6	-2.7
India	480	285	-40.6	-2.1
Japan	72	57	-20.8	-1.0
Germany	98	67	-31.6	-1.5
Canada	209	146	-30.1	-1.5
South Korea	217	137	-36.9	-1.9
United Kingdom	104	73	-29.8	-1.5
Italy	96	67	-30.2	-1.5
France	68	48	-29.4	-1.4

Sources: EIA (data); GAO (calculations).

**Administration’s Initiative Would Reduce Cumulative U.S. Emissions 2 Percent below the Otherwise Expected Level**

If the administration’s goal is met, cumulative emissions for 2002 through 2012 would be about 500 million metric tons lower than otherwise expected. EIA projected that, in the absence of any policy change, cumulative U.S. emissions from 2002 through 2012 would be 23,162 million metric tons. The administration projected that the initiative would reduce that total to no more than 22,662 million metric tons. The

reduction in emissions attributed to the initiative is expected to increase each year through 2012, reaching 106 million metric tons in that year, which would represent a 5 percent decrease from the level otherwise expected. Cumulatively, for 2002 through 2012, the initiative is projected to reduce emissions by 500 million metric tons, or 2 percent below the otherwise expected level.

## **Observations**

Emissions increased in 7 out of the 10 highest-emitting nations from 1980 through 2000 and are projected to increase in all 10 through 2025. Emissions intensity decreased in all but one of the nations from 1980 through 2000 and is projected to decrease in all 10 highest-emitting nations through 2025.

## **Agency Comments**

We provided a draft of this report for review and comment to the Secretary of Energy and to the Chairman of the Council of Economic Advisers, a part of the Executive Office of the President. The Director of EIA's Office of Integrated Analysis and Forecasting concurred with the report without further comment. A Senior Staff Economist at the Council of Economic Advisers provided technical comments, which we incorporated where appropriate.

## **Scope and Methodology**

To answer our objectives, we analyzed EIA data and the administration's February 2002 Global Climate Change Initiative and supporting documentation. For our analysis of emissions from 1980 through 2000 and from 2001 through 2025, we used data on energy-related carbon dioxide emissions (generally, emissions from the consumption of fossil fuels).<sup>7</sup> For our analysis of emissions intensity from 1980 through 2000, we used intensity data calculated using 1995 U.S. dollars and carbon dioxide emissions from the consumption and flaring of fossil fuels. For the analysis of emissions intensity from 2001 through 2025, we used intensity data calculated using 1997 U.S. dollars and carbon dioxide emissions. For the discussion of the initiative, we used Environmental Protection Agency data for all greenhouse gas emissions.

We did not independently assess the reliability of EIA data nor the validity of EIA models used in this report. In its most recent *International Energy Outlook*, EIA reported on the accuracy of certain of its projections of energy consumption and other measures. For example, it noted that its 1997 projections of 2000 energy consumption were accurate for North America (which includes Canada and the United States), 4 percent too high for Western Europe (which includes France, Germany, Italy, and the United Kingdom), and 11 percent too high for developing nations in Asia (which includes China and India), a region affected by a severe recession in the late 1990s.<sup>8</sup> We performed our work between April and October 2003

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<sup>7</sup>These emissions data do not include carbon dioxide emitted from natural gas flaring.

<sup>8</sup>See EIA's *International Energy Outlook 2003*, DOE/EIA-0484 (2003).

in accordance with generally accepted government auditing standards, except as noted.

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As arranged with your offices, unless you publicly announce the contents of this report earlier, we plan no further distribution until 10 days from the report date. At that time, we will send copies to the appropriate congressional committees; the Secretary of Energy; and the Chairman, Council of Economic Advisers. In addition, the report will be available at no charge on the GAO Web site at <http://www.gao.gov>.

Should you or your staff need further information, please contact me or David Marwick at (202) 512-3841. Anne K. Johnson and Kevin Tarmann made key contributions to this report. John Delicath and Cynthia Norris also made important contributions.

A handwritten signature in black ink, reading "John B. Stephenson". The signature is written in a cursive style with a long horizontal line extending to the right.

John B. Stephenson  
Director, Natural Resources  
and Environment

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