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Global Climate Change: U.S. Greenhouse Gas Emissions — Status, Trends, and Projections

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Specialists in Energy and Environmental Policy
Resources, Science, and Industry Division

Global Climate Change: U.S. Greenhouse Gas Emissions — Status, Trends, and Projections

Summary

This report reviews U.S. emissions of greenhouse gases in the contexts both of domestic policy and of international obligations and proposals. On October 15, 1992, the United States ratified the United Nations Framework Convention on Climate Change (UNFCCC), which entered into force on March 21, 1994. This committed the United States to "national policies" to limit "its anthropogenic emissions of greenhouse gases," with a voluntary goal of returning "emissions of carbon dioxide [CO_2] and other greenhouse gases [methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6)]" at the "end of the decade" to "their 1990 levels."

Subsequently, in the 1997 Kyoto Protocol to the UNFCCC, the United States participated in negotiations that ended with agreement on further reductions that could become legally binding. The United States signed the Kyoto Protocol in 1998, but President Clinton did not send it to the Senate for advice and consent. President Bush has said that he rejects the Protocol, and former U.S. Environmental Protection Agency Administrator Christine Todd Whitman told reporters that the Administration would not be pursuing the UNFCCC commitment either. Instead, President Bush has proposed to shift the nation's climate change program from a goal of reducing emissions per se to a goal of reducing energy intensity — the amount of greenhouse gases emitted per unit of economic productivity. Under the proposal, the intensity, which has been declining for a number of years, would decline 18% between 2002 and 2012, as opposed to a 14% projected "business as usual" decline.

Meanwhile, the UNFCCC "end of the decade" deadline has passed and U.S. greenhouse gas emissions continue on an upward trend, though with dips in 1991 and in 2001, attributed mostly to economic slowdowns. Based on historical data, 2001 emissions were about 13% in excess of the UNFCCC goal. Overall, from 1990 to 2001, U.S. greenhouse gas emissions (weighted by global warming potential) have increased an average of about 1.1% per year. Projections suggest that U.S. emissions will continue to rise for at least the next decade. Reversing the upward trend in greenhouse gas emissions would represent an extraordinary technical and political challenge to U.S. energy and environmental policy.

This report will be updated as necessary.

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Global Climate Change: U.S. Greenhouse Gas Emissions — Status, Trends, and Projections

This report reviews U.S. emissions of greenhouse gases in the contexts both of domestic policy and of international obligations and proposals. On October 15, 1992, the United States ratified the United Nations Framework Convention on Climate Change (UNFCCC), which entered into force on March 21, 1994. By this action, the nation made a legally non-binding commitment to "national policies" to limit "its anthropogenic emissions of greenhouse gases," which are believed to pose a risk of global climate change.[1] The goal was to return "these anthropogenic emissions of carbon dioxide and other greenhouse gases" at the "end of the decade" to "their 1990 levels." This goal was voluntary, to "demonstrate that developed countries are taking the lead in modifying longer-term trends in anthropogenic emissions consistent with the objective of the Convention."[2] The Convention established standards for inventorying and reporting greenhouse gas emissions.

Subsequently, the United States participated in negotiating the Kyoto Protocol to the UNFCCC.[3] Under the Kyoto Protocol, the United States would have made a legally binding agreement that for the 5-year period 2008-2012, it would reduce its average annual aggregate carbon-equivalent emissions of six gases by 7% below specified baseline years.[4] However, while President Clinton signed the Protocol in 1998, he did not send it to the Senate for its advice and consent; and President George W. Bush has said that he has no intention of pursuing the Kyoto Protocol — that it is "fatally flawed."[5]

Nonetheless, other nations continue efforts to implement the Kyoto Protocol, and the United States remains obligated under the UNFCCC to inventory its emissions of greenhouse gases and to pursue voluntary reductions. However, as

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[1] This report does not address the underlying debate over global climate change and the potential role of humans in contributing to it. On the science and policy of global climate change, see CRS Issue Brief IB89005, *Global Climate Change*.

[2] UNFCCC, Article 4, Commitments, sections 2(a) and (b).

[3] On the agreement, see CRS Report RS30692, *Global Climate Change Treaty: The Kyoto Protocol*.

[4] Technically, the net carbon-equivalent emissions of the six greenhouse gases for the 5-year period 2008-2012 are not to exceed 5 times 93% of the baseline emissions. Kyoto Protocol, Article 3(1). This is equivalent to the *average annual emission load* during the 5-year period being 7% below the baseline.

[5] White House, Office of the Press Secretary, "President Bush Discusses Global Climate Change," June 11, 2001.

described below, President Bush has announced a voluntary program to reduce the intensity of U.S. greenhouse gas emissions per unit of economic productivity.[6] Based on this initiative, according to former Environmental Protection Agency Administrator Christine Todd Whitman, "the Bush Administration does not intend to pursue emissions cuts it committed to" in the UNFCCC.[7]

It is in this context, then, that this report sets out the baseline emissions that the United States has established and portrays trends in emissions over the past decade;[8] notes the current status of U.S. emissions as compared to the UNFCCC goals; and reviews projections and, as a point of reference, compares them to the Kyoto Protocol emissions commitments. (Assessing that prospective commitment does not imply that the United States should reduce emissions, only what would be required *if* it were to join that agreement to reduce emissions.)

