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Climate Change 101: Urgency and Response

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We have only just begun to awaken to the unfolding calamity inherent in human-induced global climate change.

Through 2007, international concern intensified as a result of the efforts of the Intergovernmental Panel on Climate Change (IPCC) and others to analyze, synthesize, and explain the relevant research.[1] In a series of releases comprising its fourth

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1 The IPCC was established jointly by the World Meteorological Organization and the United Nations Environment Programme. Intergovernmental Panel on Climate Change, About IPCC, http://www.ipcc.ch/about/index.htm (last visited Feb. 19, 2008). Its 2007 reports on climate change include CLIMATE CHANGE 2007: THE PHYSICAL SCIENCE BASIS (2007), *available at* http://www.ipcc.ch/ipccreports/ar4-wg1.htm [hereinafter PHYSICAL BASIS]; CLIMATE CHANGE 2007: IMPACTS,

major assessment report (AR4), the IPCC demonstrated that climate change driven primarily by human greenhouse gas (GHG) emissions is damaging natural and human systems and, if unchecked, will alter the planet's habitability.[2] AR4 did not fully credit the implications of recent observations that suggest greatly accelerated climate change.[3] Still, the IPCC's efforts contributed to a wider understanding of the problem of climate change, a fact substantiated by the Norwegian Nobel Committee's decision to award its 2007 Peace Prize jointly to the IPCC and Al Gore.[4]

Despite these Nobel Prize winners' call to action, binding international measures adequate to counter GHG emission trends do not yet exist. That failure is largely a function of the United States' refusal to accept any legally binding limit on GHG emissions. In December 2007, the United States blocked efforts, as proposed by the European Union, to cap industrialized-nation emissions by 2010.[5] Also in December, the United States rejected a major effort by states to restrict GHG

ADAPTATION AND VULNERABILITY (2007), *available at* http://www.ipcc.ch/ipccreports/ar4-wg2.htm [hereinafter IMPACTS]; CLIMATE CHANGE 2007: MITIGATION OF CLIMATE CHANGE (2007), *available at* http://www.ipcc.ch/ipccreports/ar4-wg3.htm [hereinafter MITIGATION]; and CLIMATE CHANGE 2007: SYNTHESIS REPORT (2007), *available at* http://www.ipcc.ch/ipccreports/ar4-syr.htm [hereinafter AR4 SYR].

2 *See* AR4 SYR, *supra* note 1.

3 Any discrepancy is perhaps attributable to the IPCC's consensus process (allowing one nation to block progress), the cut-off date for consideration of new data, and scientific reticence. The IPCC analysis released in 2007 fails to account for peer-reviewed scientific information released in late 2006 and all of 2007, much of which provides reason for additional concern. Southern Alliance for Clean Energy, *Indications that Climate Is Changing Faster than Anticipated: A Sample of Peer-Reviewed Studies From 2007* 1 (2008) (on file with author); *see also* DAVID SPRATT & PHILIP SUTTON, CLIMATE 'CODE RED': THE CASE FOR A SUSTAINABILITY EMERGENCY 18–19 (2008), *available at* http://www.carbonequity.info/climatecodered/5keys.html (noting lag in the IPCC process and suggesting that "in many key areas the IPCC process has been so deficient as to be an unreliable . . . basis for policy-making); J.E. Hansen, *Scientific Reticence and Sea Level Rise*, ENVTL. RESEARCH LETTERS 2 (2007), *available at* http://www.iop.org/EJ/article/1748-9326/2/2/024002/erl7_2_024002.html.

4 Nobel Foundation, Nobel Peace Prize 2007, http://nobelprize.org/nobel_prizes/peace/laureates/2007/ (last visited Feb. 20, 2008). The IPCC and Gore were awarded the Nobel Peace Prize "for their efforts to build up and disseminate greater knowledge about man-made climate change, and to lay the foundations for the measures that are needed to counteract such change." *Id.*

5 *See* Thomas Fuller & Andrew C. Revkin, *Deal on Reviving Climate Treaty Seems Close, but Is Elusive*, N.Y. TIMES, Dec. 15, 2007, at A9.

emissions from new passenger vehicles.[6] Further, the Bush Administration continues to flout the Supreme Court's remand in *Massachusetts v. Environmental Protection Agency* (*EPA*)[7] by indefinitely delaying considerations of nationally applicable GHG regulations under the Clean Air Act.[8]

Absent U.S. leadership, work continues internationally on a post–Kyoto treaty.[9] Strong efforts are also underway within and among several states to cap and reduce emissions derived from activities within their jurisdictions.[10] This international and sub-national work is motivated by the reality that the needed technical, social, and political initiatives cannot wait for U.S. federal leadership.[11] These efforts are also bolstered by the hope that the November 2008 U.S. election will result in a fundamental change in U.S. climate change policy.[12] Planning documents declare that current measures to combat climate change will be guided by scientific research.[13] Understanding

6 *See* Letter from Stephen L. Johnson, Adm'r, Envtl. Prot. Agency, to Arnold Schwarzenegger, Governor of Cal. (Dec. 19, 2007); California v. Envtl. Prot. Agency, No. 07-1457 (D.C. Cir. filed Nov. 8, 2007).

7 Massachusetts v. Envtl. Prot. Agency, 127 S. Ct. 1438, 1459–62 (2007) (requiring the EPA to promulgate regulations limiting GHG emissions unless it provides a reasonable explanation consistent with the Clean Air Act as to why the Agency is unable or unwilling to exercise its discretion to determine that such emissions endanger public health and safety by contributing to climate change).

8 *See* Letter from Robert J. Myers, Principal Deputy Assistant Adm'r, Envtl. Prot. Agency, to James R. Milkey, Assistant Att'y Gen. of Mass. (Feb. 27, 2008) (on file with author).

9 *See* Thomas Fuller & Andrew C. Revkin, *Climate Plan Looks Beyond Bush's Tenure*, N.Y. TIMES, Dec. 16, 2007, § 1, at 11.

10 *See* PEW CTR. ON GLOBAL CLIMATE CHANGE, LEARNING FROM STATE ACTION ON CLIMATE CHANGE (2007), *available at* http://www.pewclimate.org/docUploads/States%20Brief%20Template%20_November%202007_.pdf.

11 *See, e.g.*, *id.* at 1 ("While U.S. federal policy on climate change has not been forthcoming, states have taken the lead on developing climate policies and initiatives."); *see also* Thomas Fuller & Elisabeth Rosenthal, *At Divided Climate Talks, Consensus that U.S. is at Fault*, N.Y. TIMES, Dec. 14, 2007, at A17.

12 *See* Fuller & Revkin, *supra* note 9.

13 The United Nations Framework Convention on Climate Change (UNFCCC) recognizes, for instance, that "steps required to understand and address climate change will be environmentally, socially and economically most effective if they are based on relevant scientific, technical and economic considerations and continually re-evaluated in the light of new findings in these areas." United Nations Framework Convention on Climate Change pmbl., May 9, 1992, S. TREATY DOC. NO. 102-38 (1992), 1771 U.N.T.S. 107 [hereinafter Convention on Climate Change]. Similarly, the 2007 Bali Action Plan, in which UNFCCC members agreed to a

this research generates both urgency for action and a standard by which the efficacy of proposed mitigation measures can be evaluated.

This Article begins by analyzing current scientific research and the urgency it implies. Next, mitigation options presently under consideration, including efforts by Congress and several western states, are evaluated on the basis of their consistency with IPCC research. The Article then explores the potential emerging from growing judicial recognition of the need for action, a development that should embolden state innovation. Such innovations will raise pressure on the federal government to adopt effective national policy changes, which in turn, could encourage worldwide action. The Article concludes by noting that much of the rest of the world appears willing to undertake the serious commitments needed to address the climate crisis in the event that the United States, at last, begins to exercise a modicum of leadership—perhaps under a new President in 2009.

I
EVIDENCE AND URGENCY

The IPCC and independent experts have established that climate change is occurring, that human activities are its principal cause, and that rapid and marked changes in GHG emission trends are required if severe climate change is to be avoided.[14] These conclusions are derived from instrumental measurements, scientific surveys and observations, analyses of ice core and seabed samples, and increasingly sophisticated computer model projections that are continually updated by and tested against physical data.[15] This Article summarizes principal

"comprehensive process to enable the full, effective and sustained implementation of the Convention through long-term cooperative action, now, up to and beyond 2012," stated that the process "shall be informed by, inter alia, the best available scientific information . . . ." U.N. Framework Convention on Climate Change, *Bali Action Plan,* Decision -/CP.13 (2007) (advance unedited version), *available at* http://unfccc.int/files/meetings/cop_13/application/pdf/cp_bali_action.pdf [hereinafter *Bali Action Plan*].

14 AR4 SYR, *supra* note 1. The AR4 is not the sole statement reporting a virtual consensus on the key features and causes of climate change. The IPCC reports, for example, follow statements by virtually all major U.S. scientific bodies that human activities are heating the planet's climate system. *See* Naomi Oreskes, *The Scientific Consensus on Climate Change*, 306 SCI. 1686, 1686 (2004).

