

BEFORE THE ADMINISTRATOR OF THE ENVIRONMENTAL PROTECTION AGENCY

PETITION TO ESTABLISH NATIONAL POLLUTION LIMITS FOR GREENHOUSE GASES PURSUANT TO THE CLEAN AIR ACT



Smokestacks by Phillip J. Redman, USGS; polar bear © Thomas D. Mangelsen/Imagesofnaturestock.com; Times Square © Shadia Fayne Wood

Center for Biological Diversity
350.org
Petitioners

December 2, 2009

EXECUTIVE SUMMARY

As atmospheric carbon dioxide levels approach 390 parts per million (ppm), the consequent effects of global warming are becoming ever more apparent. Severe droughts and heat waves, extreme weather events, and other climate disruptions are leaving more than 300,000 people dead per year. Arctic sea ice loss, bleaching of coral reefs, and species extinctions are mounting. At this moment, there can be no reasonable dispute that greenhouse gases endanger public health and welfare and that concentrations of carbon dioxide and other greenhouse gases in the atmosphere already exceed safe levels. Indeed, the Environmental Protection Agency (EPA) concluded in April 2009 that “[t]he evidence points ineluctably to the conclusion that climate change is upon us as a result of greenhouse gas emissions, that climate changes are already occurring that harm our health and welfare, and that the effects will only worsen over time in the absence of regulatory action.”¹

Through this Petition, the Center for Biological Diversity and 350.org request that the EPA do what the science dictates and the law requires: take necessary regulatory action to control greenhouse gas emissions. As a matter of both law and science, EPA must recognize that carbon dioxide and other greenhouse gases are reasonably anticipated to endanger public health and welfare. Accordingly, Petitioners request that EPA declare carbon dioxide a “criteria” air pollutant pursuant to the Clean Air Act and set a national pollution limit (National Ambient Air Quality Standard, or NAAQS) for carbon dioxide at no greater than 350 ppm—a level that accurately reflects the most recent scientific knowledge. Petitioners further request that EPA similarly designate other greenhouse gases as criteria pollutants and establish pollution caps for those gases at science-based levels.

Under the Clean Air Act, the Obama administration and the EPA have not only the authority, but also the clear legal duty, to take such action as is necessary to set the United States on a course towards reducing atmospheric carbon dioxide concentrations below dangerous levels. Designating carbon dioxide and other greenhouse gases as criteria pollutants and setting appropriate science-based national pollution limits for each such pollutant are essential components of this process.

The Clean Air Act provides the tools necessary for the U.S. to commit to the deep and rapid greenhouse emissions reductions—on the order of 45% or more below 1990 levels by 2020—needed to avert the worst impacts of climate change. National pollution caps for greenhouse gases under the Clean Air Act would provide a scientific benchmark to guide all national climate policy. These national pollution caps also would serve as the basis for development of emissions reduction trajectories to achieve those limits. Those reductions would then be implemented by the states through updates of their existing “state implementation plans.” Because the existing Clean Air Act not only facilitates but requires such efforts, the Obama administration need not gamble on whether Congress will pass new climate legislation, but rather should move quickly to commit to such reductions in the international climate negotiations of the United Nations Framework Convention on Climate Change.

¹ The Proposed Endangerment and Cause or Contribute Findings for Greenhouse Gases under Section 202(a) of the Clean Air Act, 74 Fed. Reg. 18886, 19904 (April 24, 2009).

Establishing science-based national pollution caps for greenhouse gases would rely on the heart of the Clean Air Act—a set of comprehensive and complementary provisions already proven effective in controlling air pollution from most major sources in the U.S. This petition seeks action under Clean Air Act sections 108-110 (42 U.S.C. §§ 7408-7410), which govern designation of criteria air pollutants, establishment of national air pollution limits (NAAQS), and coordination of state implementation planning. Section 108 (42 U.S.C. § 7408) requires EPA to make a list of air pollutants emitted by many or diverse sources that cause or contribute to air pollution that may reasonably be anticipated to endanger public health or welfare. Within 12 months of adding a pollutant to the list, the EPA must issue air quality “criteria” that specify the pollutant’s known effects on the public health and welfare, and “accurately reflect the latest scientific knowledge.”² Upon issuance of these criteria, EPA also must set a national pollution limit sufficient to protect the public health and welfare, pursuant to section 109 (42 U.S.C. § 7409). Under section 110 (42 U.S.C. § 7410), each state must develop and implement a state implementation plan to meet the national pollution limit through enforceable emissions controls for pollution sources within that state. Other complementary provisions of the statute aid the states in meeting the national pollution limit through additional requirements for stationary and mobile pollution sources.

The Clean Air Act’s state implementation program is a vital component of a comprehensive and cost-effective strategy to significantly reduce greenhouse gases. State implementation plans describe how each state will implement, maintain, and enforce existing national pollutant limits in a manner that allows each state to take its own emissions profile and industry needs into account. States have long-standing experience in reducing existing criteria pollutants through the state implementation plan process.

Indeed, through independent processes, many states already have taken several of the steps necessary for greenhouse gas-related state implementation planning. As of August 2009, at least forty-seven states have completed or are completing a greenhouse gas inventory, thirty-eight are drafting or have drafted climate action plans, and twenty-three states have adopted emissions reduction targets.³ Many of these programs achieve progress in areas not typically covered under federal programs, including land use regulation, local building codes, density patterns of development and transportation infrastructure, and the regulation of agriculture, forestry and non-hazardous waste handling, activities which together account for a significant share of total U.S. greenhouse gas emissions. The state implementation planning process will leverage such state emission control efforts by adding a common, science-based greenhouse gas pollution limit, providing technical information and assistance, ensuring consistency among states, and addressing interstate leakage concerns by requiring the participation of those states that have yet to take action—all while retaining maximum local implementation flexibility. State implementation plans will serve to integrate rapidly expanding state and local climate change programs into a comprehensive and efficient national effort.

² Clean Air Act § 108, 42 U.S.C. § 7408(a)(2). The criteria pollutants listed to date are particle pollution (PM), ground-level ozone (O₃), carbon monoxide (CO), sulfur oxides (SO_x), nitrogen oxides (NO_x), and lead.

³ U.S. Env’tl. Prot. Agency, State and Local Governments, State Planning and Measurement, http://www.epa.gov/climatechange/wycd/stateandlocalgov/state_planning.html#three (last visited Dec. 1, 2009); Pew Ctr. on Global Climate Change, U.S. Climate Policy Maps, http://www.pewclimate.org/what_s_being_done/in_the_states/state_action_maps.cfm (last visited Dec. 1, 2009).

Moreover, a national pollution limit for greenhouse gases will effectively guide both the Clean Air Act's other pollution reduction programs and other complementary efforts that may be initiated through new legislation. Informed by a science-based national pollution limit, the Clean Air Act's other successful pollution reduction programs, such as new source review, new source performance standards, and greenhouse gas reduction rules for automobiles and other mobile pollution sources, will provide the essential blueprint for the United States' greenhouse gas reduction efforts.

Climate change obviously poses global problems. Yet these problems cannot be solved unless each nation limits its own emissions sufficiently to achieve its share of the reductions necessary to stabilize atmospheric greenhouse gas concentrations below dangerous levels. With the Clean Air Act, the Obama administration and the EPA already have in their grasp a set of uniquely effective tools to reach this goal: existing and robust legal authority to set national pollution limits for greenhouse gases and to facilitate preparation of state implementation plans that will move toward attainment of those limits.

For these reasons, Petitioners Center for Biological Diversity and 350.org, pursuant to the Clean Air Act, 42 U.S.C. §§ 7401 et seq., its implementing regulations, and the Administrative Procedures Act, 5 U.S.C. § 553(e), hereby request that the Administrator of the Environmental Protection Agency (hereinafter "Administrator," or "EPA") regulate the following long-lived greenhouse gases pursuant to Clean Air Act Sections 108-110 (42 U.S.C. §§ 7408-7410):

- Carbon dioxide (CO₂);
- Methane (CH₄);
- Nitrous oxide (N₂O);
- Hydrofluorocarbons (HFCs)⁴;
- Perfluorocarbons (PFCs);
- Sulfur hexafluoride (SF₆); and
- Nitrogen trifluoride (NF₃).

Specifically, Petitioners request that the EPA complete the following actions:

(1) Pursuant to Clean Air Act section 108(a)(1) (42 U.S.C. § 7408(a)(1)): promptly revise the list of pollutants which may reasonably be anticipated to endanger public health or welfare to include the greenhouse gases;

(2) Pursuant to Clean Air Act section 108(a)(2) (42 U.S.C. § 7408(a)(2)): expeditiously (but in no event later than 12 months from the revision of section 108(a)(1) list) issue air quality criteria for the greenhouse gases;

(3) Pursuant to Clean Air Act section 109(a) (42 U.S.C. § 7409(a)): publish, simultaneously with the air quality criteria described above, proposed national primary and

⁴ Petitioners seek regulation of all HFCs and PFCs for which either significant concentrations or large trends in concentrations have been observed or a clear potential for future emissions has been identified. Appendix A provides a complete list of the petitioned HFCs and PFCs.

secondary pollution caps (national ambient air quality standards, or NAAQS) for the greenhouse gases in order to protect the public health and welfare, and finalize the pollution caps no later than 90 days from the initial publication;

(4) Pursuant to Clean Air Act sections 108 & 108(f) (42 U.S.C. §§ 7408 & 7408(f)): expeditiously make available information on processes, procedures, and methods to reduce or control pollutants of the greenhouse gases in transportation, from other mobile sources, and to protect the health of sensitive individuals and groups pursuant to section 108(f), and carry out all of the other related actions specified in section 108;

(5) Pursuant to Clean Air Act section 108(b)(1) (42 U.S.C. § 7408(b)(1)): simultaneously with the issuance of the air quality criteria above, issue information on air pollution control techniques for the greenhouse gases;

(6) Pursuant to Clean Air Act section 110 (42 U.S.C. § 7410): expeditiously facilitate and aid the states in the state implementation plan process.

In short, the Clean Air Act already contains the comprehensive, science-based, flexible, and immediately available tools necessary to address the climate crisis. For four decades, the Clean Air Act has vastly improved air quality and reduced pollution levels, saved lives and provided health and economic benefits worth many times the cost of the pollution reductions. The Clean Air Act is one of the most efficient and successful environmental laws ever devised, and its science and technology-based mechanisms are time-tested and well understood by both industry and state and federal agencies throughout the nation. This comprehensive, yet flexible and cooperative, pollution reduction system is well-suited to combat the greatest environmental crisis the modern world has faced—global warming caused by greenhouse gas emissions. The Obama administration can and must begin using its authority under the Clean Air Act towards this end.

TABLE OF CONTENTS

EXECUTIVE SUMMARY	i
NOTICE OF PETITION.....	vi
I. Statutory Authority and Actions Requested	vi
II. Petitioners	vii
INTRODUCTION AND OVERVIEW OF THE CLEAN AIR ACT	1
I. The Clean Air Act: Background and Structure.....	1
II. Benefits from Past Regulation Under the Clean Air Act Vastly Outweigh the Costs	3
III. The Clean Air Act Is a Highly Cost-Effective Tool to Regulate Greenhouse Gases from All Major Sources in the U.S.	5
ARGUMENT IN SUPPORT OF PETITIONED ACTIONS	7
I. EPA Must Issue an Endangerment Finding for Greenhouse Gas Emissions Pursuant to Section 108.....	7
A. The Section 108 Endangerment Finding.....	7
B. Data Sources and Climate Scenarios	8
C. EPA Must Find Under Section 108(a) that Greenhouse Gas Emissions Cause or Contribute to Air Pollution Which Endangers Public Health and Welfare, As EPA Has Already Determined Under Section 202(a)	10
D. Because All Prongs of Section 108(a)(1) Are Satisfied, EPA Must Expeditiously Designate Greenhouse Gases as Criteria Air Pollutants	15
E. EPA Must Comply with the other Mandatory Requirements of Section 108.....	15
II. EPA Must Establish Science-Based National Pollution Caps to Protect the Public Health and Welfare	16
A. Pollutants Subject to this Petition	17
B. The Latest Scientific Knowledge Supports a National Pollution Limit for Carbon Dioxide of No More than 350 Parts per Million.....	19
C. Pollution Limits for the Other Petitioned Pollutants.....	24
III. EPA Must Expeditiously Facilitate the State Implementation Planning Process	27
A. Overview of the State Implementation Planning Process.....	27
B. State Implementation Plans are Well Suited to Reducing Greenhouse Gas Emissions	28
C. The Substantial Benefits of State Implementation Planning for Greenhouse Gases	30
TIMELINE FOR PETITIONED ACTIONS	33
CONCLUSION.....	35
LITERATURE CITED	36
APPENDIX A: PETITIONED POLLUTANTS.....	40

NOTICE OF PETITION

I. Statutory Authority and Actions Requested

Pursuant to the Clean Air Act, 42 U.S.C. §§ 7401 et seq., its implementing regulations, and the Administrative Procedures Act, 5 U.S.C. § 553(e), Petitioners Center for Biological Diversity and 350.org hereby request that the Administrator of the Environmental Protection Agency take the actions described herein with respect to the following long-lived greenhouse gases:

- Carbon dioxide (CO₂);
- Methane (CH₄);
- Nitrous oxide (N₂O);
- Hydrofluorocarbons (HFCs)⁵;
- Perfluorocarbons (PFCs);
- Sulfur hexafluoride (SF₆); and
- Nitrogen trifluoride (NF₃).

The specific actions requested with regard to the five greenhouse gases and two categories of greenhouse gases which are the subject of this petition are as follows:

(1) Pursuant to Clean Air Act section 108(a)(1) (42 U.S.C. § 7408(a)(1)): promptly revise the list of pollutants which may reasonably be anticipated to endanger public health or welfare to include the greenhouse gases;

(2) Pursuant to Clean Air Act section 108(a)(2) (42 U.S.C. § 7408(a)(2)): expeditiously (but in no event later than 12 months from the revision of section 108(a)(1) list) issue air quality criteria for the greenhouse gases;

(3) Pursuant to Clean Air Act section 109(a) (42 U.S.C. § 7409(a)): publish, simultaneously with the air quality criteria described above, proposed national pollution caps (national primary and secondary ambient air quality standards) for the greenhouse gases in order to protect the public health and welfare, and issue final pollution caps no later than 90 days from the initial publication;

(4) Pursuant to Clean Air Act sections 108 & 108(f) (42 U.S.C. §§ 7408 & 7408(f)): expeditiously make available information on processes, procedures, and methods to reduce or control pollutants of the greenhouse gases in transportation, from other mobile sources, and to protect the health of sensitive individuals and groups pursuant to section 108(f), and carry out all of the other related actions specified in section 108;

⁵ Petitioners seek regulation of all HFCs and PFCs for which either significant concentrations or large trends in concentrations have been observed or a clear potential for future emissions has been identified. Appendix A provides a complete list of the petitioned HFCs and PFCs.