In what follows, figures for emissions are point estimates[9] and rounded to millions of metric tons of carbon equivalents (MMTCE[10]). As will be discussed, the data are of varying robustness and may be subject to adjustments. The data for CO_2, which accounts for over 80% of domestic greenhouse gas emissions, are the most robust, being largely based on comprehensive fuel use data. Subsumed estimates and uncertainties in projected emissions have greater effect the further into the future one looks. But even allowing for these imprecisions, the *trendline* of aggregate U.S. emissions of greenhouse gases is clear: over the decade of the 1990s emissions trended upward, and they are projected to continue to rise in the future.

U.S. Greenhouse Gas Emissions and Baselines

Pursuant to the United Nations Framework Convention on Climate Change, the United States has published "national inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, using comparable methodologies ... agreed upon by the Conference of the Parties."[11] (See **Table 1**.)

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[6] For documents on the Administration plan, see [http://www.whitehouse.gov/news/releases/2002/02/climatechange.html].

[7] "Bush Emissions Plan Seen Replacing Regs," *Platts Inside Energy* (Feb. 25, 2002), p. 9.

[8] Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2001* (April 2003), EPA 430R03004.

[9] Although emissions data are typically presented as individual figures for each year, this single number (point estimate) actually represents a range bounded by potential errors arising from assumptions underlying the data.

[10] MMTCE figures combine the variable greenhouse effects of the different gases by calculating and summing their equivalent effects, with carbon dioxide serving as the reference gas. Global warming potential figures have an uncertainty of + or - 35%; a recent recalculation is not included in the current figures (see discussion in EPA, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2001* (April 2003), EPA 430R03004. pp. 6-9).

[11] UNFCCC, Article 4, section 1(a) and Article 12, section 1(a).

Table 1. U.S. Greenhouse Gas Emissions (MMTCE), 1990-2001

Gas	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
CO_2	1,365	1,354	1,381	1,412	1,438	1,455	1,504	1,526	1,531	1,549	1,604	1,580
CO_2 (sinks)[a]	(293)	(289)	(291)	(291)	(292)	(290)	(289)	(229)	(226)	(229)	(228)	(229)
CH_4	176	176	176	174	176	177	174	172	170	168	167	165
N_2O	108	110	113	113	120	118	120	120	119	117	117	116
HFCs, PFCs, SF_6	26	24	25	26	26	27	31	32	35	33	33	30
Total emissions	1,675	1,664	1,694	1,726	1,760	1,777	1,829	1,850	1,855	1,867	1,921	1,892
Net emissions	1,382	1,375	1,403	1,435	1,468	1,487	1,540	1,621	1,629	1,638	1,693	1,663

Source: Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2001* (April 2003), EPA 430R03004. (Data for 1991-1994 provided by EPA.) Following international convention, EPA presents the data in teragrams of CO_2 equivalent; CRS has converted the figures to million metric tons of carbon equivalent (MMTCE), a metric that is more familiar to most U.S. policymakers.

[a]Land-use changes and forestry sinks that sequester carbon; included in net emissions total only.

The Environmental Protection Agency (EPA) publishes the official emissions data annually.[12] The United States also from time to time reports on emissions and explains its climate change programs in the *Climate Action Report (CAR)* to the United Nations; the third *CAR* was published in 2002.[13]

The U.S. baselines for the UNFCCC and the Kyoto Protocol are shown in **Table 2**. For the UNFCCC commitment, the baseline is 1990 emissions, or 1,675 MMTCE; if the United States had acceded to the Kyoto targets, the baseline would have been 1,676 MMTCE, a negligible difference. By definition, sinks are *not* included in calculating the baselines.

Table 2. U.S. Baseline Year Greenhouse Gas Emissions

<table>
<tr><th>Greenhouse Gas</th><th colspan="2">Baseline Year</th><th colspan="2">Emissions (MMTCE)</th></tr>
<tr><td>Carbon dioxide (CO_2)</td><td colspan="2">1990</td><td colspan="2">1,365</td></tr>
<tr><td>Methane (CH_4)</td><td colspan="2">1990</td><td colspan="2">176</td></tr>
<tr><td>Nitrous oxide (N_2O)</td><td colspan="2">1990</td><td colspan="2">108</td></tr>
<tr><td>Hydrofluorocarbons (HFCs)</td><td rowspan="3">1990
UNFCC</td><td rowspan="3">1995
Kyoto</td><td rowspan="3">26
UNFCC</td><td rowspan="3">27
Kyoto</td></tr>
<tr><td>Perfluorocarbons (PFCs)</td></tr>
<tr><td>Sulfur hexafluoride (SF_6)</td></tr>
<tr><td>Total</td><td colspan="2"></td><td>1,675</td><td>1,676</td></tr>
</table>

Source: EPA, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 - 2001)* April 2003, EPA 430R03004.

The emissions baselines shown in **Table 2** are not immutable. Each annual report includes updated estimates based on methodological and data revisions, although such changes are usually small. Revisions are discussed at some length in each report. The criteria for calculating emissions agreed upon by the Conference of Parties hinge on both current technical knowledge and policy judgments. New technical information can change factors, for example concerning calculation of greenhouse gas equivalents; and policy judgments can be adjusted, for example concerning the time frame for calculating effects. In addition, a few technical issues remain unresolved, for example in assigning emissions from fuels burned in international travel. However, any changes tend to be modest, seldom affecting totals

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[12]EPA, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 - 2001*, April 2003, EPA 430R03004, available at [http://yosemite.epa.gov/oar/globalwarming.nsf/content/ResourceCenterPublicationsGHGEmissionsUSEmissionsInventory2003.html].

