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

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

Summary

On 15 October 1992 the United States ratified the United Nations Framework Convention on Climate Change (UNFCCC), which entered into force 21 March 1994. This committed the U.S. 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 U.S. 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 U.S. Environmental Protection Agency Administrator Whitman has told reporters that the Administration will not be pursuing the UNFCCC commitment either. Instead, President Bush is proposing 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. Based on historical data, 1999 emissions were more than 11% in excess of the UNFCCC goal. Projections suggest that U.S. emissions will continue to rise for at least the next decade. Reversing the upward trend in greenhouse gas emissions represents an extraordinary technical and political challenge to U.S. energy and environmental policy.

This report will be updated as necessary.

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On 15 October 1992 the United States ratified the United Nations Framework Convention on Climate Change (UNFCCC), which entered into force 21 March 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."[2] 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."[3] The Convention established standards for inventorying and reporting greenhouse gas emissions.

Subsequently, the United States participated in negotiating the Kyoto Protocol to the UNFCCC.[4] 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 6 gases by 7% below specified baseline years.[5] 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."[6]

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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* by Wayne A. Morrissey and John R. Justus. See also CRS's electronic briefing book *Global Climate Change* at: [http://www.congress.gov/brbk/html/ebgcc1.shtml].

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

[3] Ibid., section 2(a).

[4] On the Agreement, see CRS Report RS30692, *Global Climate Change Treaty: The Kyoto Protocol*, by Susan R. Fletcher.

[5] Technically, the net carbon-equivalent emissions of the 6 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.

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

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

This report sets out the baseline emissions that the U.S. has established and portrays trends in emissions over the past decade; 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 the agreement to reduce emissions.) In what follows, *figures for emissions are point estimates and rounded to millions of metric tons of carbon equivalents (MMTCE[8])*. As will be discussed, even historical 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 *trendlines between baselines and the UNFCCC and Kyoto goals* can give a clear sense of the situation of the United States with respect to those goals.

At this time, the situation is that aggregate U.S. emissions of greenhouse gases over the decade of the 1990s trended upward and are projected to continue to rise in the future. In contrast, the UNFCCC called for emissions at the end of the decade to be at the 1990 level, and the Kyoto Protocol would call for U.S. greenhouse gas emissions to decrease 7% below the baseline for the period 2008-2012.

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."[9] (See Table 1.)

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

[8]MMTCE figures combine the variable greenhouse effects of the different gases by calculating and summing their equivalent effects. 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.

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

Table 1: U.S. Greenhouse Gas Emissions, 1990-1999

Gas	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
CO_2	1,340	1,326	1,353	1,384	1,410	1,424	1,474	1,494	1,497	1,516
CO_2 (sinks)[a]	(289)	(286)	(272)	(280)	(280)	(278)	(279)	(263)	(268)	(270)
CH_4	176	175	177	174	176	177	174	172	170	169
N_2O	108	110	113	113	121	118	120	121	118	118
HFCs, PFCs, SF_6	23	22	23	23	24	27	31	34	38	37
Total emissions	1,647	1,633	1,666	1,694	1,731	1,746	1,799	1,821	1,824	1,840
Net emissions	1,358	1,347	1,394	1,414	1,451	1,468	1,521	1,554	1,556	1,570

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

Source: EPA, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 - 1999)* April 2001, EPA 236-R-01-001, p. ES-4. [Data converted to MMTCE by CRS.] Data for 1992-1994 calculated from ibid., Table 1 "Revisions to U.S. Greenhouse Gas Emissions," p. xii and EPA, "U.S. Emissions Inventory – 2000," *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 – 1998)* April 2000, EPA 236-R-00-001, p. ES-4.

The Environmental Protection Agency (EPA) publishes the official emissions data annually,[10] and the United States also from time to time reports on emissions and explains its climate change programs in the *Climate Action Report* to the United Nations, the third of which is currently in draft.[11]

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 1,647 MMTCE; if the United States had acceded to the Kyoto targets, the baseline would have been 1,651 MMTCE, since the baseline years for HFCs, PFCs, and SF_6 can be 1995. 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">1,340</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">23
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>1,647</td><td>1,651</td></tr>
</table>

Source: EPA, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 - 1999)* April 2001, EPA 236-R-01-001, p. ES-4. [Data converted to MMTCE by CRS.]