(5) Pursuant to Clean Air Act section 108(b)(1) (42 U.S.C. § 7408(b)(1)): simultaneously with the issuance of the air quality criteria described above, issue information on air pollution control techniques for the greenhouse gases;

(6) Pursuant to Clean Air Act section 110 (42 U.S.C. § 7410): expeditiously facilitate and aid the states in the State Implementation Plan process.

Pursuant to the Administrative Procedure Act, 5 U.S.C. § 553(e), and the Clean Air Act, 42 U.S.C. §§ 7401 et seq., petitioners file this petition and respectfully request that EPA undertake these mandatory duties. This petition places definite response requirements on the EPA. The scientific basis for the requested actions is set forth fully in the petition and the literature cited herein.

II. Petitioners

The Center for Biological Diversity works through science, law, and creative media to secure a future for all species, great or small, hovering on the brink of extinction. The Center's Climate Law Institute develops and implements legal campaigns to limit global warming pollution and prevent it from driving species extinct. The Center has over 225,000 members and online activists with a vital interest in the immediate reduction of greenhouse gas pollution under the Clean Air Act as one of the primary solutions to the climate crisis. www.biologicaldiversity.org

350.org is an international campaign dedicated to building a movement to unite the world around solutions to the climate crisis--the solutions that science and justice demand. Their focus is on the number 350--as in parts per million, the level scientists have identified as the safe upper limit for CO₂ in our atmosphere. On October 24, 2009, 350.org organized the most widespread day of environmental action in the planet's history, when people in 181 countries at over 5,200 events gathered to call for action on the climate crisis. www.350.org

Contact:

Kassie Siegel
Director, Climate Law Institute
Center for Biological Diversity
(760) 366-2232 x302
ksiegel@biologicaldiversity.org

William J. Snape, III
Senior Counsel
Center for Biological Diversity
(202) 536-9351
bsnape@biologicaldiversity.org

INTRODUCTION AND OVERVIEW OF THE CLEAN AIR ACT

I. The Clean Air Act: Background and Structure

The Clean Air Act is one of the nation's and the world's most important and successful environmental laws. Enacted in 1970 in response to growing environmental awareness, the Clean Air Act uses a variety of complementary pollution control mechanisms, as well as combined federal-state action termed "cooperative federalism,"⁶ to reduce pollution from all sectors of the U.S. economy. The Act's far-reaching and effective pollution reduction mechanisms have substantially improved air quality and public health over the past four decades even though the American economy has expanded dramatically at the same time.

The Clean Air Act today consists of six titles which provide comprehensive, and in many cases overlapping and complementary, provisions to control pollution from most major sources in the U.S. Title I of the Clean Air Act addresses air pollution from stationary sources.⁷ The program established by sections 108-110 (42 U.S.C. §§ 7408-7410) dealing with criteria air pollutants, national air pollution limits (national ambient air quality standards, or NAAQS), and state implementation planning is in many ways the heart of the modern law. Section 108 (42 U.S.C. § 7408) requires EPA to list air pollutants emitted by many or diverse sources that cause or contribute to air pollution that may reasonably be anticipated to endanger public health or welfare. Within 12 months of adding a pollutant to the list, the EPA must issue air quality criteria which specify the known effects on the public health and welfare from each such pollutant. The criteria pollutants listed to date are particle pollution (PM), ground-level ozone (O₃), carbon monoxide (CO), sulfur oxides (SO_x), nitrogen oxides (NO_x), and lead. For each criteria pollutant, EPA must set a national pollution limit as necessary to protect the public health and welfare, pursuant to Section 109 (42 U.S.C. § 7409). Under section 110 (42 U.S.C. § 7410), each state must develop and implement a state implementation plan to meet the national pollution limit through enforceable emissions controls for pollution sources within that state. Other complementary provisions of the statute aid the states in meeting the national pollution limit through additional requirements for stationary and mobile pollution sources.

Under section 111 (42 U.S.C. § 7411), EPA must set new source performance standards for major categories of new and modified stationary pollution sources. EPA sets new source performance standards for both criteria and non-criteria pollutants. While the new source review program (discussed below) relies upon site-specific and individual permit review, the new source performance standards set a threshold level for emissions which a prevention of significant deterioration permit must meet or exceed. Once a new source performance standard has been established for a new and/or modified source, the states must set standards for existing sources in each category, except for criteria pollutants and hazardous air pollutants regulated pursuant to section 112 (42 U.S.C. § 7412).

⁶ See, e.g., Holly Doremus & W. Michael Hanemann, *Of Babies and Bathwater, Why the Clean Air Act's Cooperative Federalism Framework Is Useful for Addressing Global Warming*, 50 ARIZ. L. REV. 799, 827-28 (2008).

⁷ See generally DAVID R. WOOLEY & ELIZABETH M. MORSS, *THE CLEAN AIR ACT HANDBOOK* (Thompson West ed., 8th ed. 2008) (for further background on the Clean Air Act).

Section 112 (42 U.S.C. § 7412) requires EPA to list and issue national emissions standards for hazardous air pollutants (HAPs) from stationary sources. The Act contains low thresholds for these air toxics, defined as any pollutant that presents or may present a threat of adverse human or environmental effects, including carcinogenic, mutagenic, neurotoxic and acutely or chronically toxic substances.

The new source review program provides controls for new major sources or modifications of major sources of pollution in order to meet the national pollution caps, and is made up of two sub-programs, prevention of significant deterioration and non-attainment new source review. The prevention of significant deterioration program is designed to prevent new and modified sources from degrading air quality in areas where the air is clean enough to fall within the national pollution limits, known as “attainment areas.” This program, found in Clean Air Act sections 7470-7492, requires all new and modified stationary sources to undergo a preconstruction permitting process and to install best available control technology for each pollutant otherwise subject to regulation under the Act. The second new source review sub-program, known as “non attainment new source review,” provides similar but more ambitious permitting requirements for sources in areas where the national pollution limits are not being met, termed “non-attainment areas.”

Title II of the Clean Air Act requires EPA to regulate mobile sources of air pollution, including passenger vehicles pursuant to section 202 (42 U.S.C. § 7521), ships and non-road vehicles pursuant to section 213 (42 U.S.C. § 7547), and aircraft pursuant to section 231 (42 U.S.C. § 7571). Title II also provides for the regulation of the fuels used to power these mobile sources, and section 211(o) (42 U.S.C. § 7545(o)) establishes the renewable fuels standard program, which requires an increase in the use of renewable fuels with significantly lower lifecycle greenhouse gas emissions than the fossil-fuel based fuels they replace.

Titles III provides general provisions related to reporting on the effectiveness of the act, air quality monitoring, citizen suits, and other matters.

Title IV, established by the 1990 Amendments, added a trading program to control SO₂, a primary acid rain precursor. Under the Title IV program, regulated utilities must hold pollution allowances equal to their total allowed emissions of SO₂, and may meet their reduction obligations either by reducing pollution at their own facility or by buying allowances from other facilities that reduced their pollution below the allowed levels.

Title V, also added by the 1990 Amendments, enhanced the ability of state and federal regulators and citizen groups to monitor compliance with the Act by establishing a new operating permit system. The Title V permitting system requires all new and existing major sources to have an operating permit listing all of the rules and regulations applicable to the facility, and requires permittees to monitor compliance, self-report any violations at least semi-annually, and certify compliance annually.

Title VI requires EPA to take a number of actions to protect the stratosphere, including especially the ozone layer which protects the Earth from harmful UVB radiation. Section 615

(42 U.S.C. § 7671n) provides broad authority to regulate ozone-depleting substances that endanger public health and welfare.

II. Benefits from Past Regulation Under the Clean Air Act Vastly Outweigh the Costs

The Clean Air Act has provided indispensable benefits to this country for more than four decades. Study after study has shown that the substantial improvements in air quality achieved through the Act have not only resulted in enormous public health, ecological, and other benefits, but have also been accomplished so efficiently that the economic value of the benefits exceed by many times the costs of the pollution reduction measures.

Under the 1990 Clean Air Act amendments, Congress required EPA to issue a comprehensive assessment of the Clean Air Act's impact on the "public health, economy, and environment of the United States."⁸ EPA issued the first such report in October 1997, following an extensive and rigorous research and modeling effort.⁹ It found that emissions of SO₂ were 60 percent lower from industrial processes and 40 percent lower from electricity generation, emissions of VOCs 66 percent lower, emissions of NO_x 47 percent lower, emissions of CO 56 percent lower, emissions of PM from electric utilities 93 percent lower, and emissions of PM from industrial processes 76 percent lower in 1990 than they would have been without the Clean Air Act.¹⁰ Emissions of airborne lead had been virtually eliminated.¹¹ EPA modeled the impact of the resulting improvements in air quality on human health, including impacts such as respiratory symptoms, hospital admissions, asthma attacks, and chronic sinusitis from exposure to ozone; mortality, bronchitis, hospital admissions, and lost work days from exposure to PM; hospital admissions for congestive heart failure from exposure to CO; respiratory illness from exposure to NO_x; changes in pulmonary function and respiratory symptoms from exposure to SO₂; and mortality, hypertension, coronary heart disease, strokes, and IQ loss from exposure to lead.¹² EPA also modeled selected welfare effects including changes in crop yields from exposure to ozone, household soiling from PM, and visibility impairment from PM, NO_x and SO₂.¹³

⁸ Clean Air Act § 312, 42 U.S.C. § 7612 (2008) (the review requirements are often referred to as the "section 812" requirements as they were included in section 812 of the 1990 Clean Air Act amendments).

⁹ U.S. ENVTL. PROT. AGENCY, THE BENEFITS AND COSTS OF THE CLEAN AIR ACT: 1970 TO 1990 (1997), *available at* <http://www.epa.gov/air/sect812/copy.html>. EPA conducted the study in consultation with an outside panel of highly qualified experts known as the Advisory Council on Clean Air Act Compliance Analysis organized in 1991 under the auspices of EPA's Science Advisory Board. The study constructed and compared a "no-control scenario," in which federal, state, and local air pollution controls are frozen at the levels of stringency and effectiveness that existed in 1970 to a "control scenario" which assumes that all federal, state, and local rules promulgated pursuant to the Clean Air Act during 1970 to 1990 were implemented. The analysis estimates the differences between the economic and environmental outcomes associated with these two scenarios and brings a level of validity, breadth, and integration that exceeded any effort to that time.

¹⁰ *Id.* at 15-17.

¹¹ *Id.*

¹² *Id.* at 31.

¹³ *Id.* at 32.

EPA concluded that the economic benefits of Clean Air Act implementation, valued in 1990 dollars, range from \$5.6 to \$49.4 trillion with a central estimate of \$22.2 trillion.¹⁴

EPA also analyzed the cost of the pollution reductions by examining changes in patterns of industrial production, capital investment, productivity, consumption, employment, and overall economic growth. Using a 5% discount rate, EPA estimated the total costs of the Clean Air Act regulations to be \$.523 trillion.¹⁵

The economic value of the Act's benefits, therefore, was about 42 times greater than its costs.

More recent analyses have continued to affirm both the effectiveness and efficiency of the Clean Air Act. In 1999 EPA released the first prospective cost-benefit analysis of the 1990 Clean Air Act amendments, and concluded once again that the value of the benefits from the amendments would far exceed the costs. In total EPA estimated that in 2010 the benefits due to the 1990 Amendments would prevent 23,000 Americans from dying prematurely, avert over 1,700,000 incidences of asthma attacks and aggravation of chronic asthma, prevent 67,000 incidences of chronic and acute bronchitis, 91,000 occurrences of shortness of breath, 4,100,000 lost work days, and 31,000,000 days in which Americans would have had to restrict activity due to air pollution related illness, in addition to preventing 22,000 respiratory-related hospital admissions, 42,000 cardiovascular hospital admissions, and 4,800 emergency room visits for asthma.¹⁶ The total value of the health and ecological benefits totaled \$110 billion, as opposed to only about \$27 billion in costs.¹⁷

Thus, early critics who claimed that the Act would be unworkable, too expensive and an unsustainable burden on the American economy have been proven incorrect. "[W]hile industry claims often frame the debate, they are usually exaggerated, not accurate descriptions of the truth but tactics to stop unwanted measures, regardless of the need or merit. Many business interests predicted catastrophe were the [Clean Air Act] enacted. DuPont Chemical warned of 'severe

¹⁴ *Id.* at ES-8. EPA stressed that the monetary quantification method tended to underestimate health and environmental benefits for a number of reasons. First, limitations in air quality modeling prevented comprehensive estimates in changes in air quality. *Id.* at 25-27. Second, a wide variety of beneficial impacts to both health and the environment could not be quantified economically. *Id.* at 30. Third, the valuation of many health effects included economic costs such as physician visits, medications costs, and lost work time, but excluded the value of what one would be willing to pay to avoid the associated pain and suffering and thus, the valuations almost certainly represent lower-bound estimates for these impacts. Moreover, many recent studies show that exposure to air pollution, particularly ozone and particulate matter, is actually far more dangerous and deadly than previously thought, again tending to show that the major EPA reports of the past decade almost certainly have *underestimated* the Act's benefits.

¹⁵ *Id.* at ES-8.

¹⁶ U.S. ENVTL. PROT. AGENCY, THE BENEFITS AND COSTS OF THE CLEAN AIR ACT: 1990 TO 2010 60-61 (1999), available at <http://www.epa.gov/air/sect812/1990-2010/fullrept.pdf>; see also Press Release, U.S. Env'tl. Prot. Agency, The Benefits and Costs of the Clean Air Act, First Protective Study (Nov. 16, 1999), <http://www.epa.gov/air/sect812/r-140.html> (last visited Dec. 1, 2009).

¹⁷ U.S. ENVTL. PROT. AGENCY, *supra* note 16, at iii-iv.

economic and social disruption,’ and Mobil ‘severe supply chain disruptions’ for gasoline. But no one rioted, the economy grew, and Americans never had a problem filling up their tanks.”¹⁸

III. The Clean Air Act Is a Highly Cost-Effective Tool to Regulate Greenhouse Gases from All Major Sources in the U.S.

Despite these lessons of the past, naysayers continue to claim that regulation of greenhouse gases under the Clean Air Act is unworkable or inappropriate. They argue that the Clean Air Act is “broken,” unsuitable to the regulation of greenhouse gases, or that regulation will be too expensive.¹⁹ These arguments, however, are unsupported and contradicted by EPA’s data and analysis, and are no more correct today than they were when the Clean Air Act was first enacted.