[13]The *Climate Action Report*s, submitted by the United States of America under the United Nations Framework Convention on Climate Change, appeared in October 1994, July 1997, and May 2002; for the third report, see U.S. Department of State, *U.S. Climate Action Report* (May 2002), available at [http://yosemite.epa.gov/oar/globalwarming.nsf/content/ResourceCenterPublicationsUSClimateActionReport.html].

much more than plus or minus 1%, except for sequestration figures, which have been subject to larger changes.[14]

Besides actual quantities of emissions, an alternative measure of a nation's contribution to global warming is "greenhouse gas intensity of the economy" — that is, emissions per unit of gross domestic product (GDP). In effect, this measure focuses on the efficiency of the economy in terms of greenhouse gas emissions: the more efficient, the fewer emissions per dollar of economic output and thus the lower the "greenhouse gas intensity." For the United States, greenhouse gas intensity has been declining since at least the 1980s; for the 1990s, the decline in intensity was about 10%, based on net emissions[15] (see **Table 3**).

Emissions Projections

Projecting greenhouse gas emissions involves modeling the nation's economic growth and activity, with special attention to variables affecting fossil fuel combustion. The modeling also depends on assumptions about energy policy directions. If reducing emissions becomes a goal, then projections become subject to the outcome of unresolved issues in how the emissions reductions goals might be met.

For example, the major source of CO_2 emissions, fossil fuel combustion, is influenced by overall economic activity and growth as well as by energy policy decisions such as development of non-carbon based substitutes, the rate of adoption of energy efficient technologies, and the retirement rate of nuclear facilities, among others. These policy factors are difficult to predict in the absence of a concrete climate change policy.[16] The climate change plan proposed by President Bush in February 2002 provides some new policy directions, but many elements depend on congressional action (e.g., for funding) or voluntary private sector initiatives, making projections of their impact problematic.

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[14] See "Changes in This Year's Inventory Report," EPA, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2001,* pp. Changes-1 - Changes-13.

[15] Following the Administration's practice, discussions in this report of greenhouse gas intensity are based on *net* emissions per unit of economic activity.

[16] On current federal policies, see CRS Report RL31921, *Climate Change: Federal Laws and Policies Related to Greenhouse Gas Reductions.*

Table 3. U.S. Greenhouse Gas Intensity (1990-2001)

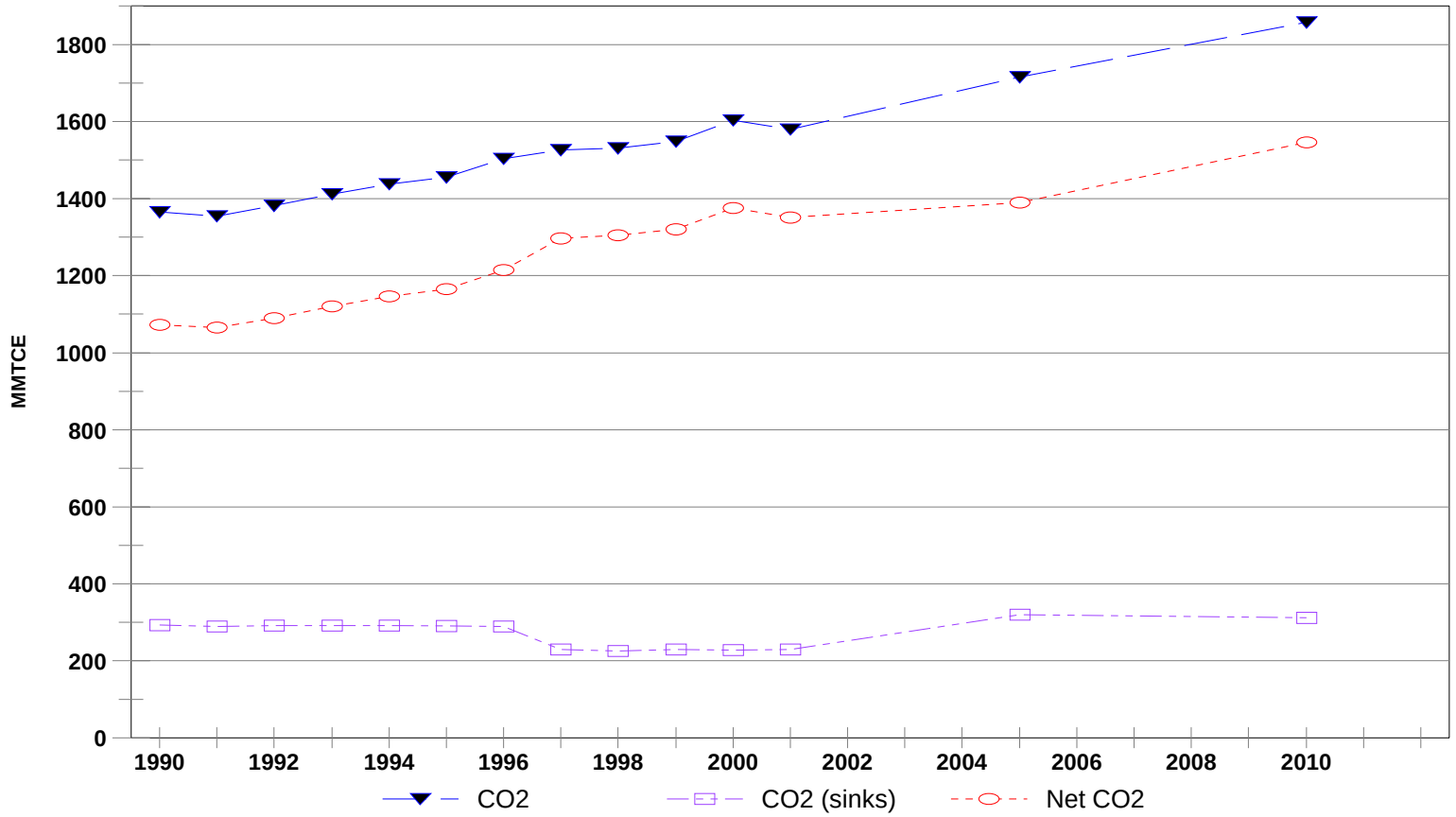
	GDP (billions of chained (1996) dollars)	Greenhouse Gas Intensity (metric tons carbon equivalent per million $ GDP)	
		Total Emissions	Net Emissions
1990	6,708	250	206
1991	6,677	249	206
1992	6,880	246	204
1993	7,063	244	203
1994	7,348	240	200
1995	7,544	236	197
1996	7,813	234	197
1997	8,160	227	199
1998	8,509	218	184
1999	8,859	211	185
2000	9,191	209	184
2001	9,214	205	180