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 the *1990-1999* report, which also converted the figures from MMTCE to teragrams of CO_2 equivalent, consistent with international practices.[12] (This report maintains the MMTCE figures, which are more familiar to most U.S. policy makers.) The criteria for calculating emissions agreed upon by the Conference of Parties hinge on both current technical

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[10]EPA, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 - 1999)* April 2001, EPA 236-R-01-001:
[http://www.epa.gov/globalwarming/publications/emissions/us2001/]

[11] The first two *Climate Action Report*s Submitted by the United States of America under the United National Framework Convention on Climate Change appeared in October 1994 and July 1997; for the third report, now in draft, see: the *Climate Action Report 2001*, Draft for Public Comment, [http://www.epa.gov/globalwarming/publications/natcomm.html]

[12] EPA, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-1999* , xi-xvii.

knowledge and on policy judgments.[13] New technical information can change factors, for example concerning calculation of greenhouse gas equivalents; and policy judgments can be adjusted, for example concerning the timeframe 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 more than plus or minus 1%.[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 (see Table 3), in large part because of the on-going phase out of chlorofluorocarbons, which deplete stratospheric ozone and which are not covered by the UNFCCC. For the 1990s, the decline in intensity has been about 15%.

Emissions Goals

Under the UNFCCC, the U.S. committed to the voluntary goal of holding greenhouse gas emissions at the end of the 1990s decade to their 1990 levels. If the U.S. had met this goal, its greenhouse gas emissions for 2000 would have been 1,647 MMTCE. However, U.S. emissions in 1999 were 1,840 MMTCE (not counting sinks). These figures indicate that in 1999, the U.S. was exceeding its UNFCCC greenhouse gas emissions commitment by 193 MMTCE, or 11.7%.

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 1,651 MMTCE baseline, or 1,535 MMTCE on average per year for the period. This goal would imply reductions equal to the difference between the goal and what would be "business as usual emissions" for the period 2008-2012. Estimating that reduction requires projecting future emissions.

The present Administration, having rejected the Kyoto Protocol, has proposed that the United States shift its climate change goal to a reduction in greenhouse gas intensity of the U.S. economy.[15] The President's initial goal is to reduce that intensity

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[13]The Kyoto Protocol requires that further studies of greenhouse gas emissions and removals be undertaken and incorporated in any future commitments for reducing greenhouse gases beyond the 2008-2012 target.

[14] See "Table Changes - 1: Revision U.S. Greenhouse Gas Emissions," EPA, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-1999*, p. xii. Total 1990 emissions were revised downward 0.2%; the largest revision was for 1998, down 0.6%. On the other hand, revisions to sequestration estimates were much greater, from -15.6% to + 31.9%: ibid., p. xiii.

[15] For documents on the Administration plan, see

(continued...)

by 18% over the next 10 years through voluntary activities, which means that the current 183 metric tons of carbon emissions per million dollars of GDP that the United States is emitting in 2002 would fall to 151 MMTCE per million dollars of GDP in 2012. To convert that reduction in intensity to a reduction in actual emissions, so it can be compared to the UNFCCC and Kyoto Protocol goals, requires projecting future emissions.

Table 3: U.S. Greenhouse Gas Intensity (1990-2000)

	GDP (billions of chained (1996) dollars)	Greenhouse Gas Intensity (metric tons carbon equivalent per million $ GDP)
1990	6,708	245
1991	6,678	245
1992	6,880	242
1993	7,063	240
1994	7,348	235
1995	7,544	231
1996	7,813	230
1997	8,160	223
1998	8,509	214
1999	8,856	208
2000	9,224	206

Source: Table 1; *Economic Report of the President*, February 2002, Table B-2; CRS calculations.

Emissions Projections

Projecting greenhouse gas emissions involves modeling of 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.

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[15](...continued)
[http://www.whitehouse.gov/news/releases/2002/02/climatechange.html]

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. The policy 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 at best.