Initially, it should be noted that most of the industries that will be affected by greenhouse gas controls are already regulated under the Clean Air Act to control other pollutants they emit; as a result, the application of the same general procedures to limit emissions of another set of pollutants will result in fewer additional costs.²⁰ Moreover, regardless of start-up or ongoing regulatory costs, a robust economics literature demonstrates that greenhouse pollution reduction will have a net economic benefit. The Stern Review of the Economics of Climate Change, a comprehensive report commissioned by the British government, concluded that allowing current greenhouse gas emissions trajectories to continue unabated would cost the global economy between 5 to 20 percent of Gross Domestic Product (GDP) each year within a decade, or up to \$7 trillion per year, and warned that these figures should be considered conservative estimates.²¹ By contrast, measures to mitigate global warming by reducing emissions were estimated to cost about one percent of global GDP each year, and could save the world up to \$2.5 trillion per

¹⁸ HENRY WAXMAN WITH JOSHUA GREEN, *THE WAXMAN REPORT: HOW CONGRESS REALLY WORKS* 101-102 (Twelve/Grand Central Publishing 2009).

¹⁹ *See, e.g.*, Advance Notice of Proposed Rulemaking Regulating Greenhouse Gas Emissions Under the Clean Air Act, Proposed Rule, 73 Fed. Reg. 44354, 44356 (July 30, 2008).

²⁰ As EPA also noted, “[t]he electricity generation, transportation and industrial sectors, the three largest contributors to GHG emission in the U.S., are subject to Clean Air Act controls to help meet national ambient air quality standards, control acid rain, and reduce exposures to toxic emissions.” *Id.* at 44407. For example, coal-fired power plants must already comply with emissions limits applicable to nitrous oxides, sulfur dioxides and other pollutants, and they must purchase and maintain equipment to monitor their emissions. *See, e.g.*, Standards of Performance for Electric Utility Steam Generating Units, 74 Fed. Reg. 5072 (Jan. 28, 2009) (to be codified at 40 C.F.R. Part 60). Similarly, dry cleaning plants, sometimes invoked as an example of an industry that could not financially withstand greenhouse emission controls, have long been regulated to reduce pollutants they create but have found innovative ways to perform their services while reducing that pollution. *See, e.g.*, Standards of Performance for New Stationary Sources; Perchloroethylene Dry Cleaners, 45 Fed. Reg. 78174 (Nov. 25, 1980) (to be codified at 40 CFR Part 60). In any event, sources emitting less than 25,000 tons of CO₂eq per year will not initially be required to obtain prevention of significant deterioration, non-attainment or Title V permits under EPA’s proposed Prevention of Significant Deterioration and Title V Greenhouse Gas Tailoring Rule, 74 Fed. Reg. 55292 (Oct. 27, 2009) (to be codified at 40 CFR Parts 51, 52, 70, and 71) (hereinafter referred to as “the Tailoring Rule”). A national pollution cap for greenhouse gases will invoke the same basic mechanisms for pollution reduction. The application of already existing and well-understood Clean Air Act pollution control processes to another set of pollutants – greenhouse gases – will thus involve fewer start-up costs and create fewer inefficiencies than those experienced during the initial implementation of the Clean Air Act, or those that would attend the implementation of a different, unproven set of regulations.

²¹ SIR NICHOLAS STERN, *STERN REVIEW ON THE ECONOMICS OF CLIMATE CHANGE* (Cambridge University Press 2006), *available at* <http://www.sternreview.org.uk>.

year.²² If no action to control emissions is taken, each ton of carbon dioxide emitted today is causing societal damage worth at least \$85.²³ Thus economic analysis demonstrates convincingly that nothing could be more costly than continued “business-as-usual” greenhouse gas emissions, while greenhouse gas pollution reduction measures will produce vast economic benefits.

A recent survey of leading economists confirmed the weight of the economic argument for action: 84% of respondents agreed or strongly agreed that “the environmental effects of greenhouse gas emissions, as described by leading scientific experts, create significant risks to important sectors of the United States and global economies.” Seventy-five percent agreed or strongly agreed that “uncertainty associated with the environmental and economic effects of greenhouse gas emissions increases the value of emission controls, assuming some level of risk-aversion.” And 57% believed that the U.S. government should commit to greenhouse gas reductions “regardless of the actions of other countries.”²⁴

Thus, despite the fact that cost benefit analysis tends to understate the true benefits of protecting the air we breathe, the water we drink, and the food we eat²⁵, even this method demonstrates the cost effectiveness of greenhouse pollution reduction measures.

The actions requested in this petition are consistent with and additive to EPA’s multiple existing obligations to regulate greenhouse gases under the Clean Air Act pursuant to other rulemakings and proceedings. These obligations include, but are not limited to the following:

- The obligation to immediately finalize the proposed Endangerment Finding and begin regulating greenhouse gas emissions from motor vehicles pursuant to Clean Air Act Section 202.
- The obligation to immediately issue an endangerment finding and begin regulating GHG emissions from ships and off-road engines pursuant to Clean Air Act section 213.
- The obligation to immediately issue an endangerment finding and begin regulating greenhouse gas emissions from aircraft pursuant to Clean Air Act section 231.
- The obligation to update existing New Source Pollution Standards, and issue new standards, as necessary to include limits and reduction measures for greenhouse gases pursuant to Clean Air Act section 111.

²² *Id.*

²³ *Id.*

²⁴ J. SCOTT HOLLADAY ET AL., NEW YORK UNIV. SCH. OF LAW INST. FOR POLICY INTEGRITY, ECONOMISTS AND CLIMATE CHANGE, CONSENSUS AND OPEN QUESTIONS (2009), *available at* <http://www.policyintegrity.org/publications/index.html>.

²⁵ *See, e.g.,* RENA STEINZOR ET AL., CTR. FOR PROGRESSIVE REFORM, A RETURN TO COMMON SENSE: PROTECTING HEALTH, SAFETY, AND THE ENVIRONMENT THROUGH “PRAGMATIC REGULATORY IMPACT ANALYSIS” (2009), *available at* <http://www.progressivereform.org/whitePapers.cfm>.

- The obligation to immediately begin regulating greenhouse gases pursuant to the New Source Review program.

ARGUMENT IN SUPPORT OF PETITIONED ACTIONS

I. EPA Must Issue an Endangerment Finding for Greenhouse Gas Emissions Pursuant to Section 108

The program established by sections 108-110 (42 U.S.C. §§ 7408-410) is designed to work in a complementary and additive manner with many of the Act's other provisions. Section 108 (42 U.S.C. § 4708) requires EPA to list air pollutants that are emitted by many sources and that cause or contribute to air pollution problems. Within 12 months of adding a pollutant to the list, EPA must issue air quality criteria which specify all of its known effects on the public health and welfare. EPA is then required to set national pollution caps (national ambient air quality standards, or NAAQS) for each such "criteria pollutant" as necessary to protect the public health and welfare, pursuant to section 109 (42 U.S.C. § 4709). Under section 110 (42 U.S.C. § 4710), each state must develop and implement a state implementation plan to meet the national pollution cap through enforceable emissions controls for pollution sources within the state. Other complementary provisions aid the states in meeting the national pollution cap through additional requirements for stationary and mobile pollution sources.

This national pollutant cap program is among the most successful programs established by the Clean Air Act and has a proven record of accomplishment in effectively dealing with complex air pollution problems that implicate a multitude of sources and a wide range of economic activities. Through their previous experience with the state implementation plans for other criteria pollutants, states have significant expertise with the national pollution caps and have effectively utilized state implementation plans to regulate those pollutants. The substantial knowledge, experience and capacity that currently exist can and must be put to use to address greenhouse gases.

A. The Section 108 Endangerment Finding

Section 108(a)(1) (42 U.S.C. § 4708(a)(1)) establishes the threshold test for listing criteria air pollutants:

(1) For the purpose of establishing national primary and secondary ambient air quality standards [national pollution caps] the Administrator shall within 30 days after December 31, 1970, publish, and shall from time to time thereafter revise, a list which includes each air pollutant –

(A) emissions of which, in his judgment, cause or contribute to air pollution which may reasonably be anticipated to endanger public health or welfare;

(B) the presence of which in the ambient air results from numerous or diverse mobile or stationary sources; and

(C) for which air quality criteria had not been issued before December 31, 1970, but for which he plans to issue air quality criteria under this section.

The finding under section 108(a)(1)(A) (42 U.S.C. § 4708(a)(1)(A)) is known as the “endangerment finding.” In its proposed Endangerment Finding for greenhouse gas emissions from automobiles under section 2002, EPA has already concluded that greenhouse gas emissions endanger public health and welfare. And as discussed in section I.D., below, because the test’s subparts (B) and (C) have also been met, the EPA must promptly designate the greenhouse gases as criteria air pollutants as requested herein.

B. Data Sources and Climate Scenarios

EPA currently has more than sufficient information and analysis to issue the endangerment finding required by section 108 (42 U.S.C. § 4708). Much of this information is discussed in the proposed Endangerment Finding and the supporting documents in Docket OAR-2009-0171, the Advance Notice of Proposed Rulemaking and Docket OAR-2008-0318, and the Supreme Court’s decision in *Massachusetts v. EPA*. This combined record contains more than enough evidence of the threat greenhouse gases pose to public health and welfare, and indeed compels EPA to make the Section 108 endangerment finding petitioned here immediately.

Authoritative synthesis reports and data sources which should form the foundation of the Section 108 endangerment finding include but are not limited to the following:

- The Proposed Endangerment and Cause or Contribute Findings for Greenhouse Gases under Section 202(a) of the Clean Air Act, 74 Fed. Reg. 18886 (April 24, 2009) (hereinafter proposed Endangerment Finding);
- The Technical Support Document for the Proposed Endangerment and Cause or Contribute Findings for Greenhouse Gases under Section 202(a) of the Clean Air Act (April 17, 2009), Docket No. OAR-2009-0171;
- The 2007 Fourth Assessment Report of the Intergovernmental Panel on Climate Change (“IPCC AR4”);²⁶

²⁶ The IPCC was established by the World Meteorological Organization and the United Nations Environment Programme in 1988 to assess available scientific and socio-economic information on climate change and its impacts and the options for mitigating climate change and to provide, on request, scientific and technical advice to the Conference of the Parties to the United Nations Framework Convention on Climate Change. Since 1990, the IPCC has produced a series of reports, papers, methodologies, and other products that have become the standard works of reference on climate change. The *Fourth Assessment Report* (AR4), cited as supporting evidence in the proposed Endangerment Finding, is the most current comprehensive IPCC reference and has built and expanded upon the IPCC’s past products. Thousands of the world’s top scientists and hundreds of coordinating lead authors contributed to the AR4, which also underwent a painstaking review process in which every comment received was addressed. Each Summary for Policymakers in IPCC documents, including the AR4, is approved line-by-line, and the PETITION TO ESTABLISH NATIONAL POLLUTION LIMITS FOR GREENHOUSE GASES
DECEMBER 2, 2009
PAGE 8

- An updated report prepared by the Climate Change Research Centre at the University of New South Wales, synthesizing peer-reviewed scientific articles published since the release of IPCC AR4;²⁷
- The Synthesis and Assessment Products of the U.S. Global Change Research Program (formerly the Climate Change Science Program);²⁸
- National Research Council (“NRC”) reports under the U.S. National Academy of Sciences (“NAS”);²⁹
- The Arctic Climate Impact Assessment (“ACIA”);³⁰

underlying chapters are then accepted, by government delegations in formal plenary sessions. The AR4 represents an extraordinary and unprecedented level of scientific effort and coordination, but is also therefore a highly conservative consensus document. Further information about the IPCC process and reports is available at <http://www.ipcc.ch/about/procd.htm>.

²⁷ I. ALLISON ET AL., THE COPENHAGEN DIAGNOSIS 2009: UPDATING THE WORLD ON THE LATEST CLIMATE SCIENCE (2009), available at <http://copenhagendiagnosis.org/>.

²⁸ Pursuant to the requirements of the Global Change Research Act of 1990, 15 U.S.C. §§ 2921-2961 (“GCRA”), the Global Change Research Program (GCRP) is charged with preparing a scientific assessment of climate change impacts in the United States which must be used by all federal agencies in decisions which implicate greenhouse gas emissions and global warming. The GCRP released the most recent scientific assessment on May 29, 2008 (*Scientific Assessment of the Effects of Global Change on the United States*). The GCRP has also identified 21 synthesis and assessment products (SAPs) that address what it has identified as the highest priorities for U.S. climate change research, observation and decision-support needs; EPA is the designated lead for three of the six SAPs addressing impacts and adaptation. The EPA utilized those SAPs that were available at the time the endangerment TSD was drafted. In each Clean Air Act endangerment finding, the EPA must utilize the most recent GCRP synthesis documents, which are available at <http://www.globalchange.gov/>. The EPA did so in the proposed Endangerment Finding, 74 Fed. Reg. 18894. The GCRP, recently released an updated report on climate impacts in the United States that integrates existing SAPs with new peer-reviewed science. See U.S. GLOBAL CHANGE RESEARCH PROGRAM, GLOBAL CLIMATE CHANGE IMPACTS IN THE UNITED STATES (2009), available at www.globalchange.gov/usimpacts.

²⁹ As the EPA has noted, “[t]he National Research Council (NRC) is part of the National Academies, which also comprise the National Academy of Sciences, National Academy of Engineering and Institute of Medicine. They are private, nonprofit institutions that provide science, technology and health policy advice under a congressional charter. The NRC has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in providing services to the government, the public and the scientific and engineering communities. Federal agencies are the primary financial sponsors of the Academies’ work. The Academies provide independent advice; the external sponsors have no control over the conduct of a study once the statement of task and budget are finalized. The NRC 2001 study, *Climate Change Science: An Analysis of Some Key Questions*, originated from a White House request. The NRC 2001 study, *Global Air Quality: An Imperative for Long-Term Observational Strategies*, was supported by EPA and NASA. The NRC 2004 study, *Air Quality Management in the United States*, was supported by EPA. The NRC 2005 study, *Radiative Forcing of Climate Change: Expanding the Concept and Addressing Uncertainties*, was in response to a CCSP request, and supported by NOAA. The NRC 2006 study, *Surface Temperature Reconstructions for the Last 2,000 Years*, was requested by the Science Committee of the U.S. House of Representatives. Each NRC report is authored by its own committee of experts, reviewed by outside experts, and approved by the Governing Board of the NRC.” Endangerment Technical Support Document at 3.

³⁰ The Arctic Council is a high-level intergovernmental forum that addresses the common concerns and challenges faced by the Arctic people and governments of the eight Arctic nations – Canada, Denmark/Greenland/Faroe Islands, Finland, Iceland, Norway, Russia, Sweden, and the United States, as well as six Indigenous Peoples organizations – Aleut International Association, Arctic Athabaskan Council, Gwich’in Council International, Inuit PETITION TO ESTABLISH NATIONAL POLLUTION LIMITS FOR GREENHOUSE GASES

DECEMBER 2, 2009

PAGE 9

- The Global Humanitarian Forum’s Human Impact Report Climate Change;³¹
- Climate Change Futures: Health, Ecological, and Economic dimensions, a report of the Center for Health and the Global Environment, Harvard Medical School;³²
- EPA annual report on U.S. greenhouse gas emission inventories.