Source: Table 1; *Economic Report of the President*, February 2003, Table B-2; CRS calculations.

The *Climate Action Report* Projection

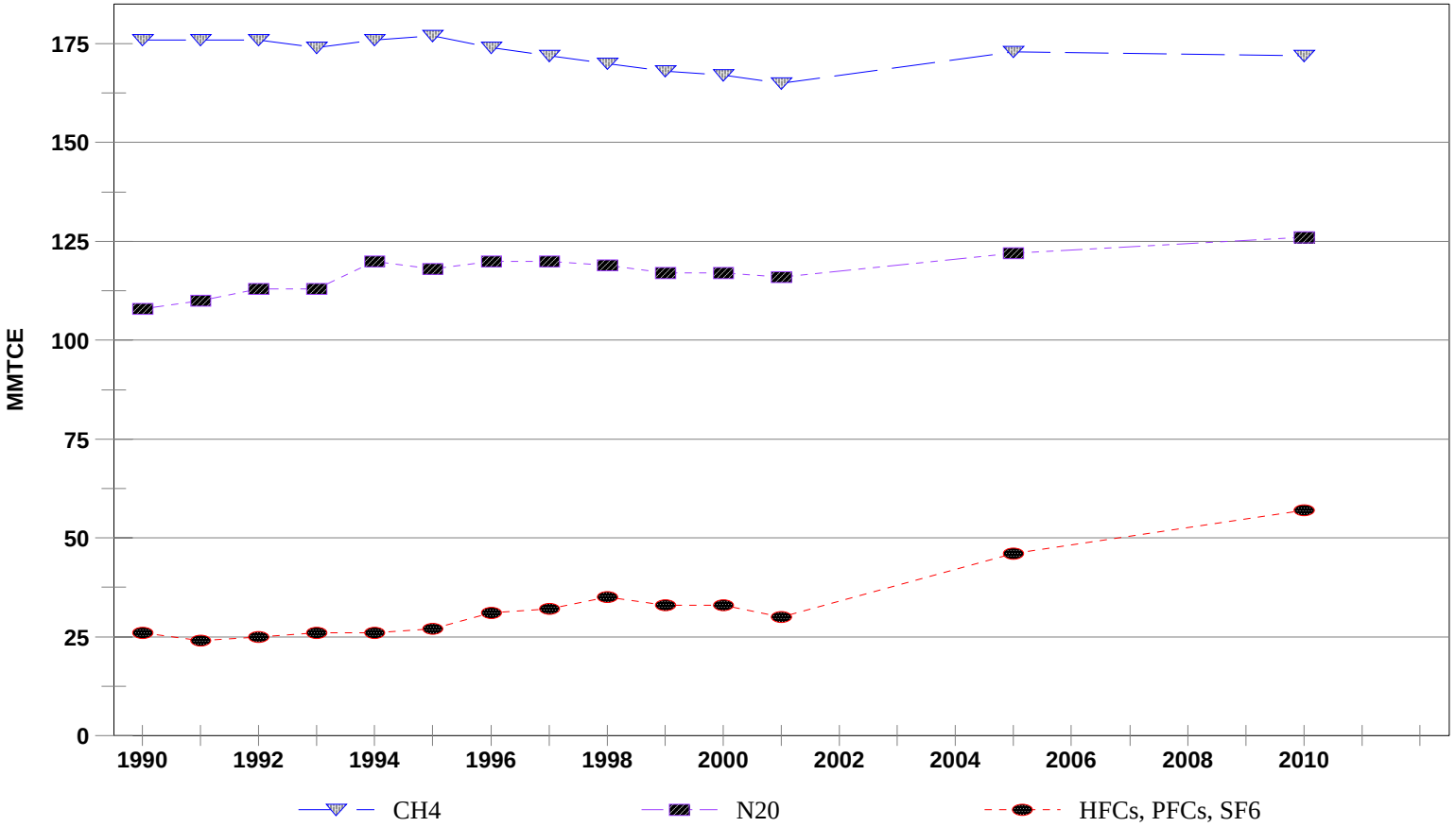
The third U.S. *Climate Action Report* (*CAR 2002*) projects greenhouse gas emissions at 5-year intervals through 2020. For this report, the projections are followed only to 2010 (see **Figures 1 and 2**), because of the difficulties in projecting into the more distant future. Also, 2010 provides a basis for evaluating a relationship to the Kyoto Protocol targets.

Figure 1. U.S. Emissions of CO_2: Historical and Projected (2005, 2010)



Sources: Historical data (through 2001): EPA, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 - 2001*, April 2003, EPA 430R03004, pp. ES-2 - ES-4. Projections (to 2010): U.S. Department of State, *Climate Action Report 2002*, May 2002. [Data converted to MMTCE by CRS.]