15 *See, e.g.*, PHYSICAL BASIS, *supra* note 1.

conclusions from AR4, focusing, unless otherwise noted, on climate change aspects in which the IPCC expresses significant confidence.[16] Readers should examine AR4 and other cited sources for further detail about potentially important long-term impacts about which there is not yet ample data.[17]

A. Observed Climate Change

"Warming of the climate system is unequivocal," reports the IPCC, citing increased average temperature, widespread melting of snow and ice, and rising sea level.[18] The IPCC notes that of the twelve-year period spanning 1995–2006, eleven years rank among the twelve warmest in the instrumental record, while average temperatures in the Northern Hemisphere during the second half of the twentieth century "were *very likely* higher than during any other 50-year period in the last 500 years and *likely* the highest in at least the past 1,300 years."[19]

Rising average global temperature is readily observed when viewed in a longer-term context. Figure 1 compares averaged annual temperatures from monitoring stations worldwide over the period from 1880–2007 with a 1951–1980 base period.[20] The average global temperature in 2007 was second only to that in

16 Specifically, unless otherwise noted, this Article summarizes: (1) those outcomes that the IPCC, using expert judgment or statistical analysis, assesses to be virtually certain, extremely likely, very likely, or likely to occur (probability greater than 99%, 95%, 90% or 66%, respectively); (2) assessments based on quantified expert judgment expressed with very high or medium confidence (probability of "at least 9 out of 10" or "about 8 out of 10," respectively); and (3) qualitative assessments in which there is high agreement. *See* AR4 SYR, *supra* note 1, at Introduction 2.

17 For example, the IPCC reports with "medium confidence" that temperature increases in higher latitudes have required earlier spring planting of crops, led to earlier onset and increases in seasonal pollen-driven allergies, impacted hunting seasons, and shortened travel seasons over snow and ice in the Arctic. *Id.* at 1.2.

18 *Id.* at 1.1.

19 *Id.* (emphasis in original).

20 NASA Goddard Institute for Space Studies, Global-mean Monthly, Annual and Seasonal dT_s Based on Met.Station Data, 1880-Present, http://data.giss.nasa.gov/gistemp/tabledata/GLB.Ts.txt (last visited Feb. 22, 2008) (data on global temperature anomalies using elimination of outliers and homogeneity adjustment).

2005 for highest in the instrumental record.[21] The unusual warmth in 2007 is especially noteworthy, according to James Hansen of NASA's Goddard Institute for Space Studies, because it occurs "at a time when solar irradiance is at a minimum and the equatorial Pacific Ocean is in the cool phase of its natural El Nino–La Nina cycle."[22]

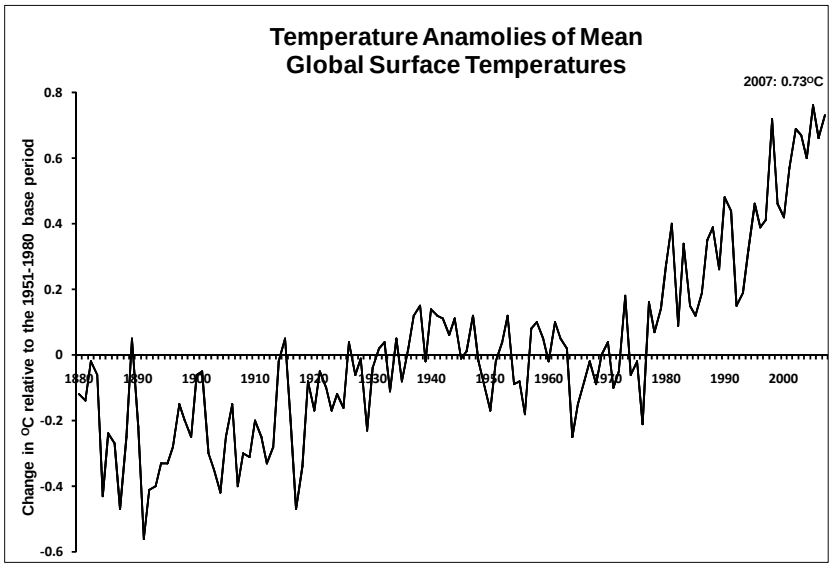

Figure 1. Author's graphic based on data compiled by the NASA Goddard Institute for Space Studies.

Consistent with the measured warming trend, the IPCC reports that "cold days, cold nights and frosts [are becoming] less frequent over most land areas, while hot days and hot nights [are becoming] more frequent."[23] Glacial lakes are growing in number and size, and mountain and other permafrost regions are encountering increasing ground instability.[24] Terrestrial

21 The 2007 average temperature was 14.73 degrees Celsius (°C) or 58.51 degrees Farenheit (°F). Author's calculations based on NASA data. *See* NASA Goddard Institute for Space Studies, *supra* note 20.

22 James E. Hansen, Solar and Southern Oscillations: GISS 2007 Temperature Analysis, http://www.columbia.edu/~jeh1/mailings/20080114_GISTEMP.pdf (Jan. 14, 2008).

23 AR4 SYR, *supra* note 1, at 1.1.

24 *Id.* at 1.2.

ecosystems are experiencing "earlier timing of spring events . . . and poleward and upward shifts in ranges in plant and animal species."[25] Changes in marine ecosystems "associated with rising water temperatures, as well as related changes in ice cover, salinity, oxygen levels and circulation . . . include shifts in ranges and changes in algal, plankton and fish abundance."[26] Other evidence includes rising sea levels from thermal expansion and melting glaciers, ice caps, and polar ice sheets, and an increase in the intensity, though not frequency, of tropical cyclone activity in the North Atlantic since 1970.[27]

B. Causes of Climate Change

The climate system's energy balance is affected by changes in atmospheric concentrations of GHGs and aerosols, solar radiation, and land cover.[28] The radiative-forcing effect of human-created GHG emissions has dominated the climate system over the last two centuries.[29] The IPCC reports that human activities since 1750 have caused warming with a net positive forcing of 1.6 watts per meter squared (W/m^2).[30]

25 *Id.*

26 *Id.*

27 *Id.* at 1.1.

28 *Id.* at 2.2.

29 *Id.* at 2.1–.2 & n.4.

30 *Id.* at 2.2.

Radiative Forcing (RF) Components (CO_2-equivalent values)	Best Estimate RF (W/m^2)
Anthropogenic CO_2	1.66
Anthropogenic CH_4, N_2O and Halocarbons	0.98
Anthropogenic Ozone	0.30
Anthropogenic CH_4-induced water vapor	0.07
Anthropogenic land use & black carbon (albedo impact)	-0.10
Anthropogenic total aerosol (direct and cloud albedo)	-1.20
Anthropogenic linear contrails	0.01
Natural solar irradiance	0.12

Figure 2. Radiative Forcing Components.[31]

The increase in atmospheric GHG concentrations is partially a function of increased anthropogenic emissions and partially attributable to the long-lived nature of several GHGs, including carbon dioxide (CO_2).[32] Figure 3 illustrates the CO_2 atmospheric decay cycle.[33] A substantial share of any given emission burst of CO_2 decays within a century.[34] However, approximately one-third remains after 100 years, and nearly one-fifth lingers after 1000 years.[35] Accordingly, a significant share of current emissions will continue to warm the climate system for many centuries even if such emission levels are reduced in the near future.

31 *Id.* at 2.2 fig.2.4.

32 *Id.* at 2.1–.2

33 Calculations by the author based on the Bern carbon cycle model. *See* James E. Hansen et al., *Dangerous Human-made Interference with Climate: A GISS ModelE Study*, 7 ATMOSPHERIC CHEMISTRY & PHYSICS 2287, 2302 (2007).

34 *Id.* at 2302 fig.9(a).

35 *Id.* at 2302.

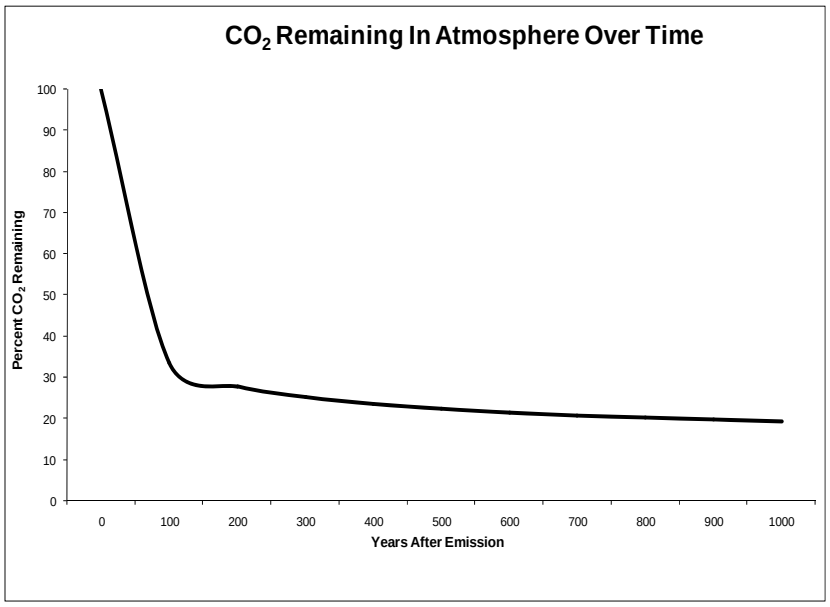

Figure 3. Graphic based on author's calculations using the Bern carbon cycle model.[36]

Scientists estimate that, taken together, the oceans and the terrestrial biosphere presently act as carbon sinks to sequester approximately half of annual anthropogenic carbon emissions.[37] However, the uptake capacity of the ocean is projected to decrease as the absorption of carbon increases oceanic acidity.[38] Other climate feedbacks in a warming world may soon begin to add to atmospheric CO_2 as well, including a switch of terrestrial forests from a net carbon sink to a net source.[39] For these reasons, the proportion of human-generated emissions that remain in the atmosphere for hundreds of generations may soon exceed the projections represented in Figure 3.