The proposed Endangerment Finding lists some of the overwhelming evidence supporting a finding of endangerment. Because the proposed Endangerment Finding conclusions compel the same action under Section 108(a) (42 U.S.C. § 4708(a)), they are summarized in Section C below. The following discussion of basic climate change concepts and scenarios is included to clarify the context of the proposed endangerment finding.

C. EPA Must Find Under Section 108(a) that Greenhouse Gas Emissions Cause or Contribute to Air Pollution Which Endangers Public Health and Welfare, As EPA Has Already Determined Under Section 202(a)

Under Section 108(a) (42 U.S.C. § 4708(a)), EPA must set a national pollution cap for greenhouse gases if it finds that greenhouse gases are air pollutants which cause or contribute to air pollution which may “reasonably be anticipated to endanger public health or welfare.” The Clean Air Act defines “welfare” as referring to effects including, but not limited to, “effects on soils, water, crops, vegetation, man-made materials, animals, wildlife, weather, visibility, and climate, damage to and deterioration of property, and hazards to transportation, as well as effects on economic values and on personal comfort and well-being.”³³ While the Clean Air Act does not include a definition of public health, the Supreme Court has defined that term in its most natural meaning: “the health of the public.”³⁴ In considering public health, “EPA has looked at morbidity, such as impairment of lung function, aggravation of respiratory and cardiovascular disease, and other acute and chronic health effects, as well as mortality.”³⁵ Using these

Circumpolar Conference, Russian Association of Indigenous Peoples of the North, and Saami Council, as well as official observers. The Arctic Council commissioned the ACIA project and charged its working groups – Arctic Monitoring and Assessment Programme (“AMAP”), Conservation of Arctic Flora and Fauna (“CAFF”), and the International Arctic Science Committee (“IASC”) - with its implementation. The efforts of hundreds of scientists over four years, as well as the special knowledge of indigenous peoples, contributed to the ACIA report. The ACIA (2005) is a comprehensively researched, fully referenced, and independently reviewed evaluation of Arctic climate change and its impacts.

³¹ GLOBAL HUMANITARIAN FORUM, HUMAN IMPACT REPORT, CLIMATE CHANGE: THE ANATOMY OF A SILENT CRISIS (2009), *available at* http://ghfgenewa.org/Portals/0/pdfs/human_impact_report.pdf (documenting the impact of climate change on human life globally).

³² HARVARD MED. SCHOOL CTR. FOR HEALTH AND THE GLOBAL ENV’T, CLIMATE CHANGE FUTURES HEALTH, ECOLOGICAL, AND ECONOMIC DIMENSIONS (2005), *available at* http://www.climatechange-futures.org/pdf/CCF_Report_Final_10.27.pdf.

³³ Clean Air Act § 302, 42 U.S.C. § 7602(h) (2008).

³⁴ *Whitman v. American Trucking Ass’n*, 531 U.S. 457, 466 (2001).

³⁵ Proposed Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act, 74 Fed. Reg. 18886, 18894 (April 24, 2009) (to be codified in 40 C.F.R. Chapter 1).

definitions, the EPA's proposed Endangerment Finding found irrefutable evidence demonstrating that greenhouse gases endanger public health and welfare.

As stated in the proposed Endangerment Finding,

*The Administrator concludes that, in the circumstances presented here, the case for finding that greenhouse gases in the atmosphere endanger public health and welfare is compelling and, indeed, overwhelming. The scientific evidence described here is the product of decades of research by thousands of scientists from the U.S. and around the world. The evidence points ineluctably to the conclusion that climate change is upon us as a result of greenhouse gas emissions, that climate changes are already occurring that harm our health and welfare, and that the effects will only worsen over time in the absence of regulatory action. The effects of climate change on public health include sickness and death. It is hard to imagine any understanding of public health that would exclude these consequences. The effects on welfare embrace every category of effect described in the Clean Air Act's definition of "welfare" and, more broadly, virtually every facet of the living world around us. And, according to the scientific evidence relied upon in making this finding, the probability of the consequences is shown to range from the likely to virtually certain to occur. This is not a close case in which the magnitude of the harm is small and the probability great, or the magnitude large and the probability small. In both magnitude and probability, climate change is an enormous problem. The greenhouse gases that are responsible for it endanger public health and welfare within the meaning of the Clean Air Act.*³⁶

EPA summarized some of the overwhelming evidence concerning the effects of climate change on health and welfare that have *already* occurred:

Effects on oceans and global sea levels: "Observations from all continents and most oceans show that many natural systems are being affected by regional climate changes, particularly temperature increases. Observations show that changes are occurring in the amount, intensity, frequency, and type of precipitation. There is strong evidence that global sea level gradually rose in the 20th century and is currently rising at an increased rate."³⁷

Loss of Arctic sea ice: "The latest data from NASA indicate Arctic sea ice set a record low in September 2007, 38 percent below the 1979-2007 average. In September 2008, Arctic sea ice reached its second lowest extent on record."³⁸

Drastic temperature increases: "U.S. average annual temperatures are approximately 1.25 °F (0.69 °C) warmer than at the start of the 20th century, with an increased rate of warming over the past 30 years. . . . [T]he rate of warming

³⁶ *Id.* at 18904 (emphasis added).

³⁷ *Id.* at 18898.

³⁸ *Id.*

increased to 0.58 °F/decade (0.32 °C/decade) for the period from 1979-2008. [¶] The last ten 5-year periods . . . were the warmest 5-year periods in the 114 years of national records, demonstrating the anomalous warmth of the last 15 years.”³⁹

Degradation of water and land resources, agriculture and biodiversity: “Climate changes are very likely already affecting U.S. water resources, agriculture, land resources, and biodiversity as a result of climate variability and change. A 2008 CCSP report that examined these observed changes concluded: ‘[t]he number and frequency of forest fires and insect outbreaks are increasing in the interior West, the Southwest, and Alaska. Precipitation, stream flow, and stream temperatures are increasing in most of the continental U.S. The western U.S. is experiencing reduced snowpack and earlier peaks in spring runoff. The growth of many crops and weeds is being stimulated. Migration of plant and animal species is changing the composition and structure of arid, polar, aquatic, coastal, and other ecosystems.’”⁴⁰

Extreme weather events: “‘Many extremes and their associated impacts are now changing. For example, in recent decades most of North America has been experiencing more unusually hot days and nights, fewer unusually cold days and nights, and fewer frost days. Heavy downpours have become more frequent and intense. . . . The power and frequency of Atlantic hurricanes have increased substantially in recent decades.’”⁴¹

As to the devastating *future* climate change impacts on health and welfare, EPA observed:

Increasing temperatures: “By the end of the century, projected average global warming ranges (compared to average temperature around 1990) varies significantly depending on emissions scenario and climate sensitivity assumptions, ranging from 1.8 to 4.0 °C (4.3 to 7.2 °F), with an uncertainty range of 1.1 to 6.4 °C (2.0 to 11.5 °F), according to the IPCC.”⁴²

Increased droughts and decreased water availability: “Drought is expected to increase in the western U.S., where water availability to meet demands for agricultural and municipal water needs is already limited. Another projected impact in the western U.S. is decreased water availability due to a range of interconnected factors. These include: decreases in snowpack, earlier snowmelt resulting in peak winter and decreased summer flows, which will disrupt and limit water storage capacity and will create additional challenges for water allocation among competing uses...”⁴³

³⁹ *Id.* at 18898-99.

⁴⁰ *Id.*

⁴¹ *Id.*

⁴² *Id.*

⁴³ *Id.* at 18900.

Sea level rises: “By the end of the century, sea level is projected to rise between 0.18 and 0.59 meters relative to around 1990 in the absence of increased dynamic ice sheet loss. Recent rapid changes at the edges of the Greenland and West Antarctic ice sheets show acceleration of flow and thinning. [¶¶] As the climate warms, glaciers will lose mass owing to dominance of summer melting over winter precipitation increases, contributing to sea level rise”⁴⁴

Floods: “The U.S. is projected to see an increase in the intensity of precipitation events, which is likely to increase the risk of flood events...”⁴⁵

Increased morbidity and mortality: “Severe heat waves are projected to intensify in magnitude and duration over the portions of the U.S. where these events already occur, with likely increases in mortality and morbidity. The populations most sensitive to hot temperatures are older adults, the chronically sick, the very young, city-dwellers, those taking medications that disrupt thermoregulation, the mentally ill, those lacking access to air conditioning, those working or playing outdoors, and the socially isolated.”⁴⁶

Increased spread of diseases: “There will likely be an increase in the spread of several food and water-born pathogens (e.g., Salmonella, Vibrio) among susceptible populations. . . . The primary climate-related factors that affect these pathogens include temperature, precipitation, extreme weather events, and shifts in their ecological regimes.”⁴⁷

Crop failures and reduced livestock production: “[W]ith increased CO₂ and temperature, the life cycle of grain and oilseed crops will likely progress more rapidly. But, as temperature rises, these crops will increasingly begin to experience failure . . . [¶] Higher temperatures will very likely reduce livestock production during the summer season, but these losses will very likely be partially offset by warmer temperatures during the winter season. [¶] In addition to human health effects, tropospheric ozone increases as a result of temperature increases and other climatic changes can have significant adverse effects on crop yields, pasture and forest growth and species composition.”⁴⁸

Damage to water infrastructure: “Water infrastructure, including drinking water and wastewater treatment plants, and sewer and stormwater management systems, may be at greater risk of flooding, sea level rise and storm surge, low flows, and other factors that could impair functioning.”⁴⁹

⁴⁴ *Id.*

⁴⁵ *Id.*

⁴⁶ *Id.* at 18901.

⁴⁷ *Id.*

⁴⁸ *Id.* at 18902.

⁴⁹ *Id.*

Ocean acidification: “Ocean acidification is projected to continue, resulting in the reduced biological production of marine calcifiers, including corals.”⁵⁰

The proposed Endangerment Finding also highlights important findings concerning the international impact of global warming, including the following:

“The IPCC identifies the most vulnerable world regions as the Arctic, because of high rates of projected warming on natural systems; Africa, especially the sub-Saharan region, because of current low adaptive capacity (e.g., lack of infrastructure and resources) as well as climate change; small islands, due to high exposure of population and infrastructure to risk of sea-level rise and increased storm surge; and Asian mega deltas, due to large populations and high exposure to sea level rise, storm surge and river flooding.”⁵¹

“On a global basis, according to the IPCC, projected climate change-related impacts are likely to affect the health of millions of people, particularly those with low adaptive capacity, as a result of a number of factors including increased cardio respiratory diseases due to higher concentrations of ground-level ozone brought on by higher temperatures, and by more frequent and intense heat waves.”⁵²

“Climate change impacts in certain regions of the world may exacerbate problems that raise humanitarian, trade and national security issues for the U.S. Climate change has been described as a potential threat multiplier regarding national security issues. This is because . . . climate change can aggravate existing problems . . . such as poverty, social tensions, general environmental degradation, and conflict over increasingly scarce water resources.”⁵³

As demonstrated by the above summary of EPA’s own findings, and as overwhelmingly proven by the literature pertaining to the two statutory factors, greenhouse gases endanger public health and welfare. The statutory language concerning the requisite endangerment findings under sections 202(a) (42 U.S.C. § 7521(a)) and 108(a) (42 U.S.C. § 7408(a)) is near-identical. In light of the proposed Endangerment Finding under section 202(a), there can be no doubt that EPA must issue the same endangerment finding under section 108(a)(1)(A)).

The condition of subpart (B) of section 108(a)(1) is also satisfied as greenhouse gases plainly result from numerous and diverse mobile and stationary sources. As EPA has recognized, greenhouse gases are emitted from millions of sources throughout the nation and across all sectors of the economy, including all mobile sources of fossil fuel, home and commercial heating and cooking with oil, natural gas and coal, land use changes, industrial

⁵⁰ *Id.*

⁵¹ *Id.* at 18903.

⁵² *Id.*

⁵³ *Id.*

processes such as cement and ammonia manufacturing, and industrial energy generation units.⁵⁴ The listing criteria of Section 108(1)(A) and (B) are indubitably met.

D. Because All Prongs of Section 108(a)(1) Are Satisfied, EPA Must Expediently Designate Greenhouse Gases as Criteria Air Pollutants

Because greenhouse gases meet the listing provisions under Section 108(a)(1) (42 U.S.C. § 7408(a)), EPA must designate greenhouse gases as criteria air pollutants. When the provisions of subpart (A) and (B) have been met, listing the pollutant and proceeding with the additional requirements of sections 108-110 is mandatory, and EPA lacks any discretion to decline to regulate.

The mandatory nature of EPA's listing obligation was explained by the Second Circuit in *NRDC v. Train*, 545 F.2d 320 (2d Cir. 1976). The Court considered whether EPA had discretion not to proceed with listing lead as a criteria pollutant despite an endangerment finding because subsection (C) states that an air quality criteria is required for any pollutant "for which air quality criteria had not been issued before December 31, 1970, but for which [the Administrator] plans to issue air quality criteria under this section." The court in *Train* held conclusively that no discretion exists: "[o]nce the conditions of [Sections] 108(a)(1)(A) and (B) have been met, the listing of lead and the issuance of air quality standards for lead become mandatory."⁵⁵ In the matter at hand, the air pollutants in question are greenhouse gases. If the conditions of the first two criteria are satisfied for greenhouse gases, then the Administrator has no discretion in whether to make an endangerment finding, issue air quality criteria, national pollutant caps, and follow the other mandatory provisions of Clean Air Act sections 108 through 110.

E. EPA Must Comply with the other Mandatory Requirements of Section 108

Once EPA has listed the greenhouse gases as criteria air pollutants, the EPA must issue air quality criteria specifying the impact of those pollutants on the public health and welfare. Section 108(a)(2) provides as follows:

Shall issue air quality criteria for an air pollutant within 12 months after [EPA] has included such pollutant in a list under paragraph (1). Air quality criteria for an air pollutant *shall accurately reflect the latest scientific knowledge useful in indicating the kind and extent of all identifiable effects on public health or welfare which may be expected from the presence of such pollutant in the ambient air*, in varying quantities. The criteria for an air pollutant, to the extent practicable, shall include information on –

(A) those variable factors (including atmospheric conditions) which of themselves or in combination with other factors may alter the effects on public health or welfare of such air pollutant;

(B) the types of air pollutants which, when present in the atmosphere, may interact with such pollutant to produce an adverse effect on public health or welfare; and

⁵⁴ 73 Fed. Reg. at 44401, 44403, 44429-437, 44453-454, 44462, 44468; *see also* 74 Fed. Reg. 18886, 18907.

⁵⁵ *Train*, 545 F.2d. at 328.

(C) any known or anticipated adverse effects on welfare.

42 U.S.C. 7408(a)(2) (emphasis added).

Simultaneously with the release of the air quality criteria, section 108(b)(1) requires EPA to issue “information on air pollution control techniques, which information shall include data relating to the cost of installation and operation, energy requirements, emission reduction benefits, and environmental impact of the emission control technology.”⁵⁶

Additionally, section 108(f) requires EPA to:

Publish and make available to appropriate Federal, State, and local environmental and transportation agencies not later than one year after November 15, 1990, and from time to time thereafter . . . information regarding processes, procedures, and methods to reduce or control pollutants in transportation; reduction of mobile source related pollutants; reduction of impact on public health.