The Draft *Climate Action Report* Projection

The third U.S. *Climate Action Report* (*CAR*), prepared as an obligation under the UNFCCC,[16] projects greenhouse gas emissions for the years 2000, 2005, 2010, and 2020. For this draft 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.

The *CAR* estimate for aggregate gross greenhouse emissions 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." Ignoring the 2-year difference between 2010 and 2012, the estimate based on the President's initiative suggests a decline in emissions of about 4.5% from the *CAR* "business as usual" projection for 2010, or gross greenhouse emissions in 2010 (2012) of approximately 2,113 MMTCE.

CAR 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) *Annual Energy Outlook* series.[17] (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

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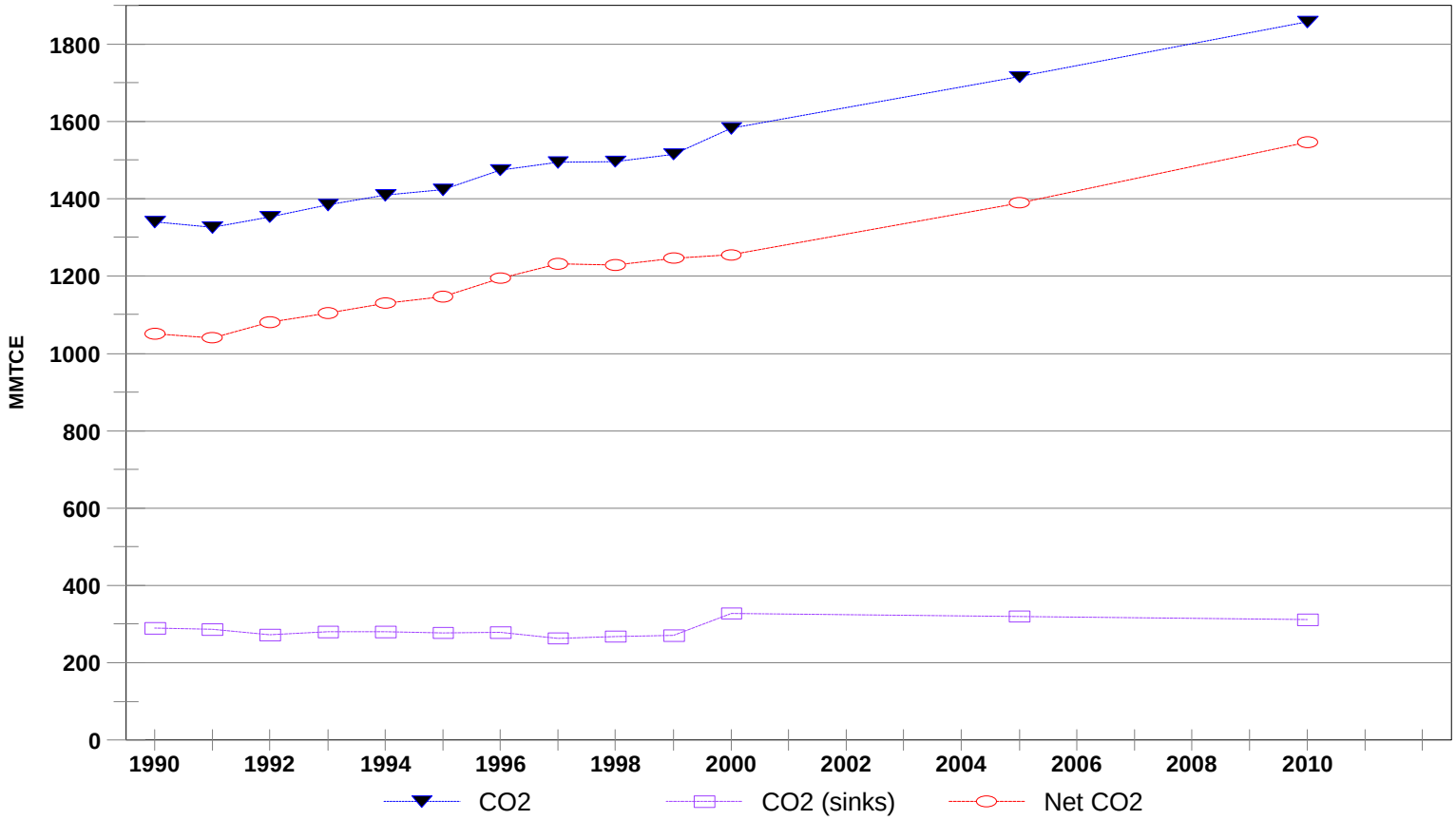
[16] [EPA,] *Climate Action Report 2001*, The United States of America's Third National Communication Under the United Nations Framework Convention on Climate Change [DRAFT FOR PUBLIC COMMENT]
[http://www.epa.gov/globalwarming/publications/natcomm.html]