GHG emissions now far exceed pre-industrial levels and have increased most sharply in recent decades (by 70% between 1970

36 The decay of a pulse of carbon dioxide emission is based on the following equation derived from the Bern carbon cycle model: $CO_2(t) = 18 + 14 \exp(-t/420) + 18 \exp(-t/70) + 24 \exp(-t/21) + 26 \exp(-t/3.4)$. *See id.* at 2302 fig.9(a).

37 Dave Reay et al., *Climate Change 2007: Spring-time for Sinks*, 446 NATURE 727, 727 (2007).

38 *Id.* at 727–28.

39 *Id.*; *see also* Hansen, *supra* note 33, at 2302.

and 2004).[40] Annual emissions of CO_2 increased by 80% between 1970 and 2004, and the rate of growth during 1995–2004 more than doubled that of the 1970–1994 period.[41]

The United States was responsible for the largest level of CO_2 emissions among nations in 2004, the most recent year for which country-by-country data is publicly available.[42]

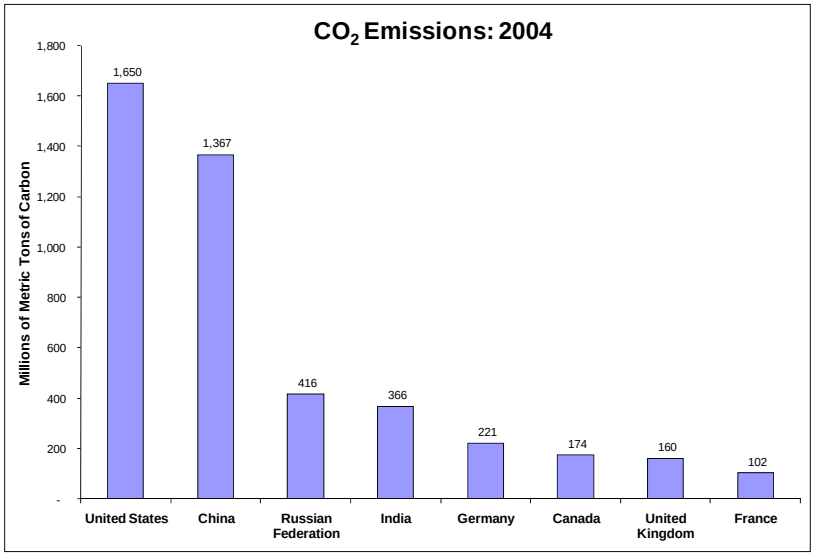

Figure 4. Author's graphic based on Carbon Dioxide Information Analysis Center (CDIAC) data.[43]

Collectively, the nation emitted 1.65 billion metric tons of carbon from fossil fuel consumption and cement production, double the U.S. emissions in 1960.[44] Of the United States total in

40 AR4 SYR, *supra* note 1, at 2.1 & fig.2.1(a).

41 *Id.* at fig.2.1.

42 *See* Carbon Dioxide Information Analysis Center (CDIAC), Oak Ridge National Laboratory, *National CO_2 Emissions from Fossil-Fuel Burning, Cement Manufacture, and Gas Flaring: 1751–2004,* http://cdiac.esd.ornl.gov/ftp/trends/co2_emis/ (last visited Feb. 24, 2008) (linking to emissions data for various countries labeled by 3-letter abbreviation) [hereinafter CDIAC Emissions Data].

43 *See id.* Emissions data for France include those from Monaco.

44 *See* Carbon Dioxide Information Analysis Center (CDIAC), Oak Ridge National Laboratory, *National CO_2 Emissions from Fossil-Fuel Burning, Cement Manufacture, and Gas Flaring: 1751–2004* (United States) (Aug. 17, 2007), http://cdiac.esd.ornl.gov/ftp/trends/co2_emis/usa.dat [hereinafter CDIAC U.S. Data].

2004, nearly 36% of emissions stemmed from coal usage and 44% from petroleum consumption.[45] Since 1800, the United States has emitted nearly 88 billion metric tons of carbon from fossil fuel consumption and cement production.[46] The record-high 2004 emission level is attributable in large part to the high U.S. per capita emission rate.[47]

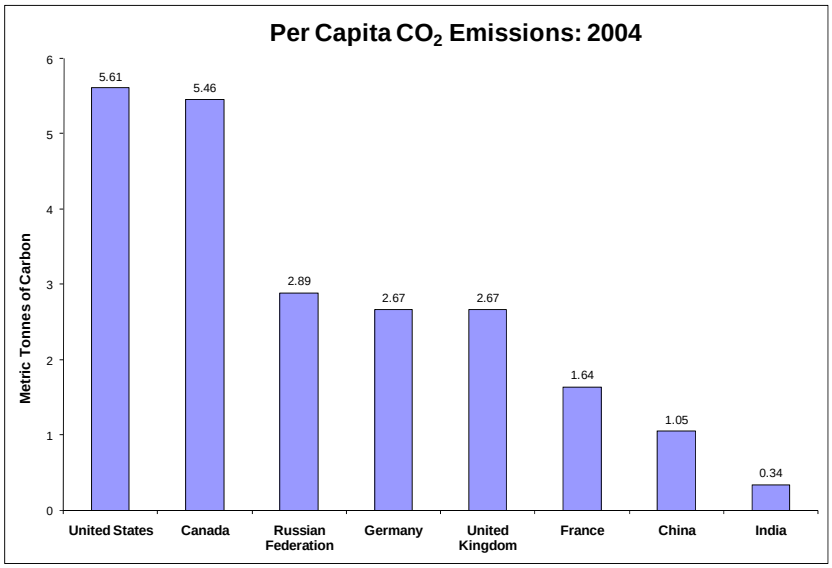

Figure 5. Author's graphic based on CDIAC data.[48]

The U.S. per capita rate has not increased markedly in recent years.[49] China, whose CO_2 emission level in 2004 approached that of the United States, experienced the sharpest percentage growth in per capita emissions in 1990–2004 among major emitting nations.[50]

45 *See id.*

46 *See id.*

47 *See id.*

48 *See* CDIAC Emissions Data, *supra* note 42. Emissions data for France include those from Monaco.

49 *See* CDIAC U.S. Data, *supra* note 44.

50 *See* Carbon Dioxide Information Analysis Center (CDIAC), Oak Ridge National Laboratory, *National CO_2 Emissions from Fossil-Fuel Burning, Cement Manufacture, and Gas Flaring: 1751–2004* (China) (Aug. 17, 2007), http://cdiac.esd.ornl.gov/ftp/trends/co2_emis/prc.dat [hereinafter CDIAC China Data].

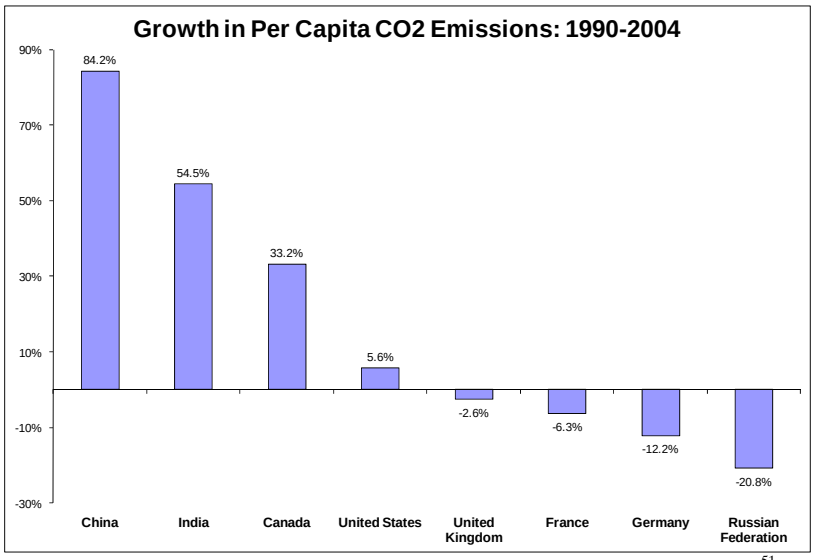

Figure 6. Graphic based on author's calculations of CDIAC data.[51]

Per capita emissions in China remain far lower than those in the United States and substantially lower than those from most European nations.[52] Growth in China's CO_2 emissions derives predominately from that nation's increased coal use, although, as a percentage of emissions, coal now accounts for less than it did in earlier periods.[53]

The rise in global CO_2 emissions stems in part from high emission rates from industrialized nations and largely from sharply increased emissions from developing nations. Industrialized nations' CO_2 emissions rose 4.3% from 1990–2004 (but remained greater than the total emissions from the more populous developing nations), while CO_2 emissions from

51 *See* CDIAC Emissions Data, *supra* note 42. France's emissions include those from Monaco. German emissions cover 1991–2004. Russian Federation data cover 1992–2004.