Section 108(f) provides a non-exhaustive list of sixteen categories of information that EPA must provide, after consultation with the Secretary of Transportation and a public comment period, “regarding the formulation and emission reduction potential of transportation control measures related to criteria pollutants and their precursors.”

Again simultaneously with publication of the air quality criteria, EPA must also publish proposed air quality standards for the pollutant pursuant to section 109 (42 U.S.C. § 7409), as discussed below.

II. EPA Must Establish Science-Based National Pollution Caps to Protect the Public Health and Welfare

Once a pollutant is listed pursuant to section 108(a)(1), EPA must establish national pollution caps sufficient to protect the public health and welfare. Specifically, EPA “shall publish, simultaneously with the issuance of such criteria and information, proposed national primary and secondary ambient air quality standards for any such pollutant” (NAAQS) in order to protect the public health and welfare.⁵⁷ EPA must finalize the national pollutant caps no later than 90 days from the initial publication, following public review and comment on the proposal.⁵⁸

⁵⁶ Clean Air Act § 108(b)(1), 42 U.S.C. § 7408(b)(1) (2008).

⁵⁷ Clean Air Act § 109(a)(2), 42 U.S.C. § 7409(a)(2) (2008). In the Advance Notice of Proposed Rulemaking for greenhouse gases, the EPA advanced the theory that it might have discretion to decline to set primary and/or secondary pollution caps for greenhouse gases, either because there are no public health or welfare impacts at current ambient greenhouse gas concentrations, or because health impacts are indirect and “largely incidental” to welfare impacts. 73 Fed. Reg. at 44426-44427. EPA itself has now definitively rejected these contentions in the proposed Endangerment Finding. EPA must issue both primary and secondary pollution caps for greenhouse gases.

⁵⁸ Clean Air Act § 109(a)(1)(B), 42 U.S.C. § 7409(a)(1)(B) (2008).

The primary national pollution caps (NAAQS) are “ambient air quality standards the attainment and maintenance of which in the judgment of the Administrator, based on such criteria and allowing an adequate margin of safety, are requisite to protect the public health.”⁵⁹

The secondary national pollution caps (NAAQS) “shall specify a level of air quality the attainment and maintenance of which in the judgment of the Administrator, based on such criteria, is requisite to protect the public welfare from any known or anticipated adverse effects associated with the presence of such air pollutant in the ambient air.”⁶⁰ As discussed above, the Clean Air Act defines “welfare” as:

All language referring to effects on welfare includes, but is not limited to, effects on soils, water, crops, vegetation, manmade materials, animals, wildlife, weather, visibility, and climate, damage to and deterioration of property, and hazards to transportation, as well as effects on economic values and on personal comfort and well-being, whether caused by transformation, conversion, or combination with other air pollutants.⁶¹

As discussed above, the scientific literature reflects, and EPA has recognized, a wide array of current and projected global and U.S. health and welfare effects. The only remaining question is the level at which the national pollution limits must be set to adequately protect the public health and welfare.

A. Pollutants Subject to this Petition

The sources and properties of the pollutants subject to this petition are discussed extensively in the IPCC’s Fourth Assessment Report and in the other primary source documents listed above. Some of the key properties of the petitioned pollutants are summarized in Table 1.

⁵⁹ Clean Air Act § 109(b)(1), 42 U.S.C. § 7409(b)(1) (2008).

⁶⁰ Clean Air Act § 109(b)(2), 42 U.S.C. § 7409(b)(2) (2008).

⁶¹ Clean Air Act § 302(h), 42 U.S.C. § 7602(h) (2008).

Table 1: Key Properties of Petitioned Pollutants

Pollutant ^a	Atmospheric Lifetime (years)	GWP ^b 20-yr	GWP 100-yr	GWP 500-yr	Pre-Industrial Concentration	Current Concentration ^c
Carbon Dioxide (CO₂)	<i>See note d</i>	1	1	1	275-285 ppm ^e	385.2 ^f ppm (2008)
Methane (CH₄)	12	72	25	7.6	715 ppb ^g	1797 ^f ppb (2008)
Nitrous Oxide (N₂O)	114	289	298	153	270 ppb	321.8 ^f ppb (2008)
Hydrofluorocarbons (HFCs)^j	1.4-270					
HFC-125	29	6,350	3,500	1,100	0	3.7 ppt ⁱ
HFC-134a	14	3,830	1,430	435	0	35 ppt
HFC-152a	1.4	437	124	38	0	3.9 ppt
HFC-23	270	12,000	14,800	12,200	0	18 ppt
Perfluorocarbons (PFCs)^j						
PFC-14	50,000	5,210	7,390	11,200	0	74 ppt
PFC-116	10,000	8,630	12,200	18,200	0	2.9 ppt
Sulfur hexafluoride (SF₆)	3,200	16,300	22,800	32,600	0	5.6 ppt
Nitrogen Trifluoride	740	12,300	17,200	20,700	0	0.454 ^k ppt (2008)

^a Unless otherwise noted, data from P. Forster et al., *Changes in Atmospheric Constituents and in Radiative Forcing*, in CLIMATE CHANGE 2007: THE PHYSICAL SCIENCE BASIS. CONTRIBUTION OF WORKING GROUP I TO THE FOURTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (Solomon, S., et al. eds., Cambridge University Press 2007).

^b direct, global mean Global Warming Potential (see discussion of GWPs, *supra*).

^c 2005 value unless otherwise noted.

^d It is not possible to give a single lifetime for CO₂, but research has highlighted its long residence time. While approximately half of the carbon emitted is removed by the natural carbon cycle within a century, a substantial fraction of anthropogenic CO₂ will persist in the atmosphere for several millennia. *See, e.g.,* A. Montenegro et al., *Long Term Fate of Atmospheric Carbon*, 34 GEOPHYS. RES. LETT. L19707 (2007) (25% of emitted CO₂ will have an atmospheric lifetime of more than 5000 years); S. Solomon et al., *Irreversible Climate Change Due to Carbon Dioxide Emissions*, 106 PNAS 1704 (2009).

^e parts per million.

^f World Meteorological Organization (WMO), WMO Greenhouse Gas Bulletin. No. 5: 23 (Nov. 2009), available at <http://www.wmo.int/pages/prog/arep/gaw/ghg/GHGbulletin.html>.

^g parts per billion.

ⁱ parts per trillion.

^j Petitioners seek regulation of all HFCs and PFCs for which either significant concentrations or large trends in concentrations have been observed or a clear potential for future emissions has been identified. Appendix A provides a complete list of the petitioned HFCs and PFCs. The compounds with the greatest contribution to global warming are included here for illustrative purposes.

^k Weiss et al., *supra* note 62.

Nitrogen trifluoride is the only gas not discussed in the proposed Endangerment Finding, and not extensively treated in the AR4 and other source documents, as it has only recently been measured in the atmosphere. Nitrogen trifluoride is used in the electronics industry for equipment cleaning, for the etching of microcircuits, and for manufacturing liquid crystal flat panel displays and thin-film photovoltaic cells.⁶² It is not included in the reporting requirements or restricted under the U.S. Framework Convention on Climate Change process, and has therefore increasingly been used as a replacement for PFCs which are covered under the Convention and Kyoto Protocol.⁶³ Scientists have recently measured nitrogen trifluoride levels of 0.454 ppt, a quasi-exponential growth from about 0.02 ppt in 1978.⁶⁴ The rise corresponds to about 620 metric tons of emissions per year, or about 16% of the poorly-constrained global production estimate of 4,000 metric tons per year.⁶⁵ As discussed below, although nitrogen trifluoride is currently a small contributor to global warming, EPA must regulate it due to its increasing use, high global warming potential, and long atmospheric lifetime.⁶⁶

B. The Latest Scientific Knowledge Supports a National Pollution Limit for Carbon Dioxide of No More than 350 Parts per Million

The national pollution cap established by EPA must be science-based and sufficient to protect the public health and welfare. The Clean Air Act also embodies a precautionary approach of considering the likelihood that emerging science will demonstrate a need for a lower threshold level as uncertainties are resolved. This idea is explicitly invoked through the “adequate margin of safety” language of section 109(b)(1).

As the Supreme Court stated in *Whitman v. American Trucking Associations*, “EPA, ‘based on’ the information about health effects contained in the technical ‘criteria’ documents compiled under section 108(a)(2), 42 U.S.C. § 7408(a)(2), is to identify the maximum airborne

⁶² R. F. Weiss et al., *Nitrogen Trifluoride in the Global Atmosphere*, 35 GEOPHYS. RES. LETT. L20821 (Oct. 2008), available at <http://www.agu.org/pubs/crossref/2008/2008GL035913.shtml>.

⁶³ *Id.*

⁶⁴ *Id.*

⁶⁵ *Id.*

⁶⁶ In the proposed Endangerment Finding, EPA determined without question that the six other greenhouse gases subject to this petition cause and contribute to air pollution even though the individual contribution of any one greenhouse gas may be deemed small: “Importantly, because no single greenhouse gas source category dominates on the global scale, many (if not all) individual greenhouse gas source categories could appear too small to matter, when in fact, they could be very significant contributors in terms of both absolute emissions or in comparison to other similar source categories within the U.S. If the U.S. and the rest of the world are to combat the risks associated with global climate change, contributors must do their part even if their contributions to the global problem, measured in terms of percentage, are smaller than typically encountered when tackling solely regional or local environmental issues.” 74 Fed. Reg. 18907. For that reason, and because of the potency and longevity of individual greenhouse gases, the Administrator determined that if she were to evaluate any of the greenhouse gases as a separate air pollutant, she would nonetheless find them to “cause or contribute” to air pollution. For example, the Administrator found methane to contribute to air pollution under section 202(a) even though in 2006, methane emissions from section 202(a) source categories were 0.03 percent of total U.S. greenhouse gas emissions and less than 0.01 percent of total global greenhouse gas emissions in 2005. 74 Fed. Reg. 18908. Similarly, because of nitrogen trifluoride’s long atmospheric lifetime (740 years), extremely potent global warming potential (17,200 times more powerful than carbon dioxide over a 100 year period) and exponential increase in atmospheric concentrations in recent years, EPA should arrive at the same conclusion here.

concentration of a pollutant that the public health can tolerate, decrease the concentration to provide an ‘adequate’ margin of safety, and set the standard at that level.”⁶⁷ On remand, the Court of Appeals for the District of Columbia held that “EPA must err on the side of caution, . . . setting the NAAQS at whatever level it deems necessary and sufficient to protect the public health with an adequate margin of safety, taking into account both the available evidence and the inevitable scientific uncertainties.”⁶⁸

In considering the impacts from CO₂ and the other greenhouse gases, the EPA must consider, and accurately reflect, the “latest scientific knowledge.”⁶⁹ The latest scientific knowledge supports a national pollution cap of no more than 350 parts per million for CO₂. Leading climate scientists, publishing in a peer-reviewed scientific journal, have concluded that the present concentration of 385 ppm CO₂, is “already in the dangerous zone.”⁷⁰ Their findings are briefly summarized as follows:

If humanity wishes to preserve a planet similar to that on which civilization developed and to which life on Earth is adapted, paleoclimate evidence and ongoing climate change suggest that CO₂ will need to be reduced from its current 385 ppm to at most 350 ppm, but likely less than that. The largest uncertainty in the target arises from possible changes of non-CO₂ forcings. An initial 350 ppm CO₂ target may be achievable by phasing out coal use except where CO₂ is captured and adopting agricultural and forestry practices that sequester carbon. If the present overshoot of this target CO₂ is not brief, there is a possibility of seeding irreversible catastrophic effects.⁷¹

Atmospheric CO₂ concentrations must be reduced quickly: “Indeed, if the world continues on a business-as-usual path for even another decade without initiating phase-out of unconstrained coal use, prospects for avoiding a dangerously large, extended overshoot of the 350 ppm level will be dim.”⁷²

The many other statements from scientists and lines of evidence in support of a pollution cap of no more than 350 ppm CO₂ include the following:

- Dr. Rajendra Pachauri, chairman of the Intergovernmental Panel on Climate Change, personally endorsed a 350ppm target: “What is happening, and what is likely to happen, convinces me that the world must be really ambitious and very determined at moving toward a 350 target.”⁷³

⁶⁷ *Whitman*, 531 U.S. at 465.

⁶⁸ *American Trucking Associations, Inc. v. EPA*, 283 F.3d 355, 378 (D.C. Cir. 2002).

⁶⁹ Clean Air Act § 108(a)(2), 42 U.S.C. § 7408(a)(2).

⁷⁰ J. Hansen et al., *Target Atmospheric CO₂: Where Should Humanity Aim?*, 2 OPEN ATMOSPHERIC SCI. J. 217, 218 (2008).

⁷¹ *Id.* at 217. Because climate forcing from anthropogenic non-CO₂ greenhouse emissions are approximately offset by the cooling effect of anthropogenic aerosol emissions, Hansen et al. (2008) consider future CO₂ change as approximating the net human-made forcing change, with several caveats.

⁷² *Id.* at 227.

⁷³ Marlow Hood, *Top UN Climate Scientist backs Ambitious CO₂ Cuts*, AGENCE FRANCE PRESS, Aug. 28, 2009, available at <http://www.mg.co.za/article/2009-08-25-top-un-climate-scientist-backs-ambitious-co2-cuts>; see also

- A United Nations project to quantify the financial costs of climate change on nature concluded that atmospheric CO₂ must be reduced to below 350 ppm to save the world's coral reefs:

Coral reef losses accelerated significantly once atmospheric concentrations of CO₂ reached around 320 ppm due to temperature-induced coral bleaching. These losses were compounded by excessive CO₂ dissolution in sea water. This caused ocean acidification, which in turn hampers reef regeneration. Scientific consensus has emerged that atmospheric CO₂ concentrations need to be “significantly below 350 ppm” for the long-term viability of coral reefs (Royal Society 2009)....[¶] Even current levels of atmospheric CO₂ are too high for coral reef survival. We need large and permanent removals of CO₂ from the atmosphere.... Accepting any stabilization target above 350 ppm CO₂ really means that society has made a decision to make do without coral reefs. It is therefore also a decision to accept the serious consequences of coral reef loss on biodiversity, on sea fisheries around the world, and on the half billion people who depend directly on coral reefs for their livelihoods. Removing CO₂ has thus become an imperative for survival.⁷⁴

- Twenty top climate scientists recently issued an open letter to President Obama and Congress to “call attention to the large difference between what U.S. politics now seems capable of enacting [targeting reduction to 450ppm] and what scientists understand is necessary to prevent climatic disruption and protect the human future...We and many others are of the view that these objectives [limiting CO₂ to 450 ppm and global temperature increase to 2° C] are inadequate to sustain the integrity of global climate and to hold the risk of ruinous climatic change to an acceptably low level.”⁷⁵

The best available science now indicates unequivocally that stabilizing CO₂ at 450 ppm with the goal of limiting warming to 2°C is not “safe” and will not protect public health and welfare. In 2001, the Intergovernmental Panel on Climate Change (IPCC) identified five “Reasons For Concern” in its Third Assessment Report to illustrate the temperature range at which impacts may be considered dangerous.⁷⁶ Relationships between the impacts reflected in each Reason For Concern and increases in global mean temperature were portrayed in a “burning embers” diagram, which reflected the severity of risk from rising temperature through gradations in color from white (no or little risk) to yellow (moderately significant risk) to red (substantial or

Yale Environment 360, *Amid Mounting Hope, a Voice of Hope for Copenhagen*, Nov. 4, 2009, <http://www.e360.yale.edu/content/feature.msp?id=2206> (last visited Dec. 1, 2009).