Figure 2. U.S. Emissions of CH_4, N_20, and HFCs, PFCs, and SF_6: Historical and Projected (2005, 2010)



Sources: Historical data (through 2001): EPA, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 - 2001*, April 2003, EPA 430R03004, pp. ES-2 - ES-4. Projections (to 2010): U.S. Department of State, *Climate Action Report 2002*, May 2002. [Data converted to MMTCE by CRS.]

The *CAR 2002* estimate for aggregate gross greenhouse emissions[17] in 2010 is 2,213 MMTCE (see **Figure 3**). The President's 2002 initiative to reduce greenhouse gas intensity proposes a series of policy initiatives that it estimates "will achieve 100 million tons of reduced emissions in 2012."[18] Extrapolating between the *CAR 2002* projections from 2010 to 2015 (a 1.9% annual growth rate), the 2012 projected emission level would be 2,298 MMTCE. The President's initiative suggesting a decline in emissions of 100 million tons in 2012 would reduce this to 2,198 MMTCE, representing a reduction of about 4.4% from "business as usual" gross greenhouse emissions in that year. In addition, largely separate from federal activities, a number of state and local governmental initiatives, as well as a variety of private sector activities, are underway to address greenhouse gas emissions.

Effect on Projections of Varying Assumptions

CAR 2002 only makes point estimates, but some sense of the implications of varying assumptions that affect the estimates can be gleaned from examining an alternative source of CO_2 emissions data, the Energy Information Agency's (EIA's) *Annual Energy Outlook* series.[19] (Because of minor differences in data calculation and presentation, EIA's annual emissions figures differ slightly from EPA's.)

The EIA report's projections of CO_2 emissions include sensitivity analyses to various changes in assumptions, and since CO_2 from fuel combustion accounts for about 80% of U.S. greenhouse gas emissions, the analysis is a reasonable test of the projections. The assumptions EIA examines include economic growth, technological innovation, oil prices, electricity demand, and others. The first two, economic growth and technological innovation, have the greatest effect on variance in projections of CO_2 emissions (see **Table 4**). For 2010, compared to EIA's "reference case" (which is equivalent to a "business as usual" case), low economic growth would reduce projected emissions by about 2%,[20] while high economic growth would increase projected emissions by about 3%. Compared to the reference case that assumes anticipated technological developments, static technology would result in emissions rising about 2%, while a "high-technology" case is projected to reduce emissions about 2%. The point reference case — *CAR's* point estimate — effectively assumes the several variances affecting emissions cancel out. But if all the variances increasing emissions prove true and cumulative, then projected emissions for 2010 could be 5% or more higher than the point estimate; conversely, if all the variances decreasing emissions prove true and cumulative, emissions could be 5% or more lower.

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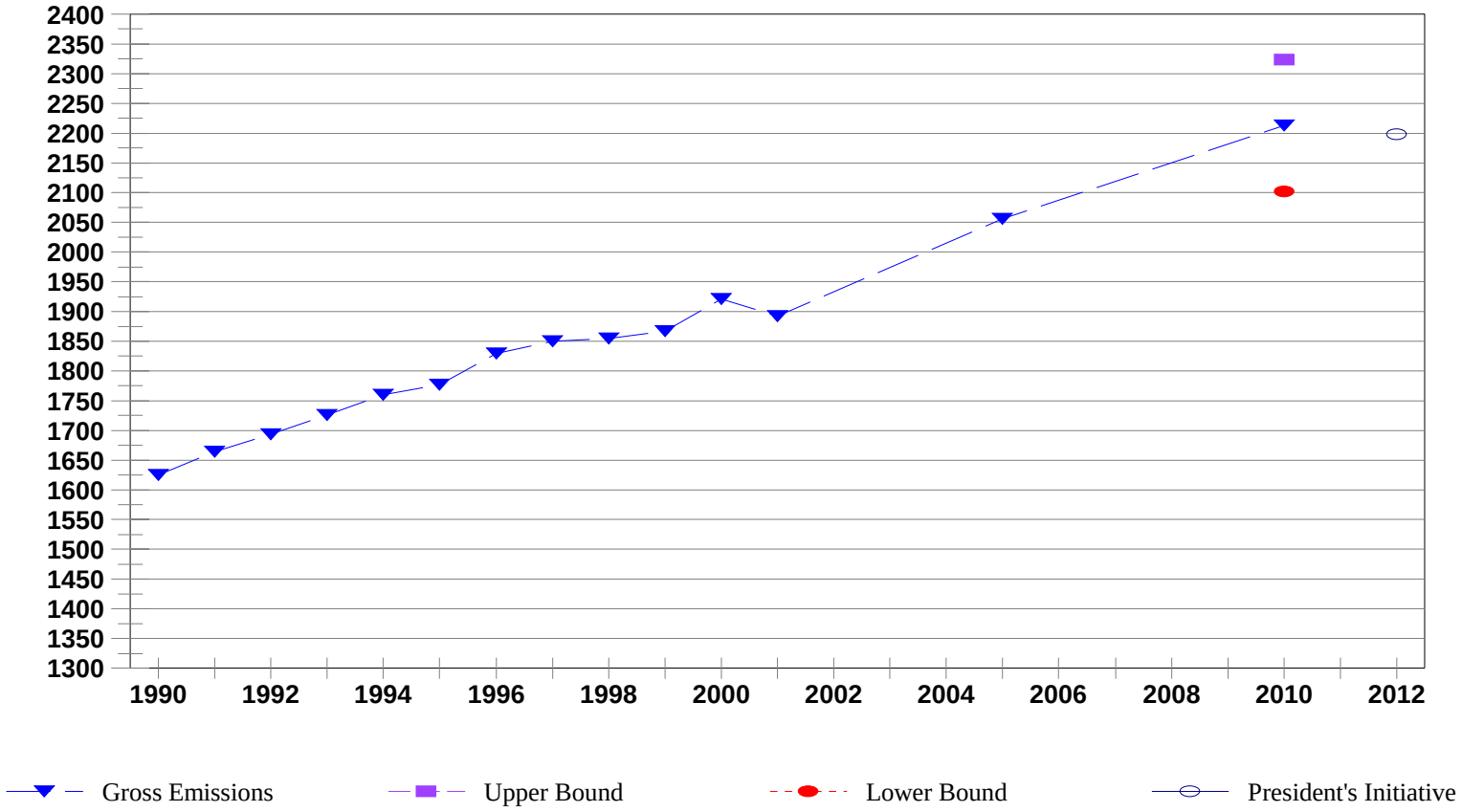
[17] *CAR 2002*, Table 5-2, p. 74; this excludes "Sequestration Removals" and includes "Adjustments."