52 *See id.* Russian Federation emission declines are more likely explained by the decline in the nation's economic growth, including industrial and energy consumption, rather than by any significant investment in renewable energy sources and displacement of long-term reliance on fossil fuel.

53 *See id.* Coal accounted for 72% of emissions in 2004 as compared with 99% of emissions in 1950. *See* CDIAC China Data, *supra* note 50.

developing nations increased nearly 70% during the same time period.[54]

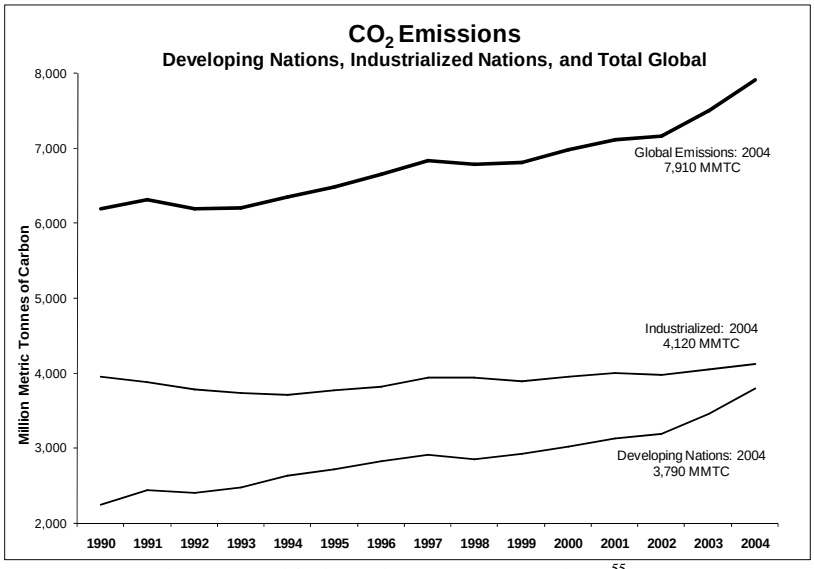

Figure 7. Author's graphic based on UNFCCC data.[55]

Vast differences in per capita emissions and emission trends exist within industrialized nations. Data for the 1990–2005 period show that while U.S. GHG emissions climbed 16% to 7,241 teragrams (Tg), GHG emissions for the European Union (E.U.) as a whole declined 8% to 5,164 Tg.[56] The lower E.U. emission total is particularly notable in that the E.U. population exceeds that of the United States by 64%.[57]

54 *See* CDIAC Emissions Data, *supra* note 42. China and India recorded especially sharp growth in emissions from 1990–2004. *See* CDIAC China Data, *supra* note 50; Carbon Dioxide Information Analysis Center (CDIAC), Oak Ridge National Laboratory, *National CO_2 Emissions from Fossil-Fuel Burning, Cement Manufacture, and Gas Flaring: 1751–2004* (India) (Aug. 17, 2007), http://cdiac.esd.ornl.gov/ftp/trends/co2_emis/ind.dat.

55 *See* UNFCCC, Greenhouse Gas Inventory Data—Detailed Data by Party, http://unfccc.int/di/DetailedByParty/Setup.do (last visited Feb. 24, 2008) (author's calculations using data obtained by comparing various countries on UNFCCC database).

56 *See id.* (author's calculations based on UNFCCC data comparing U.S. and E.U. emissions).

57 *See* Central Intelligence Agency, The World Factbook: European Union, https://www.cia.gov/library/publications/the-world-factbook/print/ee.html (last visited Feb. 24, 2008) (providing E.U. population data); U.S. Census Bureau,

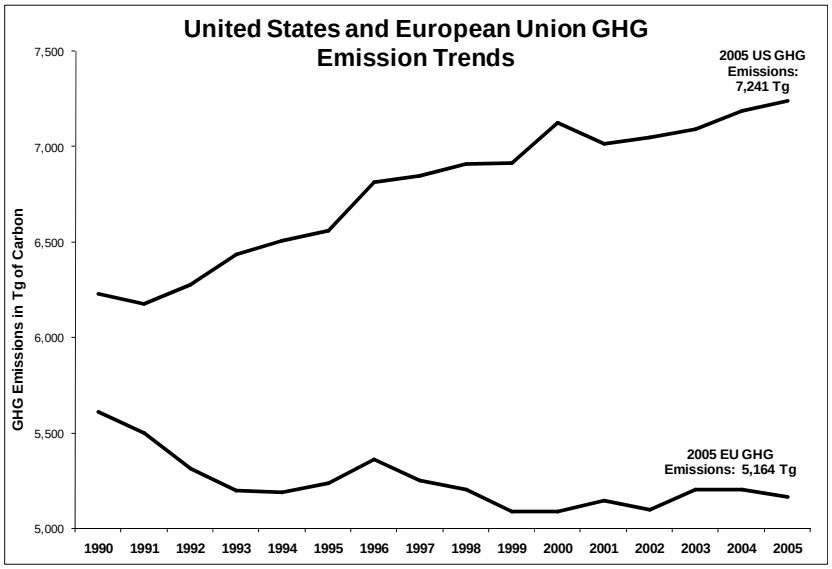

Figure 8. Author's graphic based on UNFCCC data.[58]

The long-lived nature of key GHGs combined with steadily increasing emissions has led to increasing atmospheric concentrations of GHGs. Global atmospheric concentrations of CO_2 and methane (CH_4) now far exceed the natural range over the last 650,000 years, as determined by analyses of ice cores.[59] For the modern period, the IPCC reports that global atmospheric CO_2 concentrations increased from 280 parts per million (ppm) prior to 1750 to 379 ppm in 2005,[60] while CH_4 concentrations climbed from 715 parts per billion (ppb) prior to 1750 to 1774 ppb in 2005.[61]

Annual Estimates of the Population for the United States, Regions, States, and Puerto Rico: April 1, 2000 to July 1, 2007 (2007), http://www.census.gov/popest/states/NST-ann-est.html (listing U.S. population data).

58 *See* Greenhouse Gas Inventory Data, *supra* note 55. One teragram (Tg) is equivalent to 10^{12} grams, 10^9 kilograms, and one million metric tons.

59 PHYSICAL BASIS, *supra* note 1, at 2.3.1–.2.

60 *Id.* at 2.3.1.

61 *Id.* at 2.3.2. For completeness, nitrous oxide (N_2O) concentrations climbed from 270 to 319 ppb while halocarbons increased from near zero to concentrations measuring in the low ppb range, amounts that are nonetheless worrisome given the exceptionally high global warming potential and virtually indefinite lifespan of halocarbons. *See id.* at 2.3.3.

Figure 9 illustrates this upward pattern, including a recent increase in the rate of growth, by incorporating data retrieved from the Mauna Loa Observatory.[62] From 1959–2007, CO_2 concentrations grew 21% to 384 ppm.[63] Moreover, because the annual rate of increase in recent decades exceeds that of the 1959–2007 period as a whole, the record data suggests that the rate of growth in atmospheric CO_2 concentration is increasing.[64]

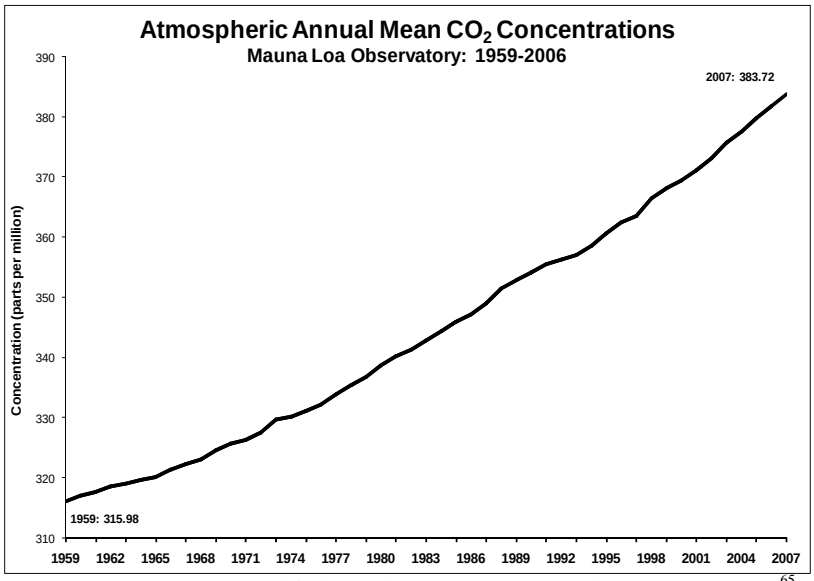

Figure 9. Author's graphic based on Mauna Loa Observatory data.[65]

The IPCC finds that "[m]ost of the observed increase in globally-averaged [sic] temperatures since the mid-20th century is *very likely* due to the observed increase in anthropogenic GHG concentrations."[66] Moreover, AR4 reports that it is "*extremely unlikely* that global climate change of the past 50 years can be explained without external forcing, and *very likely*

62 *See* National Oceanic Atmospheric Agency (NOAA), Mauna Loa CO_2 Annual Mean Data (Feb. 3, 2008), ftp://ftp.cmdl.noaa.gov/ccg/co2/trends/co2_annmean_mlo.txt.