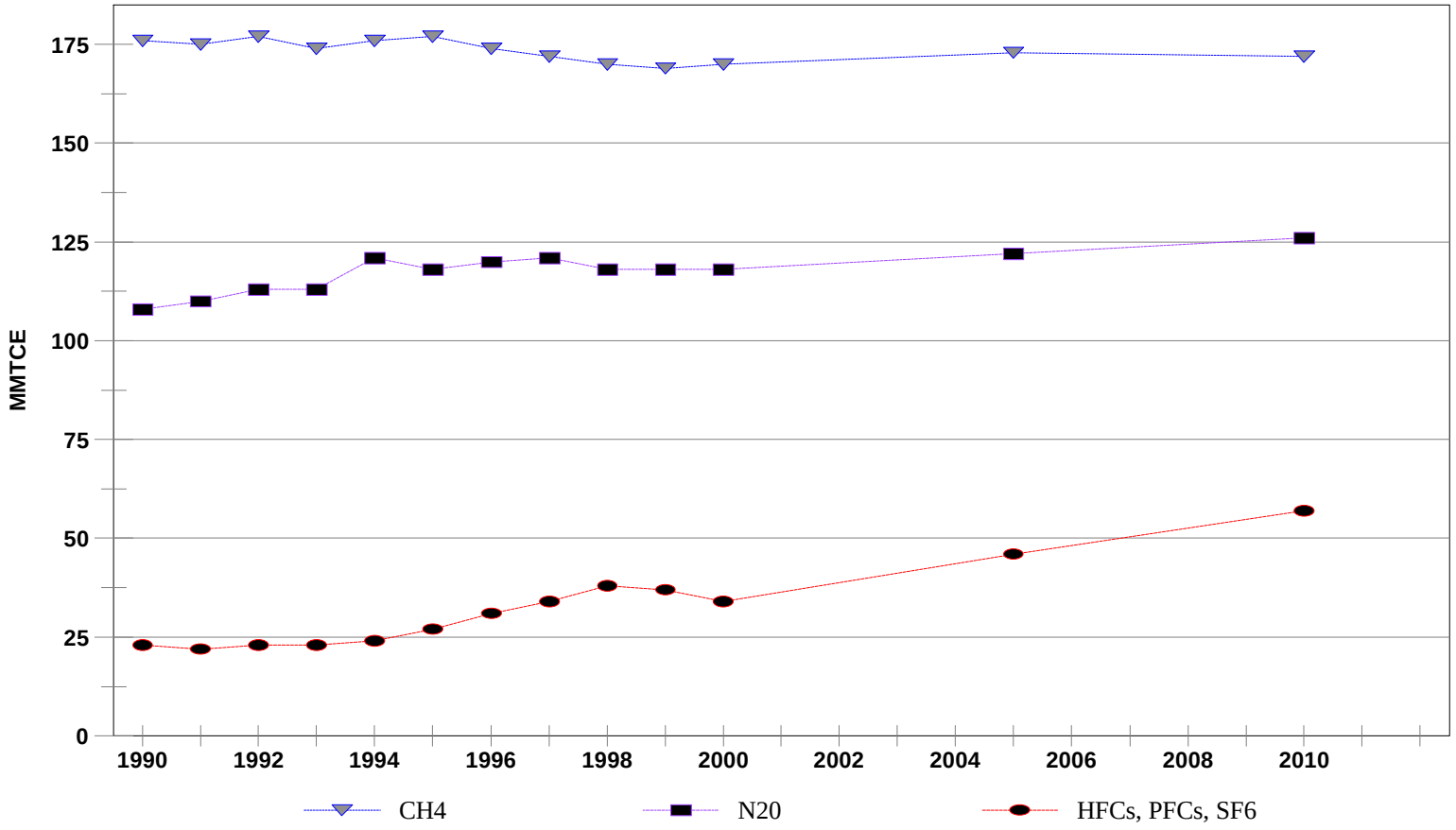
[17] EIA, *Annual Energy Outlook 2001* (Dec. 2001), DOE/EIA-0383(2002).