[18] White House, *Global Climate Change Policy Book*, "Executive Summary," at [http://www.whitehouse.gov/news/releases/2002/02/climatechange.html].

[19] EIA, *Annual Energy Outlook 2003* (Jan. 2003), DOE/EIA-0383(2003).

[20] The impact of economic activity can be seen (**Table 1**) in the fact that gross emissions declined in both 1991 and 2001, in tandem with economic downturns.

Figure 3. U.S. Aggregate Gross Emissions of Six Greenhouse Gases: Historical and Projected (2005, 2010) (MMTCE)



Sources: Historical data (through 2001): EPA, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 - 2001*, April 2003, EPA 430R03004, pp. ES-2 - ES-4. Projections (to 2010): U.S. Department of State, *Climate Action Report 2002*, May 2002. [Data converted to MMTCE by CRS.] Upper and lower bound equal + 5% and - 5%, as discussed in text. President's initiative is from documents on the Administration plan at [http://www.whitehouse.gov/news/releases/2002/02/climatechange.html].

Table 4. Impact of Economic Assumptions on Projections of CO_2 Emissions

Case Comparisons	Change in CO_2 Emissions from Fuel Use, 2010		
	Low economic growth MMTCE (%)	Reference case MMTCE	High economic growth MMTCE (%)
Economic Growth	1,759 (-2%)	1,800	1,852 (+3%)
	2003 Technology	Reference Case	High Technology
Integrated Technology	1,831 (+2%)	1,800	1,759 (-2%)

Source: EIA, *Annual Energy Outlook 2003* (January 2003) DOE/EIA-0383(2003), pp. 174, 218.

Some studies suggest that even greater variance in projections is possible — for example, that new energy-efficient technologies could be deployed more quickly than generally assumed if appropriate policies were instituted. A November 2000 DOE study, commonly called the "New 5-Lab Study," shows that energy efficiency gains in the transportation, industry, commercial, and residential sectors could reduce emissions from the "business as usual" scenario.[21] The "business as usual" scenario in this study is very similar to EIA's reference case, though it projects somewhat smaller emissions in 2010 (1,769 MMTCE from fossil fuel combustion, compared to EIA's most recent projection of 1,800). The study compares "moderate" and "advanced" scenarios "that are defined by policies that are consistent with increasing levels of public commitment and political resolve to solving the nation's energy-related challenges." Policies examined include "fiscal incentives, voluntary programs, regulations, and research and development."[22]

Under the "moderate scenario," energy efficiency is improved through such policies as expanded labeling, new efficiency standards, tax credits, and cost-shared R&D; renewable energy grows more rapidly than in the "business as usual" scenario, and a higher proportion of nuclear power is retained. Under the "advanced scenario," which has more aggressive demand- and supply-side policies and a doubling of R&D, a federally sponsored carbon trading system is announced in 2002 and

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[21] DOE, Interlaboratory Working Group, *Scenarios for a Clean Energy Future*, ORNL/CON-476, LBNL-44029, and NREL-TP-620-29379 (Oak Ridge, TN: Oak Ridge National Laboratory; Berkeley, CA: Lawrence Berkeley National Laboratory; Golden, CO: National Renewable Energy Laboratory, November 2000), at [http://www.ornl.gov/ORNL/Energy_Eff/CEF.htm].

[22] Ibid., p. 1.4.

implemented in 2005 with a clearing equilibrium price of $50 per ton of carbon.[23] The results of this analysis are shown in **Table 5**.

Table 5. Impact of Technology/Efficiency Assumptions on Projections of CO_2 Emissions

Case Comparisons	Total CO_2 Emissions from Fuel Use, 2010 (MMTCE)
"Business as Usual" (BAU)	1,769
Moderate Scenario	1,684 (-5% from BAU)
Advanced Scenario	1,467 (-17% from BAU)

Source: DOE, Interlaboratory Working Group, *Scenarios for a Clean Energy Future*, ORNL/CON-476 and LBNL-44029 (Oak Ridge, TN: Oak Ridge National Laboratory; Berkeley, CA: Lawrence Berkeley National Laboratory, 2000), Table 1.8, p. 1.18.

This "New 5-Lab Study" thus suggests that if specified policies were adopted, emissions could be considerably lower than even EIA's high-technology scenario indicates, by as much as 17% compared to EIA's high-technology reduction in emissions of about 2%. EPA and the Department of Energy (DOE) have underway a number of programs to foster the development and deployment of energy-efficient technologies.[24]

The President's greenhouse gas intensity reduction initiative is a new variable affecting projections. It would have the effect of reducing anticipated emissions below "business as usual" levels in the future (see **Figure 3**); however, the initiative does not reflect the level of aggressiveness assumed by the "New 5-Lab Study" for policy interventions to achieve its "advanced scenario" for rapid penetration of energy-efficient technologies.