63 *See id.*

64 The annual rate of increase for 1959–2007 is 0.45%, for 1987–2007 it is 0.50%, and for 1997–2007 it is 0.56%. Author's calculations based on Mauna Loa Observatory data. *See id.*

65 *See id.*

66 AR4 SYR, *supra* note 1, at 2.4 (emphasis in original).

that it is not due to known natural causes alone."[67] Indeed, absent anthropogenic emissions, the combined impact of solar changes and volcanic events, i.e. natural forcings, "would *likely* have produced [global] cooling, not warming."[68]

C. Impacts and Projections

The IPCC reports high agreement that current policies and practices will result in continuous increases in global GHG emissions.[69] Further warming will result, inducing changes in the climate system "during the 21st century that would *very likely* be larger than those observed in the 20th century."[70]

Due to the feedback effects of the climate-carbon cycle and the length of time required for removal of CO_2 from the atmosphere, human-produced, GHG-induced atmospheric warming and sea level thermal expansion will likely continue for centuries even if GHG concentrations were to stabilize at present levels.[71] These ongoing changes will likely cause a sea level rise of up to 0.59 meters this century, exclusive of the possible impacts resulting from changes in ice sheet flow.[72] Less reticent scientists account for the possibility of rapid ice sheet loss in a warming world and warn of the potential for a sea level rise "on the order of meters on the century timescale."[73] The IPCC notes that even if GHG concentrations were to be stabilized, "[a]nthropogenic warming and sea level rise would continue for centuries due to the time scales associated with climate processes and feedbacks."[74]

67 *Id.* (emphasis in original).

68 *Id.* (emphasis in original).

69 *Id.* at 3.1.

70 *Id.* at 3.2.1 (emphasis in original).

71 *See* PHYSICAL BASIS, *supra* note 1, at FAQ 10.3.

72 AR4 SYR, *supra* note 1, at 3.2.1 & tbl.3.1. The IPCC notes that the added sea level rise from Greenland ice sheet disintegration could be "several meters, and larger than from thermal expansion, should warming in excess of 1.9–4.6°C above pre-industrial be sustained over many centuries." *Id.* at 5.4. The IPCC also states that the risk of additional sea level rise from ice sheet melting, beyond that from thermal expansion alone, "may be larger than projected by ice sheet models and could occur on century time scales. . . . because ice dynamical processes seen in recent observations . . . could increase the rate of ice loss." *Id.* at 5.2; *see also id.* at 3.2.1.

73 Hansen, *supra* note 3, at 2.

74 AR4 SYR, *supra* note 1, at 3.2.3.

Significant public health consequences from climate change are projected to occur within this century, including increased mortality, morbidity, and injuries attributable to the increasing frequency of heat waves, greater intensity of hurricanes and cyclones and associated flooding, and risks of food and water shortages.[75] Impacts on natural ecosystems are projected to be predominately negative. Scientists estimate that a warming of 1.5–2.5°C above 1980–1999 levels will likely cause the extinction of 20–30% of the Earth's species.[76] A temperature increase exceeding 3.5°C is projected to result in a "significant extinction" of 40–70% of species.[77]

Polar, island, and high-mountain communities and ecosystems are among the most vulnerable to the impacts of climate change, and the IPCC notes "increasing evidence of greater vulnerability of specific groups such as the poor and elderly in not only developing but also developed countries."[78] Impacts to ecosystems and associated species worldwide climb with greater global average temperature increases.[79]

IPCC projections show that climate change will likely impact the United States in several ways. First, all of North America is very likely to experience warming this century, more so than the planet as a whole.[80] In northern regions, including Alaska, "warming is likely to be largest in winter, and in the southwest USA largest in summer."[81] Warming may also be more significant in winter throughout elevated areas "as a result of snow-albedo feedback."[82] In the mountain regions of the West, warming is "projected to cause decreased snowpack, more winter flooding, and reduced summer flows, exacerbating competition for over-allocated water resources."[83] In agricultural regions, climate change may at first increase yields of rain-fed crops, but major challenges are projected "for crops

75 *Id.* at 3.3.1 & tbl.3.2.

76 *Id.* at 3.4.

77 *Id.*

78 *Id.* at 5.2.

79 *Id.*

80 *See* PHYSICAL BASIS, *supra* note 1, at 11.5.

81 *Id.*

82 *Id.* at 11.5.3.1.

83 AR4 SYR, *supra* note 1, at 3.3.2.

that are near the warm end of their suitable range or which depend on highly utilized water resources."[84] In cities, heat waves are anticipated to become more numerous, intense, and protracted within this century.[85] Coastal communities and habitats "will be increasingly stressed by climate change impacts interacting with development and pollution."[86]

II
MITIGATION OPTIONS: DANGER, URGENCY, AND VIABLE TARGETS

The IPCC reports "*high agreement* and *much evidence* of substantial economic potential for the mitigation of global GHG emissions over the coming decades . . . ."[87] "[N]o single technology can provide all of the mitigation potential in any sector," but there are "a wide variety of national policies and instruments . . . available to governments to create the incentives for mitigation action."[88] While it is not possible to avoid all climate change impacts, mitigation options combined with adaptation efforts can reduce, delay, or avoid many of the risks of climate change.[89] According to the IPCC, effective mitigation options include integrating climate policies in wider development policies; regulations and standards; taxes and charges; tradable permits; financial incentives; voluntary agreements; information instruments; and research, development, and demonstration.[90]

Some mitigation opportunities may have net negative costs. If grasped, these prospects can yield an annual reduction of approximately six billion metric tons of CO_2 equivalent emissions by 2030, an amount that is between 1/6 and 3/5 of the amount of increased emissions projected by IPCC emission scenarios.[91] However, realization of such "no regrets opportunities" requires

84 *Id.*

85 *Id.*

86 *Id.*

87 *Id.* at 4.3 (emphasis in original).

88 *Id.*

89 *Id.* at 5.3.

90 *Id.* at 4.3.

91 *Id.* at 3.1, 4.3 & fig.4.1.

dealing with "implementation barriers."[92] Other mitigation options entail raising costs, such as a carbon tax, or other means of sending a clear price signal, including capped emissions programs featuring allowances that are reset at progressively more stringent levels of scarcity.[93]

Macroeconomic costs of mitigation "generally rise with the stringency of the stabilisation target . . . ."[94] For example, the IPCC reports that by 2050, stabilization of GHG atmospheric concentrations at a CO_2 equivalent level of 710 ppm will allow an additional average global gross domestic product (GDP) gain of 1%, while stabilization at 445 ppm likely will involve a decrease of 5.5% of global GDP.[95] However, the IPCC also reports *high agreement* that mitigation actions can result in near-term benefits, such as improved health due to reduced air pollution, which may offset a substantial fraction of mitigation costs.[96] In addition, *high agreement* exists that changes in lifestyle, behavior patterns, and management practices "can contribute to climate change mitigation across all sectors."[97]

A. The IPCC's Response

Virtually all nations have committed themselves, at least nominally, to stabilizing GHG concentrations "at a level that would prevent dangerous anthropogenic interference with the climate system."[98]

The IPCC warns that anthropogenic warming is likely to lead to at least "some irreversible impacts," including wide species extinctions.[99] The AR4 notes that while all stabilization scenarios require GHG emissions to peak and decline thereafter, more ambitious stabilization targets require earlier peaks and

92 *Id.* at 4.3 & n.22.

93 *See id.* at 4.3.

94 *Id.* at 5.6.

95 *Id.*

96 *Id.* at 4.3.

97 *Id.*

98 Convention on Climate Change, *supra* note 13, art. 2. By Aug. 22, 2007, 192 nations had formally ratified, approved or accepted the Convention. *See* UNFCCC, Status of Ratification, http://unfccc.int/files/essential_background/convention/status_of_ratification/application/pdf/unfccc_conv_rat.pdf (last visited Feb 25, 2008).