Figure 1. U.S. Emissions of CO_2: Historical (1990s) and Projected (to 2010)



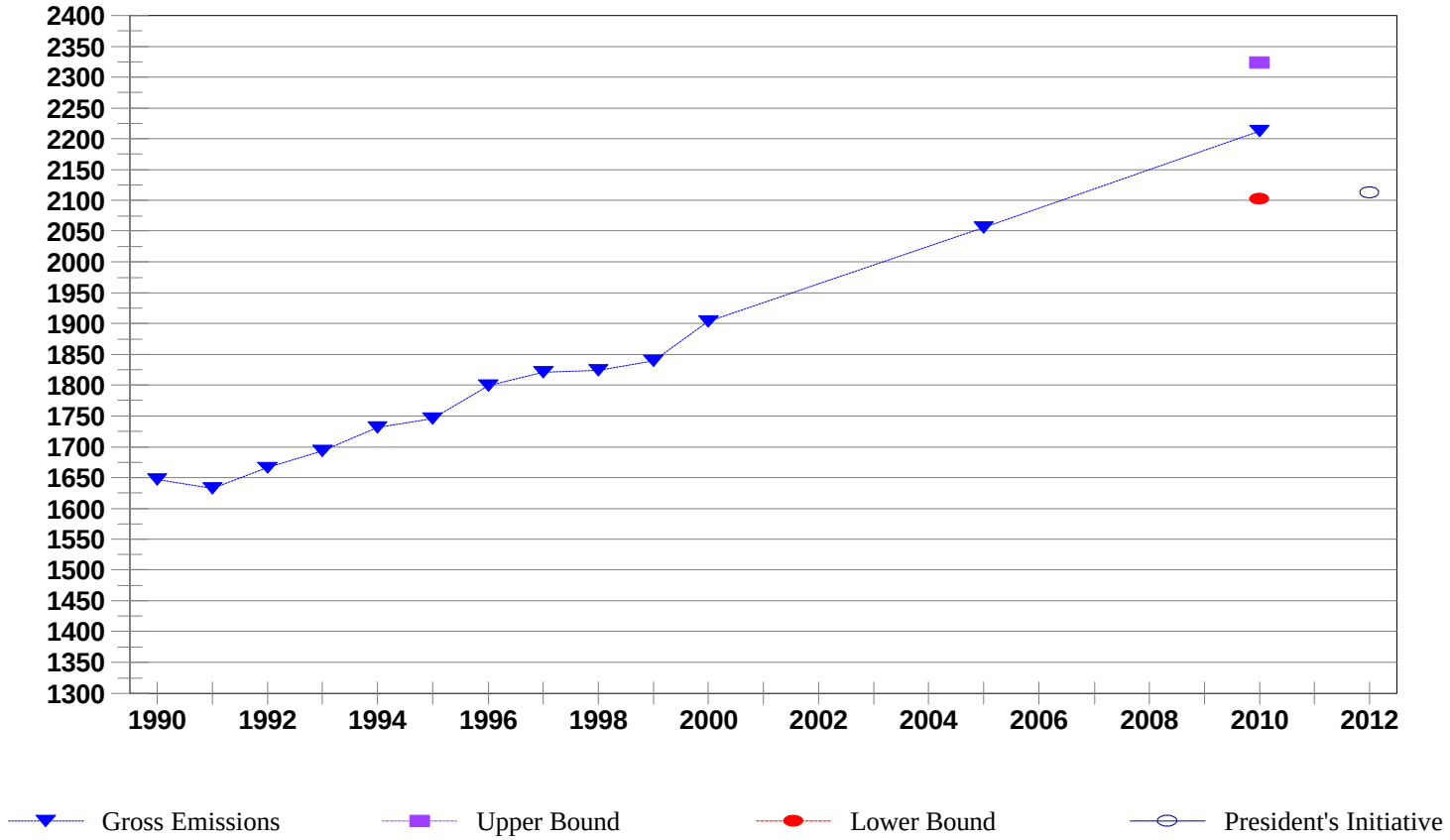
Sources: Historical data (through 1999): EPA, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 - 1999*, April 2001, EPA 236-R-01-001, p. ES-4. Data for 1992-1994 calculated from ibid., Table 1 "Revisions to U.S. Greenhouse Gas Emissions," p. xii and EPA, "U.S. Emissions Inventory – 2000," *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 – 1998*, April 2000, EPA 236-R-00-001, p. ES-4. Year 2000 (preliminary) and projections (to 2010): [EPA,] *Climate Action Report 2001*, The United States of America's Third National Communication Under the United Nations Framework Convention on Climate Change [DRAFT FOR PUBLIC COMMENT] [http://www.epa.gov/globalwarming/publications/natcomm.html] [Data converted to MMTCE by CRS.]