⁷⁴ THE ECONOMICS OF ECOSYSTEM BIODIVERSITY (TEEB), TEEB CLIMATE ISSUES UPDATE (Sept. 2009), *available at* <http://www.teebweb.org/InformationMaterial/PresentationTools/tabid/1053/language/en-US/Default.aspx>.

⁷⁵ Dean Abrahamson, *An Open Letter to the President and Members of Congress Strong Leadership Needed Now on Climate* (June 23, 2009).

⁷⁶ IPCC, CLIMATE CHANGE 2001: SYNTHESIS REPORT, SUMMARY FOR POLICYMAKERS 11 (2001), *available at* <http://www.ipcc.ch/pdf/climate-changes-2001/synthesis-spm/synthesis-spm-en.pdf>. The five Reasons For Concern identified in the Third Assessment Report are: 1) risks to unique and threatened systems; 2) risks of extreme weather events; 3) distribution of impacts; 4) aggregate impacts; and 5) risks of large scale discontinuities.

severe risk).⁷⁷ Depending on the Reason For Concern, the IPCC predicted that substantial impacts or risks (transition from yellow to red) would occur with a temperature rise 1–4°C above current levels.⁷⁸

Since the release of the Third Assessment Report, scientific understanding of the vulnerability of the climate to temperature rise has evolved considerably.⁷⁹ Based on new findings in the growing scientific literature, the burning embers diagram was revised in 2008 to reflect the dangerous risks posed by smaller increases in temperature than identified in the Third Assessment Report.⁸⁰ In the updated burning embers diagram, the IPCC now predicts that substantial impacts or risks occur at or near current temperature levels for a number of the Reasons For Concern.⁸¹ As reflected in the updated Reasons for Concern, a 2°C temperature increase from pre-industrial levels (or 1.4°C increase from 1990 levels) is well past the point where severe and irreversible impacts will occur.⁸²

It is now estimated that a mean global temperature increase of 1.5°C above pre-industrial levels has the potential to trigger irreversible melting of the Greenland ice sheet, a process that would result in an eventual seven meter sea level rise over and above that caused by thermal expansion of the oceans, and that could potentially cause an additional sea level rise of 0.75 meters, as soon as 2100.⁸³ Specific consequences of a 2°C temperature rise from pre-industrial levels include the loss of 97 percent of the world's coral reefs and the transformation of 16 percent of global ecosystems. Indeed, given increased confidence that a 1–2°C increase poses significant risks to many unique and threatened systems, including many biodiversity hotspots, the updated burning embers diagram indicates substantial impacts and/or moderate risks from warming that has already occurred.⁸⁴ At a 2°C temperature rise, approximately one to three billion people would experience an increase in water stress, sea level rise and cyclones would displace millions from the world's coastlines, and agricultural yields would fall in the developed world.⁸⁵ In the Arctic, ecosystem disruption is predicted upon expectations of a complete loss of summer sea ice, with only 42 percent of the tundra remaining stable. Such a disruption would

⁷⁷ *Id.*; see also Joel B. Smith et al., *Assessing Dangerous Climate Change Through an Update of the Intergovernmental Panel on Climate Change (IPCC) "Reasons for Concern,"* 106 PROC. OF THE NAT'L ACAD. SCI. 4133 (2009), available at <http://www.pnas.org/content/early/2009/02/25/0812355106.abstract>.

⁷⁸ IPCC, *supra* note 76. The Reasons For Concern assessed impacts from a baseline of 1990 temperature levels rather than pre-industrial levels. Because pre-industrial warming until 1990 was 0.6°C, an impact resulting from a temperature rise of 1°C equates to a 1.6°C rise from pre-industrial levels. *Id.*

⁷⁹ See Smith, *supra* note 77, at 4133, 4137.

⁸⁰ See *id.* An updated burning embers diagram was omitted from the 2007 Fourth Assessment Report due to opposition from the United States, China, Russia, and Saudi Arabia. Because the Assessment Report is a consensus document, these countries were able to prevent the inclusion of an updated diagram despite the insistence by New Zealand, small islands states, Canada, Germany, and the United Kingdom that inclusion of an updated burning embers diagram was essential. See also Andrew C. Revkin, *Why 2007 I.P.C.C. Report Lacked 'Embers'*, N.Y. TIMES, Feb. 26, 2009, available at <http://dotearth.blogs.nytimes.com/2009/02/26/why-2007-ipcc-report-lacked-embers>.

⁸¹ See *id.*

⁸² Smith, *supra* note 77, at 3.

⁸³ Rachel Warren, *Impacts of Global Climate Change at Different Annual Mean Global Temperature Increases*, in AVOIDING DANGEROUS CLIMATE CHANGE 95 (2006). Unlike the IPCC's Reason For Concern, Warren assessed impacts from temperature rise from pre-industrial levels, not 1990 levels.

⁸⁴ Smith, *supra* note 77, at 3.

⁸⁵ See Warren, *supra* note 83, at 98.

severely affect northern peoples and cause the extinction of the polar bear and many other species. Moreover, because Arctic ice functions to reflect heat back into the atmosphere, its loss would allow more sunlight to heat the Arctic Ocean, creating a negative feedback loop that would further accelerate the melting of the Greenland ice sheet. As the devastating and irreversible impacts resulting from a 2°C mean global temperature rise are clearly dangerous to public health and welfare, the commonly referenced 450 ppm CO₂ stabilization and 2°C targets are not adequate.

In light of the scope and irreversibility of the consequences of overshooting a 2°C threshold, the risk tolerance for such an outcome should be extremely low. The risk of overshooting a 2°C threshold is 50–82 percent at stabilization levels of 450–550 ppm CO₂eq.⁸⁶ On the other hand, stabilizing greenhouse gas concentrations at 350 ppm CO₂eq would reduce the mean probability of overshooting a 2°C temperature rise to 7 percent.⁸⁷

Ultimately, it may well be necessary to reduce atmospheric CO₂ to below 350 ppm. In September 2008, the director of the Potsdam Institute for Climate Impact Research in Germany, John Schellnhuber, told the *Guardian* that proposed GHG reduction targets were insufficient, and that a reduction of CO₂ to the pre-industrial level of 280 ppm would be required to ensure a stable climate.⁸⁸ Schellnhuber stated, “It is a very sweeping argument, but nobody can say for sure that 330ppm is safe. Perhaps it will not matter whether we have 270ppm or 320ppm, but operating well outside the [historic] realm of carbon dioxide concentrations is risky as long as we have not fully understood the relevant feedback mechanisms.”⁸⁹

Protection of the Arctic and other particularly vulnerable regions such as coastal areas and low lying islands may also require a lower level. Hansen et al. (2008) concluded:

Stabilization of Arctic sea ice cover requires, to first approximation, restoration of planetary energy balance. Climate models driven by known forcings yield a present planetary energy imbalance of +0.5-1 W/m². Observed heat increase in the upper 700 m of the ocean confirms the planetary energy imbalance, but observations of the entire ocean are needed for quantification. CO₂ amount must be reduced to 325-355 ppm to increase outgoing flux 0.5-1 W/m², if other forcings are unchanged. A further imbalance reduction, and thus CO₂ ~300-325 ppm, may be needed to restore sea ice to its area of 25 years ago.⁹⁰

Because current evidence indicates that limiting atmospheric CO₂ to no more than 350 ppm is necessary to protect public health and welfare, Petitioners request both a primary and

⁸⁶ Malte Meinshausen, *What Does a 2°C Target Mean for Greenhouse Gas Concentrations? A Brief Analysis Based on Multi-Gas Emission Pathways and Several Climate Sensitivity Uncertainty Estimates*, in AVOIDING DANGEROUS CLIMATE CHANGE 268, 270 (2006).

⁸⁷ *Id.*

⁸⁸ David Adam, *Roll Back Time to Safeguard Climate, Expert Warns: A Return to Pre-Industrial Levels of Carbon Dioxide Urged as the Only Way to Prevent the Worst Impacts of Global Warming*, THE GUARDIAN, Sept. 15 2008, available at <http://www.guardian.co.uk/environment/2008/sep/15/climatechange.carbonemissions>.

⁸⁹ *Id.*

⁹⁰ *Id.* at 226 (internal citations omitted).

secondary national pollution limit (NAAQS) of no more than 350 ppm CO₂. The EPA may be required to adjust the pollution limit downward as further information becomes available.

C. Pollution Limits for the Other Petitioned Pollutants

Petitioners request that EPA issue national pollution limits for each additional greenhouse gas as specified in Table 2: Petitioned National Pollution Limits. Petitioners recognize that in the proposed endangerment finding, EPA proposes to regulate the six greenhouse gases together, and that the EPA has flexibility with regard to regulating the petitioned greenhouse gases either individually or as a group.⁹¹ Petitioners also recognize the importance of the CO₂-eq metric⁹² in many circumstances, and the potential administrative efficiency benefits that can be achieved through the regulation of greenhouse gases as a group as opposed to individually. EPA could also utilize a combination of approaches, so long as the chosen approach facilitates achievement of the Clean Air Act's objectives and is neither arbitrary nor capricious. The Clean Air Act's flexibility in this regard allows differentiated prioritization and achievement of various policy objectives.

However, setting national pollution caps for each of the greenhouse gases individually allows for greater precision in achieving a number of policy objectives. For example, methane is particularly effective at warming the Arctic in part because, in addition to being a potent greenhouse gas in its own right, it is also an ozone precursor. Tropospheric ozone, unlike other greenhouse gases, absorbs both infrared radiation and shortwave radiation (visible light). Thus, tropospheric ozone is a powerful warming agent over highly reflective surfaces like the Arctic in the springtime, because it traps shortwave radiation from the sun both as it enters the Earth's atmosphere and when it is reflected back out again by snow and ice. Reducing global methane emissions will reduce ozone concentrations in the Arctic, providing a double benefit to the region.⁹³ Deep and rapid reductions in methane are needed in order to save the seasonal Arctic ice pack and Arctic species.⁹⁴ Stated another way, a given volume of methane reductions with

⁹¹ "Air pollutant" is defined by the Clean Air Act as follows:

The term "air pollutant" means any air pollution agent or *combination of such agents*, including any physical, chemical, biological, radioactive (including source material, special nuclear material, and byproduct material) substance or matter which is emitted into or otherwise enters the ambient air. Such term includes any precursors to the formation of any air pollutant, to the extent the Administrator has identified such precursor or precursors for the particular purpose for which the term "air pollutant" is used. Clean Air Act § 302(g), 42 U.S.C. 7602(g) (2008) (emphasis added).

⁹² Greenhouse gases differ in their warming influence on the global climate system due to both their different radioactive properties and different lifetimes in the atmosphere. Therefore, a common method is needed to compare the gases. The most widely used method for doing so is CO₂-eq, which expresses a common warming influence based on the radiative forcing of CO₂. The term "CO₂-eq emissions" refers to the amount of CO₂ that would cause the same time-integrated radiative forcing, over a given time horizon, as an emitted amount of a long lived greenhouse gas or a mixture of greenhouse gases. The CO₂-eq emission is obtained by multiplying the emission of a greenhouse gas by its Global Warming Potential (GWP) for the given time horizon. L. BERNSTEIN ET AL., INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2007: SYNTHESIS REPORT 36 (2007), available at http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf.

⁹³ See, e.g., J. Hansen et al., *Climate Change and Trace Gases*, 365 PHIL. TRANS. R. SOC. A. 1925 (2007), available at http://pubs.giss.nasa.gov/docs/2007/2007_Hansen_etal_2.pdf; Shindell, D., *Local and Remote Contributions to Arctic Warming*, GEOPHYS. RES. LETT. 34, L14704 (July 20, 2007), available at <http://www.agu.org/pubs/crossref/2007/2007GL030221.shtml>.

⁹⁴ *Id.*

the same CO₂-eq measure as a given volume of CO₂ emissions reductions would have a greater impact on Arctic warming in the short term.

The EPA must carefully consider such issues in order to ensure that the public health and welfare is protected with an adequate margin of safety.⁹⁵ As the climate crisis rapidly worsens, it is essential to regulate at least some of the pollutants individually to protect particularly vulnerable regions such as the Arctic or prevent or ameliorate certain other impacts. And while the Clean Air Act grants discretion to EPA as to whether to regulate individual pollutants or groups of pollutants, ultimately EPA must ensure that its choice allows it to achieve the substantive goals of the Clean Air Act, including Section 109's mandate to protect the public health with an adequate margin of safety.

For these reasons, Petitioners request individual national pollution limits for each pollutant at the levels specified in Table 2.

⁹⁵ Similar issues were discussed by one commentator as follows:

Comparing [greenhouse gases] is not a straightforward issue for several reasons. Perhaps the most fundamental reason is the gases' various lifetimes in the atmosphere. While the radiative forcing of methane emissions lasts for a decade or two, the radiative forcing of carbon dioxide lasts for centuries. Additional difficulties are raised due to the complexities in the relationship between radiative forcing and a more relevant metric of climate change: temperature change. Moreover, as pointed out by the IPCC (2001b, Ch. 19), there is evidence that the impact from emissions of various GHGs in some cases (such as impact on ecosystems) depends more on the rate of change of temperature rather than changes in level. In other cases (such as sea-level rise), impacts may depend more on the integrated change of surface temperature. Taking into account possible threshold values of climate change is also important. The functional form of damages will hence affect the efficient trade-off between various GHGs. Furthermore, because of the nonlinearities of the climate system, the evaluation of the present emissions of some GHGs will depend on which future background scenario is used (see, e.g., Smith and Wigley, 2000). Because of all these issues, designing an index to compare today's emissions of various GHGs is a challenging task. Odd Godal, *The IPCC's Assessment of Multidisciplinary Issues: The Case of Greenhouse Gas Indices*, 58 CLIMATIC CHANGE 243 (Nov. 2003).