99 AR4 SYR, *supra* note 1, at 3.4.

steeper declines.[100] Indeed, the more ambitious stabilization targets involving scenarios that keep additional warming within 2°C entail that GHG emissions peak no later than 2015.[101] The risk of mass species extinction and loss of world coastlines from a sea level rise of several meters can be avoided, if at all, only with GHG-concentration stabilization at these lower levels.[102] While the IPCC identified and assessed a number of regional and global impacts that correlate with varying degrees of additional warming—impacts that any reasonable observer would deem dangerous to human health and the environment—the IPCC steered clear of drawing a specific conclusion as to what level of warming constitutes "dangerous anthropogenic interference with the climate system."[103]

B. Less Reticent Scientific Responses

Writing in a peer-reviewed journal, forty-seven scientists from NASA, the Lawrence Berkeley and Argonne National Laboratories, MIT, and other leading institutes recently concluded that "global temperature is nearing the level of dangerous climate effects . . . ."[104] To avoid such effects, additional warming must be kept to less than 1°C, requiring atmospheric CO_2 concentrations to be stabilized at a level below 450 ppm.[105] According to these scientists, "little time remains to achieve the international cooperation needed to avoid widespread undesirable consequences."[106]

> CO_2 emissions are the critical issue, because a substantial fraction of these emissions remain in the atmosphere "forever," for practical purposes . . . . The principal implication is that avoidance of dangerous climate change requires the bulk of coal and unconventional fossil fuel resources to be exploited only under condition that CO_2 emissions are captured and sequestered. A second inference is that

100 *Id.* at 5.4.

101 *Id.* at 5.4 n.29 & fig.5.1.

102 *Id.* at 5.2–.4.

103 *Id.* at 5.1 (quoting Convention on Climate Change, *supra* note 13, art. 2). The IPCC notes, however, that "[s]cience can support informed decisions on this issue . . . ." *Id.*

104 Hansen, *supra* note 33, at 2308.

105 *Id.* at 2306.

106 *Id.* at 2308.

> remaining gas and oil resources must be husbanded, so that their role in critical functions such as mobile fuels can be stretched until acceptable alternatives are available, thus avoiding a need to squeeze such fuels from unconventional and environmentally damaging sources. The task is to achieve a transition to clean carbon-free energy sources, which are essential on the long run, without pushing the climate system beyond a level where disastrous irreversible effects become inevitable.[107]

In September 2007, the Union of Concerned Scientists (UCS), a non-partisan advocacy group, released a report elaborating upon the policy implications for the United States if the nation chooses to take a leadership role in limiting the global temperature to no more than 2°C above pre-industrial levels.[108] After "accounting for the most aggressive reductions that can be reasonably expected of developing nations," UCS found that the United States needs to reduce its GHG emissions by at least 80% below 2000 levels by 2050.[109]

Reductions averaging 4% per year must begin in 2010.[110] However, if the date at which emissions are capped and reductions commenced is delayed until 2020, greatly accelerated annual reductions (8% per year) would be needed in the 2020–2050 time frame.[111]

Recent research also indicates that even after GHG atmospheric concentrations are stabilized, global temperatures may continue to increase for centuries because of the declining capacity of forests and oceans to absorb carbon.[112] Accordingly,

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107 *Id.*

108 AMY L. LUERS ET AL., HOW TO AVOID DANGEROUS CLIMATE CHANGE: A TARGET FOR U.S. EMISSIONS REDUCTIONS 1–2 (Union of Concerned Scientists 2007), *available at* http://www.ucsusa.org/assets/documents/global_warming/emissions-target-report.pdf.

109 *Id.* at 2.

110 *Id.*

111 *Id.* The IPCC similarly noted that "[d]elayed emission reductions significantly constrain the opportunities to achieve lower stabilization levels and increase the risk of more severe climate change impacts." AR4 SYR, *supra* note 1, at 5.3. "Mitigation efforts over the next two to three decades will have a large impact on opportunities to achieve lower stabilisation levels." *Id.* at 5.4.

112 H. Damon Matthews & Ken Caldeira, *Stabilizing Climate Requires Near-Zero Emissions*, 35 GEOPHYSICAL RESEARCH LETTERS L04705 (2008), *available at* http://www.agu.org/pubs/crossref/2008/2007GL032388.shtml. For an analysis of old-growth forests as effective carbon sinks, see OREGON WILD, THE STRAIGHT FACTS

stable global temperatures, as contrasted with stable atmospheric GHG concentrations, will require virtually eliminating GHG emissions, unless effective methods are developed and deployed to actively remove significant amounts of CO_2 from the atmosphere.[113]

C. The United States' Response

Several measures to regulate GHG emissions nationwide were introduced in Congress in 2007. Many of these fail to regulate all GHG-emitting sectors,[114] and only two of the proposed measures provide for reductions of GHG emissions by 2050 that meet or exceed the UCS' minimum reduction standard.[115] Further, as of January 2008, the Bush Administration had not endorsed any of the legislative proposals.

ON FORESTS, CARBON AND GLOBAL WARMING (2007), *available at* http://www.oregonwild.org/oregon_forests/old_growth_protection/forests-global-warming/oregon-wild-report-on-forests-carbon-and-global-warming.

113 Matthews & Caldeira, *supra* note 112.

114 According to EPA, S. 2191 covers no more than 80% of the economy, while H.R. 620 and S. 280 cover 85%.

115 *See* LUERS ET AL., *supra* note 108, at 16–17.

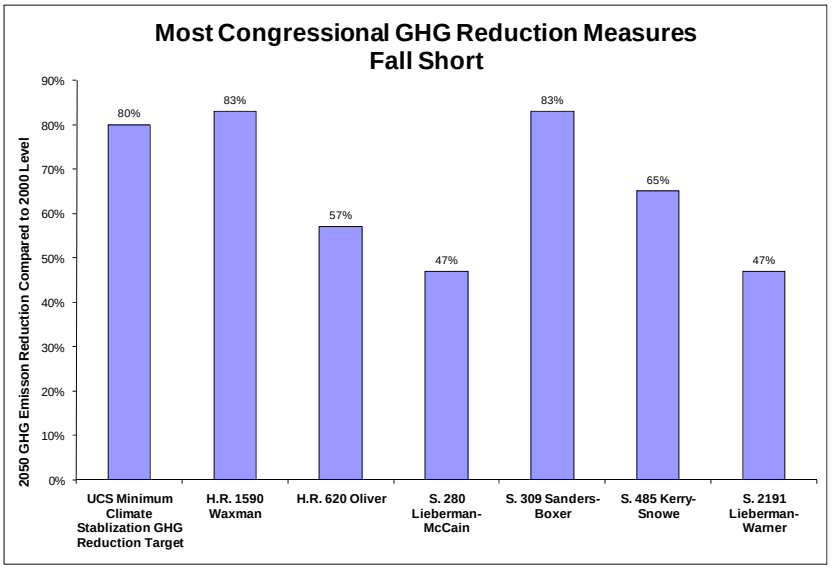

Figure 10. Emissions-reduction targets from the Union of Concerned Scientists.[116]

D. State and Regional Responses

In the absence of federal leadership, a number of states have set their own goals for GHG emission reductions and initiated programs to achieve those goals.[117] As is the case at the national level, state efforts to cap and reduce GHG emissions are complicated by a high degree of economic reliance on fossil fuels. In West Coast states, for instance, this reliance has led to overall growth in CO_2 emissions from 1990–2004.[118] Emissions in California and Oregon rose 8% and 37%, respectively.[119] Other western states with large increases in CO_2 emissions over that

116 *See id.*

117 *See, e.g.*, Press Release, Western Climate Initiative, Five Western Governors Announce Regional Greenhouse Gas Reduction Agreement (Feb. 26, 2007), *available at* http://www.westernclimateinitiative.org/ewebeditpro/items/O104F12774.pdf.

118 U.S. Environmental Protection Agency, *State CO2 Emissions from Fossil Fuel Combustion: 1990–2004*, http://epa.gov/climatechange/emissions/state_energyco2inv.html (follow "State CO_2 Emissions from Fossil Fuel Combustion, 1990–2004" hyperlink) (last visited Feb. 25, 2008) [hereinafter State CO_2 Emissions Data].

119 *See id.* (author's analysis of EPA data). For completeness, Washington CO_2 emissions from fossil fuel combustion climbed by 18% in the period.

same period include Alaska (35%), Arizona (53%), Colorado (38%), Idaho (37%), and Nevada (55%).[120]

In the West, several states and two provinces participating in the Western Climate Initiative (WCI) have set short- and long-term GHG reduction goals.[121] Several of these fall below UCS' minimum reduction targets, while other state targets approach or even exceed that level of targeted reduction.[122]

120 *Id.* Montana CO_2 emissions from fossil fuel combustion climbed by 24%, New Mexico by 11%, and Utah by 20% over the 1990–2004 period.

121 WESTERN CLIMATE INITIATIVE, STATEMENT OF REGIONAL GOAL 1–3 & tbl.1 (2007), *available at* http://www.westernclimateinitiative.org/ewebeditpro/items/O104F13006.pdf. As of February 2008, WCI "Partners"—that is, fully-committed members of the initiative—were Arizona, British Columbia, California, Manitoba, Montana, New Mexico, Oregon, Utah, and Washington. *See id.* at 3. There are also a number of observer U.S. states (Alaska, Colorado, Idaho, Kansas, Nevada, and Wyoming), Canadian provinces (Ontario, Quebec, and Saskatchewan), and the Mexican state of Sonora. *See* Western Climate Initiative, http://westernclimateinitiative.org/Index.cfm (last visited Feb. 25, 2008). Montana's climate action plan and goals are still under development. *See* Montana Department of Equality, Climate Change Advisory Committee, http://www.mtclimatechange.us (last visited Feb. 27, 2008).