Figure 2. U.S. Emissions of CH_4, N_2O, and HFCs, PFCs, and SF_6: Historical (1990s) and Projected (to 2010)



Sources: Historical data (through 1999): EPA, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 - 1999*, April 2001, EPA 236-R-01-001, p. ES-4. Data for 1992-1994 calculated from ibid., Table 1 "Revisions to U.S. Greenhouse Gas Emissions," p. xii and EPA, "U.S. Emissions Inventory – 2000," *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 – 1998*, April 2000, EPA 236-R-00-001, p. ES-4. Year 2000 (preliminary) and projections (to 2010): [EPA,] *Climate Action Report 2001*, The United States of America's Third National Communication Under the United Nations Framework Convention on Climate Change [DRAFT FOR PUBLIC COMMENT] [http://www.epa.gov/globalwarming/publications/natcomm.html] [Data converted to MMTCE by CRS.]

Figure 3. U.S. Aggregate Gross Emissions of Six Greenhouse Gases: Historical (1990s) and Projected (to 2010) (MMTCE)



Sources: Historical data (through 1999): EPA, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 - 1999*, April 2001, EPA 236-R-01-001, p. ES-4. Data for 1992-1994 calculated from ibid., Table 1 "Revisions to U.S. Greenhouse Gas Emissions," p. xii and EPA, "U.S. Emissions Inventory – 2000," *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 – 1998*, April 2000, EPA 236-R-00-001, p. ES-4. Year 2000 (preliminary) and projections (to 2010): [EPA,] *Climate Action Report 2001*, The United States of America's Third National Communication Under the United Nations Framework Convention on Climate Change [DRAFT FOR PUBLIC COMMENT] [http://www.epa.gov/globalwarming/publications/natcomm.html] [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]

innovation, have the greatest effect on variance in projections of CO_2 emissions. 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%, 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 faster-than-expected technological development is projected to reduce emissions about 3%. Overall, if those variances that increase emissions prove true and cumulative, then projected emissions for 2010 could be higher than the point reference case – or *CAR's* point estimate – by at least 5%; conversely, if those variances that decrease emissions prove true and cumulative, then projected emissions for 2010 could be at least 5% lower than projected.

Some studies suggest that even greater variance in projections is possible – for example, that new energy efficient technologies are available and 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.[18] 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 1,835). 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."[19]

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 federal-sponsored carbon trading system is announced in 2002 and implemented in 2005 with a clearing equilibrium price of $50 per ton of carbon.[20] The results of this analysis are shown in Table 4.

This "New 5-Lab Study," 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 3%. EPA and the Department of Energy (DOE) have underway

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

[19] Ibid., p. 1.4.

[20] Ibid., pp. 1.6-1.7.

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	1,794 (-2%)	1,835	1,888 (+3%)
	2002 Technology	Reference Case	High Technology
Integrated Technology	1,868 (+2%)	1,835	1,782 (-3%)

Source: EIA, *Annual Energy Outlook 2002* (December 2001) DOE/EIA-0383(2002), pp. 177, 218.