Table 2: Petitioned National Pollution Limits

Pollutant^a	Lifetime (years)	Pre-Industrial Concentration	Current Concentration^b	Primary Pollution Limit	Secondary Pollution Limit
Carbon Dioxide (CO₂)	<i>See note c below</i>	275-285 ppm ^d	385.2 ^e ppm (2008)	350 ppm	350 ppm
Methane (CH₄)	12	715 ppb ^f	1797 ^e ppb (2008)	715 ppb	715 ppb
Nitrous Oxide (N₂O)	114	270 ppb	321.8 ^e ppb (2008)	270 ppb	270 ppb
Hydrofluorocarbons (HFCs)^h	1.4-270				
HFC-125	29	0	3.7 ppt ^g	1 ppt	1 ppt
HFC-134a	14	0	35 ppt	1 ppt	1 ppt
HFC-152a	1.4	0	3.9 ppt	1 ppt	1 ppt
HFC-23	270	0	18 ppt	1 ppt	1 ppt
Perfluorocarbons (PFCs)^h					
PFC-14	50,000	0	74 ppt	75 ppt	75 ppt
PFC-116	10,000	0	2.9 ppt	3 ppt	3 ppt
Sulfur hexafluoride (SF₆)	3,200	0	5.6 ppt	5.7 ppt	5.7 ppt
Nitrogen Trifluoride (NF₃)	740	0	0.454 ⁱ ppt (2008)	0.46 ppt	0.46 ppt

^a Unless otherwise noted, data from P. Forster et al., *Changes in Atmospheric Constituents and in Radiative Forcing*, in CLIMATE CHANGE 2007: THE PHYSICAL SCIENCE BASIS. CONTRIBUTION OF WORKING GROUP I TO THE FOURTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (Solomon, S., et al. eds., Cambridge University Press 2007).

^b 2005 value unless otherwise noted.

^c It is not possible to give a single lifetime for CO₂, but research has highlighted its long residence time. While approximately half of the carbon emitted is removed by the natural carbon cycle within a century, a substantial fraction of anthropogenic CO₂ will persist in the atmosphere for several millennia. *See, e.g.,* A. Montenegro et al., Long term fate of atmospheric carbon, *Geophys. Res. Lett.*, 34, L19707, doi:10.1029/2007GL030905 (2007) (25% of emitted CO₂ will have an atmospheric lifetime of more than 5000 years); S. Solomon et al., Irreversible climate change due to carbon dioxide emissions, *PNAS* 106: 1704-1709 (2009).

^d parts per million.

^e World Meteorological Organization (WMO). 2009. WMO Greenhouse Gas Bulletin. No. 5: 23 November 2009. Available at <http://www.wmo.int/pages/prog/arep/gaw/ghg/GHGbulletin.html>.

^f parts per billion.

^g parts per trillion.

^h Petitioners seek regulation of all HFCs and PFCs for which either significant concentrations or large trends in concentrations have been observed or a clear potential for future emissions has been identified. The compounds with the greatest contribution to global warming are included here for illustrative purposes.

ⁱ Weiss et al. 2008, *supra* note 62.

As with CO₂, because current evidence indicates these levels are necessary to protect both the public health and welfare from global warming and climate disruption, Petitioners seek these levels as both the primary and secondary national pollution limits.

Methane and nitrous oxide are the two most important greenhouse gases after carbon dioxide, and the deep and rapid reduction of both of these pollutants is an essential part of any action plan to stabilize the climate system. Petitioners thus request that EPA set the national pollution limits for these gases at the natural level that existed prior to significant human-caused emissions, 715 ppb for methane and 270 ppb for nitrous oxide. Because methane has a relatively short atmospheric lifetime of 12 years, this level, though ambitious, will be achievable if combined with other greenhouse reduction measures sufficient to slow and reverse climate feedbacks, such as the release of methane from melting Arctic permafrost, which if left unchecked may overwhelm other reduction efforts. While nitrous oxide remains in the atmosphere for 114 years, an ambitious reduction target is warranted due to its high global warming impact and importance to overall greenhouse reduction efforts.

Significant reductions in the HFCs, which have relatively short atmospheric lifetimes, are also needed. Thus the petitioned pollutant limit of 1 ppt for each of the HFCs, which are entirely man-made and do not occur naturally in the environment, would require release of these chemicals to be virtually eliminated, resulting in an eventual return to near zero concentration of these greenhouse gases in the atmosphere.

The extremely long atmospheric lifetimes of the PFCs, sulfur hexafluoride, and nitrogen trifluoride means that their atmospheric concentrations will remain elevated for many hundreds to thousands of years even if all emissions end immediately. Thus the petitioned pollution limits are set at close to current levels, which would require the phase out of these pollutants in the short term, but at least for the next centuries would only result in stabilization of current concentrations of these pollutants, until and unless a method for removing these chemicals from the atmosphere is developed.

III. EPA Must Expediently Facilitate the State Implementation Planning Process

After EPA adopts national pollution limits, each “[s]tate shall, after reasonable notice and public hearings, adopt and submit to the Administrator . . . a plan which provides for implementation, maintenance, and enforcement of [these limits].”⁹⁶ Through this “cooperative federalism” structure, the Clean Air Act delegates the primary responsibility for choosing the steps necessary to achieve and maintain the national pollution limits to the states. The state implementation planning process effectively combines the benefits of both state and federal involvement in greenhouse gas reductions. The successful state implementation planning process should be mobilized immediately to address the climate crisis.

A. Overview of the State Implementation Planning Process

A state implementation plan is a comprehensive strategy devised by each state to achieve or maintain the national pollution limits. Generally, a state begins the state implementation

⁹⁶ Clean Air Act § 110(a)(1), 42 U.S.C. § 7410 (a)(1) (2008).

planning process by creating an inventory of all emissions sources in the state.⁹⁷ It then determines the amount of emissions reductions that will be necessary to attain or, if it is already in attainment, maintain the ambient levels required by the national pollution limits through air quality modeling.⁹⁸ After determining the amount of reductions necessary, the state outlines a suite of measures designed to achieve those reductions, including emissions limitations, monitoring requirements, enforcement mechanisms, and schedules for compliance.⁹⁹ The state formally adopts these measures into the state implementation plan after public comment.¹⁰⁰

The states must submit their completed state implementation plans to EPA for approval.¹⁰¹ EPA must approve state implementation plans if they show that the state will attain or maintain the national pollution limits,¹⁰² although EPA may also partially or conditionally approve a state implementation plan and require revisions.¹⁰³ If a state fails to submit a state implementation plan that demonstrates attainment or maintenance of the national pollution limits, EPA must apply a variety of funding and compliance sanctions.¹⁰⁴

If a state has failed to submit an approvable state implementation plan two years after the deadline, EPA must issue a federal implementation plan.¹⁰⁵ A federal implementation plan is “a plan (or portion thereof) promulgated by the Administrator to fill all or a portion of a gap or otherwise correct all or a portion of an inadequacy in a State implementation plan . . . and provides for attainment of the relevant national [pollution limit].”¹⁰⁶ Therefore, if the states fail to do their job under section 110, EPA must create, and the states must implement, a federal plan in order to attain or maintain the national pollution limit.

B. State Implementation Plans are Well Suited to Reducing Greenhouse Gas Emissions

Once EPA sets national pollution limits for greenhouse gases, the states must update their state implementation plans to achieve or maintain those limits as they do for the other criteria air pollutants. Although greenhouse gases present a different set of concerns than the existing criteria pollutants, the state implementation plan process is fully able to address these unique concerns and is well suited to effectively reducing greenhouse gas emissions.¹⁰⁷

⁹⁷ See Clean Air Act § 172, 42 U.S.C. § 7502(c)(3) (2008) (for nonattainment areas); 40 C.F.R. § 51.114 (for attainment areas).

⁹⁸ Clean Air Act § 110(a), 42 U.S.C. § 7410(a) (2008); Doremus et al., *supra* note 6.

⁹⁹ Clean Air Act § 110(a)(2), 42 U.S.C. § 7410(a)(2) (2008).

¹⁰⁰ *Id.* § 7410(a)(1).

¹⁰¹ *Id.*

¹⁰² *Id.* § 7410(k)(3).

¹⁰³ *Id.* § 7410(k)(4).

¹⁰⁴ Clean Air Act § 179, 42 U.S.C. § 7509 (2008).

¹⁰⁵ Clean Air Act § 110(c)(1), 42 U.S.C. § 7410(c)(1) (2008).

¹⁰⁶ Clean Air Act § 302(y), 42 U.S.C. § 7602(y) (2008).

¹⁰⁷ EPA’s proposed Tailoring Rule has already commenced the process of tailoring greenhouse gas permitting procedures required under the Clean Air Act’s Title V and prevention of significant deterioration program, and can create similar procedures to allow an efficient and streamlined process to amend and implement state implementation plans, beginning with the regulation of large emitters and including smaller emitters as soon as administratively possible. See 74 Fed. Reg. 55292.

Unlike the existing criteria air pollutants, greenhouse gases are globally dispersed, so that attainment of a national pollution limit for greenhouse gases is a global rather than merely a local concern. Therefore, instead of focusing solely on achieving local air quality standards, state implementation plans for greenhouse gases must focus on achieving each state's proportional share of greenhouse pollution reductions needed to attain the national pollution limit. EPA will need to allocate proportional emissions reduction targets to the states; they, in turn, will demonstrate through state implementation plans how they will integrate the federal minimum requirements by means of their own initiatives to achieve that proportional share of national emissions reductions.

Under the Clean Air Act, a state implementation plan must: 1) monitor, compile, and analyze data on ambient air quality; 2) include enforceable emission limitations and other control measures, means, or techniques (which may include economic incentives such as fees, marketable permits, and auctions of emission rights), as well as schedules and timetables for compliance; and 3) include a program to provide for enforcement of emission reduction measures.¹⁰⁸

Many states are already implementing or are well on their way to completing greenhouse gas reduction plans, and their success to date illustrates the feasibility of developing state implementation plans for greenhouse gases. Many of the required state implementation plan elements are already included in these climate change action plans. As of August 2009, at least forty-seven states have completed or are completing a GHG inventory, thirty-eight are drafting or have drafted climate action plans, and twenty-three states have adopted emissions reduction targets.¹⁰⁹ These existing state climate change plans will undoubtedly form the basis of future greenhouse gas state implementation plans.

In its Advance Notice of Proposed Rulemaking on greenhouse gases, EPA questioned whether it might be unable to approve state implementation plans for greenhouse gases because it is not possible for any individual state (or country) to attain an atmospheric greenhouse gas limit solely through its own efforts.¹¹⁰ In the proposed Endangerment Finding, however, EPA fully recognized that such a concern is misplaced; because of the global nature of greenhouse emissions, their treatment under the Clean Air Act requires a differentiated approach:

Greenhouse gas emissions from section 202(a) source categories, or from any other U.S. source, will become globally mixed in the atmosphere, and thus will have an effect not only on the U.S. regional climate but on the global climate as a whole, and indeed for years and decades to come. The Administrator believes that these unique, global aspects of the climate change problem tend to support a finding that lower levels of emissions should be considered to contribute to the air pollution than might otherwise be considered appropriate when considering contribution to a local or regional air pollution problem. [¶] . . . *If the U.S. and the rest of the world are to combat the risks associated with global climate change, contributors must do their part even if their contributions to the global*

¹⁰⁸ Clean Air Act § 110(2), 42 U.S.C. § 7410(2) (2008).

¹⁰⁹ U.S. Env'tl. Prot. Agency, *supra* note 3; Pew Ctr. on Global Climate Change, *supra* note 3.

¹¹⁰ 73 Fed. Reg. at 44481.

*problem, measured in terms of percentage, are smaller than typically encountered when tackling solely regional or local environmental issues.*¹¹¹

In other words, EPA now fully acknowledges that the U.S. must reduce its greenhouse gas emissions from all sources even though reduction in any individual state or in the U.S. alone will not achieve the full remediation of their deleterious impacts on public health and welfare.

Moreover, Section 179B of the Clean Air Act specifically contemplates and provides an answer to the problem of international emissions.¹¹² Section 179B states that a state implementation plan

shall be approved by the Administrator [if the state] establishes to the satisfaction of the Administrator that the implementation plan of such State would be adequate to attain and maintain the relevant national ambient air quality standards by the attainment date . . . *but for* emissions emanating from outside of the United States.¹¹³

Because greenhouse gases are globally mixed, precisely this calculation must be performed by all nations in whatever attempt is made to reduce their own emissions so that a sustainable global greenhouse gas concentration level can be reached – whether through the Clean Air Act, a carbon tax, a cap-and-trade scheme, or some combination or other alternative. There is, therefore, no obstacle to the successful implementation of the statutory scheme. As long as each greenhouse gas state implementation plan accomplishes the state’s proportional share of the greenhouse gas reductions necessary to achieve the national pollution cap, and otherwise complies with the requirements of section 110, EPA must approve the state implementation plan. If the plan does not meet these requirements, then EPA must design a federal implementation plan in order to do so. A state’s proportionate share would be based on the emissions reductions necessary for the nation as a whole to contribute to global greenhouse gas reductions to below the established pollution limit. The allocation of a proportionate share to a state can be based on any reasonable allocation, such as on the types and numbers of emission sources within its boundaries, population numbers or some other reasonable metric or combination of metrics.

C. The Substantial Benefits of State Implementation Planning for Greenhouse Gases

The development of state implementation plans will have numerous regulatory and practical benefits, including allowing states to build upon existing programs, taking advantage of existing expertise and familiarity with the current regulatory structure, encouraging innovation, and providing consistency and coordination among state programs. Without federal involvement in the ongoing state efforts, their success rate and economic return will necessarily be diminished by the lack of a common pollution limit, lack of nationwide participation, overlapping and/or contradictory requirements, lack of collective learning and potential unnecessary duplication of effort. It is essential that EPA facilitate the state implementation planning process as

¹¹¹ 74 Fed. Reg. at 18907 (emphasis added).

¹¹² Clean Air Act § 179, 42 U.S.C. § 7509a (2008); Christopher T. Giovino, *Defending Overstatement: The Symbolic Clean Air Act*, 30 HAR. ENV. L. REV. 99, 154-55 (2006).

¹¹³ 42 U.S.C. § 7509a(a)(2) (2008) (emphasis added).

expeditiously as possible in order to realize these substantial benefits, a few of which are enumerated below.

First, many strategies that can best reduce greenhouse gas emissions will require policy actions in areas that have traditionally been regulated by states and municipalities, such as land use policies, building codes for residential, commercial and industrial facilities, transportation, utility regulation and agriculture regulation, forestry, and non-hazardous waste handling.¹¹⁴ By influencing building codes, development patterns, efficiency requirements and land use policies, states are able to control the emissions from these types of projects. The state implementation plan process incorporates these critically important, but traditionally state-controlled areas of regulation into a unified greenhouse gas reduction structure for the nation. Studies performed to date indicate that such local measures can have a significant impact on GHG emissions in the United States.¹¹⁵ Because greenhouse gases are emitted by numerous stationary and mobile sources, there is no silver bullet solution to the climate crisis; rather, EPA must implement reductions in a variety of contexts in a complementary fashion. The Clean Air Act is designed to do just that, and the importance of mobilizing all the states in their traditional areas of jurisdiction cannot be overemphasized.