122 STATEMENT OF REGIONAL GOAL, *supra* note 121, at tbl.2.

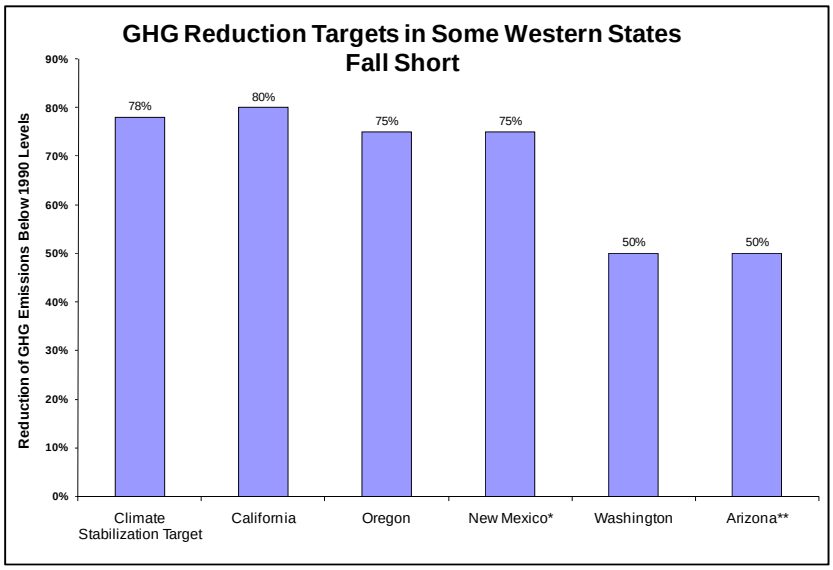

Figure 11. Author's graphic based on data from the Western Climate Initiative and UCS.[123] *New Mexico's goal is 75% below 2000 levels by 2050. ** Arizona's goal is 50% below 2000 by 2040. Other state 2050 goals listed here are relative to their 1990 levels.

GHG emissions within states vary in intensity by sector. For example, at least 50% of emissions in the three West Coast states stems from transportation.[124] In contrast, Arizona, Montana, New Mexico, and Utah generate at least 50% of emissions from their own electric power sectors.[125] This breakdown masks the fact that California, Oregon, and Washington import energy from out-of-state, fossil-fuel consuming electricity plants and are therefore responsible for the generation of a share of those out-of-state GHG emissions.

123 *See supra* notes 108 and 121 and accompanying text.

124 Calculations by author based State CO_2 Emissions Data, *supra* note 118.

125 *Id.*

2004 CO_2 Emissions from Fossil Fuel Combustion: Share by Sector						
	Arizona	**New Mexico**	**Utah**	**California**	**Oregon**	**Washington**
Commercial	2.1%	2.9%	3.7%	3.4%	4.2%	3.6%
Industrial	4.8%	14.2%	12.0%	20.3%	17.2%	23.4%
Residential	2.3%	4.0%	5.6%	7.7%	6.1%	5.6%
Transportation	37.5%	26.8%	25.6%	56.6%	53.6%	50.8%
Electric Power	53.3%	52.2%	53.1%	12.0%	18.9%	16.6%

Figure 12. Author's calculations based on EPA data.[126]

WCI states and provinces are presently focused on developing a regional cap-and-trade program to limit GHG emissions from the electricity sector and other sectors that the states deem appropriate for inclusion in the program.[127] The WCI plans to complete a design of this program for the consideration of the relevant governors and premiers by August 2008.[128] Although a number of issues remain to be resolved, the WCI partners have signaled that the program is to be "load-based," that is, regulated emissions will include not only those generated from within the WCI but also emissions produced outside WCI boundaries by electricity generation to satisfy demand stemming from consumption and activity within WCI states and provinces.[129]

In addition to participating in the design of the nascent cap-and-trade program, individual WCI states have enacted a range of initiatives, including limits on new-vehicle tailpipe GHG emissions, enactment of a low-carbon fuel standard, renewable

126 *Id.*

127 WESTERN CLIMATE INITIATIVE, WORK PLAN: OCTOBER 2007–AUGUST 2008 3 (2007), *available at* http://www.westernclimateinitiative.org/ewebeditpro/items/O104F13792.pdf.

128 *Id.* at 1–2.

129 *See id.* at 7, 20. According to the plan, "[e]lectricity sector emissions are tentatively defined as the greenhouse gas emissions from all generating plants that serve WCI Partners, including generation outside the borders of the WCI Partners that serve end users in WCI states and provinces." *Id.* at 20.

energy portfolio standards, GHG performance standards for long-term baseload electric power generation, and accounting for carbon emissions in a climate registry.[130] State policy makers understand that their initiatives would be more effective at limiting global emissions if they were adopted nationwide.[131] Many hope, however, that their state and regional initiatives will serve both as a laboratory and springboard for similar federal action, particularly with a new administration in 2009.[132]

III
GROWING JUDICIAL IMPATIENCE WITH FEDERAL INACTION

State efforts to reduce GHG emissions by limiting the use of fossil fuels have incurred a number of industry legal challenges. While a detailed analysis of these challenges is beyond the scope of this Article, the strength of argument with which two federal district courts rejected industry challenges to recently adopted state tailpipe emission regulations is highlighted below.

As background, in 2004 California adopted GHG standards for new passenger cars and light trucks.[133] To enable it to enforce its tailpipe GHG program, the State sought a Clean Air Act waiver.[134] For the sixteen states that have already adopted the California standards, their programs too are contingent on

130 PEW CTR. ON GLOBAL CLIMATE CHANGE, *supra* note 10, at 3–10.

131 *See id.* at 1–2.

132 At the WCI's first Public Stakeholder Workshop, for example, a representative from the Oregon Governor's Office openly speculated that the design features of the WCI cap and trade program may be adopted at the federal level when Congress amends S. 2191, the Lieberman-Warner cap and trade measure. David Van't Hoff, Oregon Governor's Office Sustainability Policy Advisor, Remarks at the WCI Public Stakeholder Workshop (Jan. 10, 2008). For an extended analysis of the capacity of state environmental programs to influence federal policy, see ANDREW AULISI ET AL., CLIMATE POLICY IN THE STATE LABORATORY: HOW STATES INFLUENCE FEDERAL REGULATION AND THE IMPLICATIONS FOR CLIMATE CHANGE POLICY IN THE UNITED STATES (World Resources Institute 2007), *available at* http://pdf.wri.org/climate_policy_in_the_state_laboratory.pdf.

133 *See* Letter from Catherine Witherspoon, Executive Officer, Cal. Air Res. Bd., to Stephen L. Johnson, Adm'r, Envtl. Prot. Agency (Dec. 21, 2005).

134 *Id.*; *see also* Clean Air Act § 209(b), 42 U.S.C. § 7543(b) (2006); California State Motor Vehicle Pollution Control Standards, Request for Waiver of Federal Preemption, Opportunity for Public Hearing, 72 Fed. Reg. 21260, 21261 (Apr. 30, 2007).

California's receipt of its waiver.[135] The EPA has rejected California's waiver request, and California, joined by other states and several environmental organizations, sued the EPA for failure to grant the waiver.[136] Automakers and dealers, on the other hand, have challenged both the California regulation and the ability of other states to adopt those regulations as preempted under federal law even if the states eventually obtain the EPA waiver.

In *Green Mountain Chrysler Plymouth Dodge Jeep v. Crombie*, the court upheld Vermont's adoption of California's vehicle tailpipe GHG emissions standards and, in the process, specifically credited the reliability of expert witness testimony that continuously high GHG emissions risk abrupt climate change and irreversible damage to civilization.[137] Similarly, in *Central Valley Chrysler-Jeep, Inc. v. Goldstene*, the court rejected industry claims that California's GHG emission standards for new motor vehicles were preempted by federal law or by U.S. foreign policy.[138] The court pointedly cited with approval to the Supreme Court's earlier decision that year, which "impliedly recognized that EPA's contention that it should not regulate greenhouse gas emissions even if it is empowered to do so is little more than a post-hoc rationalization for inaction."[139]

These cases demonstrate that the judiciary is not immune to the growing recognition that climate change is a matter of grave urgency and that the federal government's studied inaction constitutes a virtual dereliction of duty. States and environmental litigants are likely in 2008 and beyond to bring to

135 Green Mountain Chrysler Plymouth Dodge Jeep v. Crombie, 508 F. Supp. 2d 295, 343 n.50 (D. Vt. 2007); *see also* Clean Air Act § 177, 42 U.S.C. § 7507.

136 *See* Letter from Stephen L. Johnson, Adm'r, Envtl. Prot. Agency, to Arnold Schwarzenegger, Governor of Cal. (Dec. 19, 2007) (on file with author); Federal Register Notice of Decision Denying a Waiver of Clean Air Act Preemption for California's 2009 and Subsequent Model Year Greenhouse Gas Emission Standards for New Motor Vehicles of Feb. 29, 2008, *available at* http://www.epa.gov/otaq/url-fr/fr-waiver.pdf.