Status of Emissions Relative to Goals

Under the UNFCCC, the United States committed to the voluntary goal of holding greenhouse gas emissions at the end of the 1990s to their 1990 levels. If the United States had met this goal, its greenhouse gas emissions for 2000 would have been 1,675 MMTCE. However, U.S. emissions in 2000 were 1,921 MMTCE (not

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[23] Ibid., pp. 1.6-1.7. Note that the carbon trading assumption has been effectively mooted since it was not implemented in 2002 as assumed in the study.

[24] See the *Climate Action Report*, Chapter 4; EIA, *Analysis of the Climate Change Technology Initiative*, SR/OIAF/99-1, available at [http://www.eia.doe.gov/oiaf/archive/climate99/climaterpt.html]; and EIA, *Analysis of the Climate Change Technology Initiative: Fiscal Year 2001*, SR/OIAF/2000-01, April 2000, available at [http://www.eia.doe.gov/oiaf/climate/index.html].

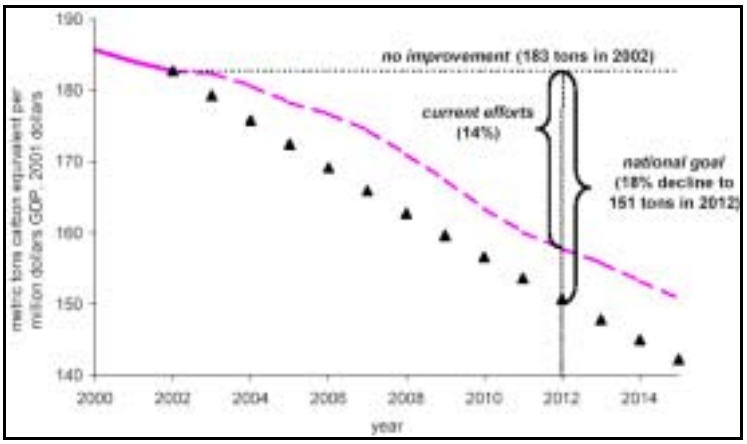
counting sinks). These figures indicate that in 2000, the nation was exceeding its UNFCCC greenhouse gas emissions commitment by 246 MMTCE, or nearly 15%.

If the United States had acceded to the Kyoto Protocol, its greenhouse gases emissions target for the period 2008-2012 would have been 5 times 93% of the 1,676 MMTCE baseline, or 1,559 MMTCE on average per year for the period. This hypothetical goal would imply reductions equal to the difference between the goal and what would be "business as usual emissions" for the period 2008-2012. Based on the *CAR* projection that emissions will be 2,213 MMTCE in 2010, the average annual reduction that would be necessary for the United States to meet the Kyoto target of 1,559 MMTCE per year for 2008-2012 would be 654 MMTCE per year, or about 30% below the estimated level of "business as usual" emissions. Higher than base case economic growth or lower penetration of energy-efficient technologies would mean that emissions would be even higher (and reductions necessary to meet a goal like Kyoto greater). Slower economic growth, or faster penetration of energy-efficient technologies as suggested by the 5-Lab Study, would decrease emissions (and hence reductions to meet a goal).

The President's greenhouse gas initiative has the goal of reducing, through voluntary activities, the intensity of *net* greenhouse gas emissions per unit of economic activity by 18% over the next 10 years; this compares to a projected "business as usual" decline in intensity of 14% for the period — compared to a decline during the 1990s of about 10% (see **Table 3**). According to the White House announcement, this goal means that the current (2002) intensity of 183 metric tons of carbon emissions per million dollars of GDP would fall to 151 MMTCE per million dollars of GDP in 2012 (see **Figure 4**).[25] At the anticipated increased rate of intensity decline, total emissions would decline 100 MMTCE below "business as usual" emissions (although the absolute amount of emissions would continue to rise). It is too early to assess progress toward the Administration's goal of diminishing greenhouse gas intensity.

[25] Current data suggests that the 2002 carbon intensity baseline may have dropped below 180 MMTCE (see **Table 3**).

Figure 4. Greenhouse Gas Intensity: President's Initiative



Source: White House, *Global Climate Change Policy Book*, Feb. 14, 2002, at [http://yosemite.epa.gov/oar/globalwarming.nsf/UniqueKeyLookup/SHSU5BNMAJ/$File/bush_gccp_021402.pdf].

These projected emissions levels (and any implied reductions) are gross estimates and do not take sinks into account (except for the intensity projection). As previously noted, the baseline could be revised, at least slightly. More important, such projections depend on assumptions about economic trends as well as about policy actions at the local, domestic, and international levels. However, whatever the assumptions, the trend in total emissions experienced over the past decade and projected for the next decade is clearly upward, while the UNFCCC goal was for stabilization and the Kyoto Protocol calls for emissions levels of developed nations to decline.

Additional Considerations in Assessing Possible Reductions

If one is concerned about assessing the implications of possible reduction requirements in the future, two further factors must be considered. One is sequestration, which removes CO_2 from the atmosphere, thereby reducing gross emissions. The second is a series of proposed trading mechanisms that could allow a country to take credit for reductions it sponsors in other countries. The United States was a strong supporter of including both these variables in the Kyoto Protocol. Sequestration could directly diminish a country's reduction requirement; trading does not change a reduction requirement, but it could affect costs and who would actually achieve the reductions.