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* (Oak Ridge, TN; Oak Ridge National Laboratory and Berkeley, CA; Lawrence Berkeley National Laboratory, 2000) (ORNL/CON-476 and LBNL-44029), Table 1.8, p. 1.18.

a number of programs to foster the development and deployment of energy efficient technologies.[21] However, even the President's greenhouse gas intensity reduction initiative does not reflect the level of aggressiveness assumed by the "New 5-Labs Study" for policy interventions to achieve its "advanced scenario" for rapid penetration of energy efficient technologies. Based on the *CAR* projection that emissions will be 2,213 MMTCE in 2010, the average annual reduction that would

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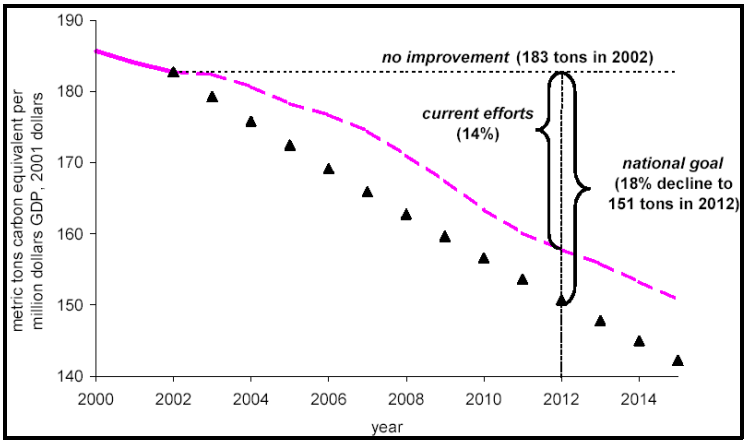
[21] See the *Climate Action Report*, Chapter 4, and EIA, *Analysis of the Climate Change Technology Initiative* (SR/OIAF/99-1) [www.eia.doe.gov/oiaf/climate99/climaterpt.html] and EIA, *Analysis of the Climate Change Technology Initiative: Fiscal Year 2001* (SR/OIAF/2000-01 (Washington, D.C.: April 2000) [www.eia.doe.gov/oiaf/climate/index.html]

be necessary for the United States to meet the Kyoto target of 1,535 MMTCE per year for 2008-2012 would be 668 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).

If successful, the President's greenhouse gas reduced intensity initiative would mean that emissions would be less than "business as usual" (see Figure 3). In terms of the Administration goal of reducing greenhouse gas intensity, the President's initiative is projected to reduce that intensity by 18% over the next 10 years; this compares to a projected "business as usual" decline in intensity of 14% for the period (see Figure 4).[22] Even at this increased rate of intensity decline, the absolute amount of emissions will continue to rise.

These projected emissions levels (and any implied reductions) are gross estimates and do not take sinks into account. As previously noted, the baseline could be revised, at least slightly. More importantly, such projections depend on

Figure 4: Greenhouse Gas Intensity: President's Initiative



Source: White House, *Global Climate Change Policy Book*, Feb. 14, 2002: [http://www.epa.gov/globalwarming/publications/actions/us_position/bush_gccp_021402.pdf]

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 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.

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[22]The 14% is about the same as for the 1990s decade (see Table 3 and accompanying text).

Additional Variables Affecting Possible Reductions

If one is concerned about estimating possible reduction requirements in the future, then two variables besides those affecting the projection of emissions trendlines need to 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, which 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 -1999,* 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[23] that under the methodology agreed

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[23]"Draft Decision on Implementation of the Kyoto Protocol on Climate Change," adopted in (continued...)

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[24] that can be used to "supplement" domestic reductions; this offers the possibility that actual 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[25]; 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.[26] 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.[27] 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

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[23](...continued)
Bonn, Germany, July 23, 2001, footnote to Appendix Z.

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

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

[26]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 Larry Parker.

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

trendline for aggregate greenhouse gas emissions is telling: for the United States, the overall trend is inexorably 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 – reverse the upward trend in aggregate greenhouse gas emissions by 2010.[28]

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 below 1990 – as the Kyoto Protocol calls for – would require the continuing upward trend to turn down. Even with the potential for emissions trading and sinks 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.

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