137 *Crombie*, 508 F. Supp. 2d at 316–17, 397–99. The court upheld the state regulations contingent upon California receiving the waiver of federal preemption it has sought from EPA under the Clean Air Act. *Id.* at 343 n.50.

138 Cent. Valley Chrysler-Jeep, Inc. v. Goldstene, No. CV F 04-6663 AWI LJO, 2007 WL 4372878, at *39 (E.D. Cal. Dec. 11, 2007).

139 *Id.* at *36 (citing Massachusetts v. Envtl. Prot. Agency, 127 S. Ct. 1438, 1462–63 (2007)).

the courts the ever-mounting evidence that federal inaction increasingly runs the risk of irreversible damage to natural and human systems.

IV
CONCLUSION: HOPE AFTER BALI

The backdrop of international scientific consensus that human-induced climate change endangers the planet and that concerted, effective action to reduce the danger must not be delayed generated high expectations for the thirteenth session of the Conference of the Parties to the 1992 United Nations Framework Convention on Climate Change. Held in December 2007 in Bali, Indonesia, the conference drew delegates from nearly 190 signatory nations for the purpose of strengthening the Convention and planning a successor to the 1997 Kyoto Protocol to the UNFCCC, which expires in 2012.[140] The European Union and several other parties pressed hard for a statement committing parties to targeted reductions of GHG emissions in order to stabilize atmospheric concentrations at a level below which "dangerous anthropogenic interference with the climate system" is likely.[141] A draft paper by the convenors reflected this position by pointing to "unequivocal scientific evidence" that necessitates richer nations to reduce GHG emissions 25–40% below 1990 levels by 2020, and for global emissions to peak within fifteen years and "be reduced to very low levels, well below half of levels in 2000 by 2050."[142]

140 Fuller & Rosenthal, *supra* note 11, at A17. On the eve of the Bali conference, over 200 scientists issued a "Bali Climate Declaration" summarizing their view of the implications of IPCC's research. University of New South Wales Climate Change Research Centre, *2007 Bali Climate Declaration by Scientists*, *available at* http://www.climate.unsw.edu.au/bali/ (last visited Feb. 27, 2008). Noting that "there is no time to lose," the scientists urged the prime goal for international efforts be to limit additional global warming to no more than 2°C above preindustrial levels, and that to accomplish that goal, GHG emissions must peak within 10 to 15 years and be reduced by 2050 to less than 50 percent of 1990 levels. *Id.*

141 Convention on Climate Change, *supra* note 13, art. 2.

142 U.N. Framework Convention on Climate Change, COP Item 4: Contact Group on Long-term Cooperative Action, *Non-paper by the Co-facilitators*, Draft decision x/CP.13, (Oct. 12, 2007), *available at* http://unfccc.int/files/meetings/cop_10/agenda/application/pdf/1cp13_081207_final__nonpaper.pdf.

The United States, however, stuck to its standing position that there should be no mandatory GHG emission limits.[143] Without U.S. participation, the effort to forge consensus on emission limitations collapsed. Delegates understood that atmospheric GHG concentrations will not be reduced without the cooperative participation of all major emitters, including the United States or, for that matter, China.[144] Thus, U.S. opposition eviscerated a key moment in Bali to back the climate system away from the precipice.

Delegates accordingly shifted to lesser goals. One of these objectives—achieved over U.S. opposition—involved the Kyoto Protocol of 1997. The Protocol commits industrialized nations to emission limitations "with a view to reducing . . . overall emissions of [greenhouse] gases by at least 5 per cent below 1990 levels" by 2012.[145] Although President Clinton signed the Kyoto Protocol, the Senate never ratified the treaty; therefore, the United States remains a non-party.[146] Given the United States' continued refusal to ratify the Protocol, the parties to the Kyoto Protocol in Bali were free to ignore U.S. opposition to continued work on a successor protocol. They therefore committed to "appropriate action" at the next review of the existing Protocol, a cumbersome formulation widely understood to mean a strengthened successor to the Protocol.[147]

143 Posting of Andrew C. Revkin to Dot Earth, *Bali Update: 'Non Paper' a Nonstarter for U.S.*, http://dotearth.blogs.nytimes.com/2007/12/11/bali-update-non-paper-a-nonstarter-for-us/?scp=1-b&sq=climate+%2B+bali+update&st=nyt (Dec. 11, 2007, 16:30 EST). According to Revkin, the United States "bluntly refused to consider language—even in the nonbinding preamble—that included any specific numbers for how much overall emissions from wealthy countries would need to be cut to have a chance of avoiding the worst climate dangers." *Id.* Revkin notes that the U.S. position in Bali was consistent with its position that it is unable, or unwilling, to decide on a level of atmospheric GHG concentrations that constitute dangerous interference with the climate system. Posting of Andrew C. Revkin to Dot Earth, *'Dangerous' Warming Still Undefinable to White House*, http://dotearth.blogs.nytimes.com/2007/11/17/dangerous-warming-still-undefinable-to-white-house/ (Nov. 17, 2007, 16:45 EST).

144 Fuller & Rosenthal, *supra* note 11, at A17.

145 Kyoto Protocol to the United Nations Framework Convention on Climate Change art. 3, Dec. 10, 1997, 37 I.L.M. 22.

146 *See* UNFCCC, United States of America Ratification Status, http://maindb.unfccc.int/public/country.pl?country=US (last visited Feb. 27, 2008).

147 U.N. Framework Convention on Climate Change, *Scope and Content of the Second Review of the Kyoto Protocol Pursuant to its Article 9*, Decision -/CMP.3

The second achievement was agreement on the Bali Action Plan.[148] Again, this was achieved over U.S. opposition.[149] The draft Bali Action Plan included, for the first time, a provision requiring developing nations to consider "[m]easurable, reportable and verifiable nationally appropriate mitigation commitments or actions . . . ."[150] Convention delegates frequently referred to this document as a "roadmap" designed to strengthen the Convention by launching a "comprehensive process" aimed at a "shared vision" for long-term national and international action on mitigation.[151] The parties achieved consensus on the document, however, only by couching mitigation expectations in precatory, nonbinding language.[152]

Bali ended almost as it began. The Convention reaffirmed two paths forward. The first path guides those parties willing to build a successor to the Kyoto Protocol and its present mechanisms of tradable permits intended to achieve targeted reductions in GHG emissions. The second remains wide enough to encompass nations that continue to be reluctant to accept binding emission limits. The Convention did not make any additional binding, accountable commitments to reverse present emission trends. Yet throughout the debates, as well as within the finally approved Bali Action Plan, the parties recognized and

(2007) (advance unedited version), *available at* http://unfccc.int/files/meetings/cop_13/application/pdf/cmp_art _nine.pdf.

148 United Nations Climate Change Conference, Conference of the Parties Archived Video, sess. 3 (Dec. 15, 2007), *available at* http://www.un.org/webcast/unfccc/2007/ [hereinafter Climate Change Conference Archived Video].

149 *Id.* The U.S. delegate renounced the Plan as unbalanced as it conditioned developing nation mitigation obligations on their receipt from richer nations of adequate technology and financing, whereas there was no similar caveat placed on the Plan's expectations for mitigation actions to be undertaken by industrialized nations. *Id. Compare Bali Action Plan*, *supra* note 13, at 1(b)(i), *with* 1(b)(ii). That statement was greeted with notably indecorous hissing, followed by sustained criticism from delegates ranging from South Africa to Brazil. *See* Climate Change Conference Archived Video, *supra* note 148. Papua New Guinea's delegate summed up the sentiment by admonishing the United States: "[i]f for some reason you are not willing to lead, leave it to the rest of us. Please, get out of the way." *Id.* Notably, no nation stood to support the United States' position. *Id.* Perhaps unwilling to be the sole cause of diplomatic collapse, the U.S. delegate, this time to sustained acclamation, reversed course in order to "join consensus." *Id.*; *see also* Fuller & Revkin, *supra* note 9, § 1, at 11.

150 *See Bali Action Plan*, *supra* note 13, at 1(b)(i).

151 Climate Change Conference Archived Video, *supra* note 148.

152 *See* Fuller & Rosenthal, *supra* note 11, at A17.

affirmed two central facts: (1) that "deep cuts" in global emissions are required to stabilize atmospheric GHG concentrations at a level below the point of dangerous interference with the climate system; and (2) that the situation confronting the planet is urgent.[153]

The two paths outlined in Bali will converge in December 2009 in Copenhagen with the jointly held Second Review of the Protocol and the Fifteenth Session of the Convention.[154] By that date, a new U.S. President and Congress, perhaps less solicitous of fossil-fuel interests, will determine U.S. policy. In the meantime, as relevant policy initiatives continue to surface, they must be evaluated first and foremost in terms of their effectiveness in reducing the risk of irreversible, catastrophic damage.

153 *See Bali Action Plan*, *supra* note 13, at 1.

154 U.N. Framework Convention on Climate Change, *Date and Venue of the Fourteenth and Fifteenth Sessions of the Conference of the Parties and the Calendar of Meetings of Convention Bodies*, Draft Decision -/CP.13, (2007) (advance unedited version), *available at* http://unfccc.int/files/meetings/cop_13/application/pdf/cp_date_ven_cal.pdf.