Carbon Sequestration. Atmospheric greenhouse gas levels are affected not only by emissions, but also by carbon sinks — processes that remove and sequester carbon from the atmosphere. Activities that affect sequestration include farming and forestry practices. For example, a positive net growth of trees removes carbon from the atmosphere; clearing forests typically releases carbon. **Table 1**, "U.S.

Greenhouse Gas Emissions, 1990 -2001," includes figures for carbon sequestration from land-use activities and forestry, which are the difference between "total emissions" and "net emissions."

The UNFCCC states that signatory nations shall commit to "promote sustainable management, and promote and cooperate in the conservation and enhancement, as appropriate, of sinks and reservoirs of all greenhouse gases ... , including biomass, forests and oceans as well as other terrestrial, coastal and marine ecosystems" (Article 4(1)(d)).

The Kyoto Protocol also would provide that sinks can be taken into account in calculating a nation's emissions and its reduction obligation. "The net changes in greenhouse gas emissions from sources and removals by sinks resulting from direct human-induced land-use change and forestry activities, limited to afforestation, reforestation, and deforestation since 1990, measured as verifiable changes in stocks ... shall be used to meet" the 2008-2012 commitments (Article 3(3)). In general, then, a net increase in human-induced carbon sequestration from forestry practices between 1990 and 2008-2012 would be subtracted from emissions during the period, thereby reducing the amount of actual emissions that will have to be curtailed. Conversely, net negative sequestration from forestry practices would be added to the emissions that will have to be reduced.

Just how this calculation would be done is not prescribed in the Protocol, and disagreements on how much carbon sequestration could be counted toward a nation's reduction obligations were debated through several subsequent conferences. In July 2001, the Sixth Conference of Parties in Bonn (COP6) agreed to limits on sequestration activities that could be credited against the Protocol's reduction requirements. Although the United States chose not to participate in these proceedings, the Conference stated in a footnote[26] that under the methodology agreed upon, the United States could take credit for net increases of sequestration of up to 28 million metric tons per year.

Emissions Trading. Emissions trading, strongly supported by the United States in the Kyoto negotiations, derives from the principle of economic efficiency — that reductions, if necessary, should be achieved at the lowest cost. Trading mechanisms thus are designed to allow low-cost reductions to substitute for higher-cost ones. The idea is that a country could achieve its reduction goal not only by reducing its domestic emissions, but also by reducing emissions elsewhere. Trading does not actually reduce a nation's reduction requirement, but it does allow it to contract for and to count reductions elsewhere that are cheaper to achieve than domestic ones.

The Kyoto Protocol provides for emissions trading mechanisms[27] that can be used to "supplement" domestic reductions; this offers the possibility that actual

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[26]"Draft Decision on Implementation of the Kyoto Protocol on Climate Change," adopted in Bonn, Germany, July 23, 2001, footnote to Appendix Z.

[27]Kyoto Protocol, articles 4, 6, and 12; see also CRS Issue Brief IB97057, *Global Climate Change: Market-Based Strategies to Reduce Greenhouse Gases*.

domestic greenhouse gas reductions achieved by a party to the Kyoto Protocol will be less than the party's actual commitment. Some portion of the reduction requirement could be shifted elsewhere. The Clinton Administration argued that emission trading would be critical to U.S. compliance with Kyoto;[28] a Clinton Administration economic analysis suggested that U.S. compliance costs would drop from $193 per ton with no international emissions trading to $23 per ton with global trading.[29] COP6 agreed that there would be no quantitative limit on the amount of credit a country could receive from trading, but that domestic action must constitute a significant part of a nation's reduction efforts.[30] With no quantitative limit on trading, any estimate of actual domestic reduction required to comply with the Kyoto Protocol, or of the costs involved, remains problematic — and is moot as long as the United States declines to participate in the Kyoto process.

Conclusion

The precise numerical projections of greenhouse gas emissions (or of proposed reductions) should be viewed as indicative (see **Figure 3**). They are less accurate than they appear, given the potential for revisions in data and the uncertainties of projections. But in assessing the status of U.S. greenhouse gas emissions, the trendline for aggregate greenhouse gas emissions is clear: for the United States, the overall trend is up. None of the reviewed scenarios using assumptions that diminish emissions — low economic growth, putting off retirement of nuclear facilities, accelerated fostering of energy-efficient technologies, the President's voluntary program to reduce greenhouse gas intensity — reverses the upward trend in aggregate greenhouse gas emissions by 2010.[31]

Historical data show that the United States failed to meet its voluntary commitment under the UNFCCC for returning aggregate emissions at the end of the 1990s decade to the 1990 level. Any goal to reduce emissions to or below 1990 levels would require the continuing upward trend to turn down. Even with the potential for sequestration and emissions trading to reduce domestic reduction efforts, a goal to reverse greenhouse gas emissions trends would represent an extraordinary technical and political challenge for U.S. energy and environmental policy.

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[28]Statement of Janet Yellen, Chair, President's Council of Economic Advisors, House Committee on Commerce, Subcommittee on Energy and Power, March 4, 1998.

[29]For a discussion of the impact of emissions trading on costs, see CRS Report RL30285, *Global Climate Change: Lowering Cost Estimates through Emissions Trading — Some Dynamics and Pitfalls*, by (name /redacted).

[30]"Draft Decision on Implementation of the Kyoto Protocol on Climate Change," adopted in Bonn, Germany, July 23, 2001.

[31]The "advanced" scenario of the "New 5-Lab Study" projects the trend turning downward after 2020.