Second, because state implementation plans can effectively address areas traditionally under state and local control, the state implementation plan process would fill the gaps in proposed federal emission trading strategies. While cap-and-trade strategies may address some aspects of the greenhouse gas problem, achieving emission reductions on a large enough scale and rapidly enough to prevent the most extreme manifestations of climate change will require substantial changes in behavior among many actors in all sectors of the economy that cap-and-trade strategies are unlikely to fully or effectively address.¹¹⁶ Rather than rely solely on an untested emissions market, state and local planning strategies must also target areas, such as land use and building codes, for which trading schemes are not well suited.

Third, the significant strides states have already made in reducing their emissions are presently not integrated with federal action. Federal review of state climate reduction efforts

¹¹⁴ Doremus, *supra* note 6, at 827-28; Alice Kaswan, *A Cooperative Federalism Proposal for Climate Change Legislation: The Value of State Autonomy in a Federal System*, 95 DENV. U. L. REV. 791, 829 (2008). For example, one study found that residential and commercial buildings—structures that fit squarely within a state’s jurisdiction—account for one-third of U.S. carbon emissions. MARILYN A. BROWN ET AL., BROOKINGS INST. METROPOLITAN POLICY PROGRAM, *Shrinking the Carbon Footprint of Metropolitan America* (May 2008), available at http://www.brookings.edu/reports/2008/05_carbon_footprint_sarzynski.aspx. Another study concluded that compact development patterns can reduce vehicle miles traveled, and the associated carbon emissions, by as much as 20 – 40%. REID EWING ET AL., *GROWING COOLER: THE EVIDENCE ON URBAN DEVELOPMENT AND CLIMATE CHANGE* 10-11 (2007), available at <http://www.smartgrowthamerica.org/documents/growingcoolerCH1.pdf>.

¹¹⁵ As of 2007, almost half (23) of the states had joined one of three regional emission reduction programs that together account for about 39% of U.S. CO₂ emissions and pursue reduction targets. JONATHAN L. RAMSEUR, CONGRESSIONAL RESEARCH SERVICE, *CLIMATE CHANGE: ACTION BY STATES TO ADDRESS GREENHOUSE GAS EMISSIONS* 25 (2007), available at <http://www.ncseonline.org/NLE/CRSreports/07Dec/RL33812.pdf>. For example, a study has shown that compact residential and commercial development patterns can, by themselves, reduce total transportation-related CO₂ emissions by 7 to 10 percent in 2050. EWING ET AL., *supra* note 114, at 9. Residential and commercial buildings account for 21 and 18 percent, respectively, of CO₂ emissions that can be reduced by local building codes. *Id.*

¹¹⁶ Doremus, *supra* note 6, at 800.

though the state implementation plan process will ensure uniformity among states, address interstate leakage concerns by requiring all states to take action, and vertically integrate rapidly expanding state and local climate change programs, as well as international programs, into a comprehensive national program.¹¹⁷

Fourth, the autonomy given to the states and significant latitude to experiment with control methods and technologies through the state implementation plan process also encourages innovation.¹¹⁸ As Justice Brandeis noted in 1932, states have greater flexibility that allows them to innovate with less severe consequences and use their ability to experiment to provide models for future federal legislation.¹¹⁹ In addition to allowing states to experiment, the state implementation plan framework allows states to learn from each other's successes and failures, and provides opportunity for greater collaboration among states.¹²⁰

Fifth, mandatory state planning also allows policy choices to respond to local variation in challenges and opportunities in a cost-effective manner. Each state has important differences in climate, resources, industry mix, transportation and legal structures for local government, public finance and utility regulation. Because of these differences among states, individualized consideration of the mix of greenhouse gas emission reduction measures, strategies and market and non-market approaches appropriate for each state will produce a more cost-effective approach than a single federal plan.¹²¹

Sixth, state emission reduction plans for greenhouse gases are extremely cost-effective and can result in significant economic benefits, even beyond those obtained through regulation of traditional air pollutants. Not only do greenhouse gas reduction measures result in economic benefits through avoidance of climate change damages, but the many measures targeting energy efficiency and reduced reliance on fossil fuels result in substantial savings over time.¹²² Recent state climate action plans demonstrate net economic savings from combined effects of specific, tried and tested action at the state level when combined with long-term transitions toward new technologies, systems and practices.¹²³ In a preliminary analysis based on data from 20 states with completed climate action plans, the Center for Climate Strategies estimated that "the U.S. could reduce GHG emissions to 10% below 1990 levels by 2020 at an estimated net economic savings of \$20.8 billion in 2012 and \$85 billion in 2020, from 2009 to 2020 cumulative savings of \$535.5 billion, through implementing a climate plan involving all U.S. states and economic

¹¹⁷ See Thomas D. Peterson et al., *Developing a Comprehensive Approach to Climate Change Policy in the United States that Fully Integrates Levels of Government and Economic Sectors*, 26 VIR. ENV. L. J. 227, 229, 264 (2008).

¹¹⁸ Kaswan, *supra* note 114, at 800.

¹¹⁹ *New State Ice Co. v. Liebmann*, 285 U.S. 262 (1932) (Brandeis, J., dissenting).

¹²⁰ Doremus, *supra* note 6, at 829.

¹²¹ Robert McKinstry et al., *The New Climate World: Achieving Economic Efficiency in a Federal System for GHG Regulation Through State Planning Combined with Federal Programs*, 34 N.C.J. INT'L L. & COM. REG. 767, 777 (2009).

¹²² See, e.g., CALIFORNIA AIR RESOURCES BOARD, CLIMATE CHANGE SCOPING PLAN 73 (Dec. 2008), available at <http://www.arb.ca.gov/cc/scopingplan/document/psp.pdf>.

¹²³ Peterson et al., *supra* note 117, at 250-51.; see also CALIFORNIA AIR RESOURCES BOARD, *supra* note 122, at 73-97 (economic evaluation of greenhouse gas scoping plan).

sectors.”¹²⁴ The savings estimate did not include the potential for additional co-benefits such as energy independence and health and environmental protection.¹²⁵

Finally, additional benefits of the Clean Air Act and the state implementation plan process include the minimization of pollution havens and establishing greater incentives for pollution control research and development than individual state or local rules could provide.¹²⁶ The Act has long promoted health and environmental research, as well as technology transfer and other information management and dissemination services, and has resulted in the provision of substantial financial resources to state and local government programs and many other services.¹²⁷ The Clean Air Act has been responsible for controlling some of our most seemingly intractable air pollution problems, including the regional fine particle pollution which is responsible for much of the estimated monetary benefit of historical air pollution control;¹²⁸ these same successful strategies must be put to work reducing greenhouse gas pollution.

The national pollution limit and state implementation planning program is one of the primary mechanisms by which the Clean Air Act combines the best of both state and federal involvement to create a coherent and comprehensive program for the most effective regulation of greenhouse gases. The cooperative federalism structure already embodied in this modern law is ideally suited to achieving the required greenhouse gas reductions from all sectors of the economy.

TIMELINE FOR PETITIONED ACTIONS

The Clean Air Act includes mandatory deadlines for the petitioned actions (e.g., issuance of national pollution caps) and actions which consequently become required (e.g., preparation and submission of state implementation plans). Based on the urgency of the climate crisis, Petitioners believe the EPA and the states can and must act far faster than the maximum time allowed by statute. Table 3 sets forth both the statutory deadlines and the petitioned timeline for some of the key petitioned and consequent actions.

¹²⁴ CENTER FOR CLIMATE STRATEGIES, CLIMATE CHANGE POLICY AS ECONOMIC STIMULUS: EVIDENCE AND OPPORTUNITIES FROM THE STATES 4 (2008), *available at* <http://www.climatestrategies.us/ewebeditpro/items/O25F20494.pdf>.

¹²⁵ *Id.*

¹²⁶ U.S. ENVTL. PROT. AGENCY, *supra* note 9, at 3.

¹²⁷ *Id.*

¹²⁸ *Id.*

Table 3: Timeline for Petitioned and Consequent Actions

Petitioned or Consequent Action	Maximum Time Allowed by Statute	Action Requested Within (Time from Present)
Designate the greenhouse gases as criteria air pollutants	EPA must respond to the petition within a reasonable time	6 months
Issue air quality criteria and information on air pollution control techniques for the greenhouse gases pursuant to section 108(a)(2) and (b)(1)	12 months from criteria air pollutant designation	9 months
Publish proposed national primary and secondary pollution caps for the greenhouse gases pursuant to section 109(a)	12 months from criteria air pollutant designation	9 months
Publish final national primary and secondary pollution caps for the greenhouse gases	No later than 90 days after initial publication of proposed caps	1 year
States submit state implementation plan revisions incorporating measures for greenhouse gases to EPA pursuant to section 110(a)	3 years (or “such shorter period as the Administrator may prescribe”) from promulgation of final pollution caps	2 years
EPA find the plans complete or requires revision	Within 60 days of receipt of plan	2 years, 2 months
Full or partial approval of state plans, begin full implementation	Within 12 months of finding a plan complete	2 ½ years

Petitioners recognize that the petitioned timeline is faster in many regards than past compliance for current criteria air pollutants. Petitioners further recognize that some may argue that establishment of a national pollution limit for greenhouse gases and full deployment of the state implementation planning process will take too long, based in part on lengthy delays in past implementation. Petitioners, however, reject any cynical assertion that the EPA and states cannot be expected to meet the timelines set forth in the law. Moreover, to the degree that some may argue that further delays in implementation are inevitable due to industry lawsuits, or that the system would be too complicated or unworkable, those arguments could all be made with greater strength with regard to the currently proposed cap-and-trade program in federal climate legislation. It is, in fact, more likely that an entirely new greenhouse regulatory scheme will be subject to delay due to lawsuits from industry, as opposed to implementation of the Clean Air Act, under which the EPA, states, and industry have four decades of experience.

CONCLUSION

The EPA's delay to date in implementing greenhouse gas regulation pursuant to the Clean Air Act not only jeopardizes public health and welfare, but has taken us almost to a point of no return that may change our planet's future in profound and tragic ways. For all the reasons discussed above, we urge the EPA to quickly implement the steps described in this petition.

As leading climate scientists note, "[r]ealization that we must reduce the current CO₂ amount has a bright side: effects that had begun to seem inevitable, including impacts of ocean acidification, loss of fresh water supplies, and shifting of climatic zones, may be averted by the necessity of finding an energy course beyond fossil fuels sooner than would otherwise have occurred."¹²⁹

These authors conclude

[w]ith simultaneous policies to reduce non-CO₂ greenhouse gases, it appears still feasible to avert catastrophic climate change. Present policies, with continued construction of coal fired power plants without CO₂ capture, suggest that decision-makers do not appreciate the gravity of the situation. We must begin to move now toward the era beyond fossil fuels. Continued growth of greenhouse gas emissions, for just another decade, practically eliminates the possibility of near-term return of atmospheric composition beneath the tipping level for catastrophic effects. The most difficult task, phase-out over the next 20-25 years of coal use that does not capture CO₂, is Herculean, yet feasible when compared with the efforts that went into World War II. The stakes, for all life on the planet, surpass those of any previous crisis. The greatest danger¹³⁰ is continued ignorance and denial, which could make tragic consequences unavoidable.

We urge the EPA to rapidly and fully utilize the tools provided by the Clean Air Act—tools that for many years have proven both successful and cost-effective—to address the climate crisis as detailed in this petition.

Respectfully Submitted this 2nd day of December, 2009.



Kassie Siegel, Director
Climate Law Institute
Center for Biological Diversity
P.O. Box 549
Joshua Tree, CA 92252
Phone: (760) 366-2232
Facsimile: (760) 366-2669
ksiegel@biologicaldiversity.org



Gillian May Boeve
Global Partnerships, Policy, Operations, and
US/Canada Outreach
350.org
Suite 340, The David Brower Center
2150 Allston Way, Berkeley, CA 94704
Phone: (707) 815-0054
may@350.org

¹²⁹ Hansen, *supra* note 70, at 228.

¹³⁰ *Id.* at 229.

LITERATURE CITED

Dean Abrahamson, An Open Letter to the President and Members of Congress Strong Leadership Needed Now on Climate (June 23, 2009).

David Adam, Roll Back Time to Safeguard Climate, Expert Warns: A Return to Pre-Industrial Levels of Carbon Dioxide Urged as the Only Way to Prevent the Worst Impacts of Global Warming, *The Guardian*, Sept. 15 2008.

I. Allison et al., *The Copenhagen Diagnosis, 2009: Updating the World on the Latest Climate Science* (2009).

L. Bernstein, et al., *IPCC, Climate Change 2007: Synthesis Report*. (2007).

Marilyn A. Brown, et al., *Brookings Institute, Shrinking the Carbon Footprint of Metropolitan America* (May 2008).

California Air Resources Board, *Climate Change Proposed Scoping Plan: A Framework for Change* (2008).

Center for Climate Strategies, *Climate Change Policy as Economic Stimulus: Evidence and Opportunities from the States* (2008).

Holly Doremus and W. Michael Hanemann, Of Babies and Bathwater, Why the Clean Air Act's Cooperative Federalism Framework Is Useful for Addressing Global Warming, 50 *Ariz. L. Rev.* 799 (2008).

P.R. Epstein et al., *Harvard Med. School Ctr. For Health and the Global Env't, Climate Change Futures Health, Ecological, and Economic Dimensions* (2005).

Reid Ewing et al., *Growing Cooler: the Evidence on Urban Development and Climate Change* (2007).

P. Forster et al., *Changes in Atmospheric Constituents and in Radiative Forcing*, in *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* (Solomon, S., et al. eds., Cambridge University Press 2007).

Christopher T. Giovino, *Defending Overstatement: The Symbolic Clean Air Act*, 30 *Har. Env. L. Rev.* 99 (2006).

The Global Humanitarian Forum, *Human Impact Report Climate Change: the Anatomy of a Silent Crisis* (2009).

Odd Godal, *The IPCC's Assessment of Multidisciplinary Issues: The Case of Greenhouse Gas Indices*, *Climatic Change*, Nov. 2003.

J. Hansen et al., Target Atmospheric CO₂: Where Should Humanity Aim?, *The Open Atmospheric Science Journal*, 2008, 217, 218.

J. Hansen et al., Climate Change and Trace Gases, 365 *Phil. Trans. R. Soc. A*. 1925 (2007).

J.S. Holladay et al., New York University School of Law, *Economists and Climate Change Consensus and Open Questions* (2009).

Marlow Hood, Top UN Climate Scientist backs Ambitious CO₂ Cuts, *Agence France Press*, Aug. 28, 2009.

Intergovernmental Panel on Climate Change, *Climate Change 2001: Synthesis Report, Summary for Policymakers* (2001).

Alice Kaswan, A Cooperative Federalism Proposal for Climate Change Legislation: The Value of State Autonomy in a Federal System, 95 *Denv. U. L. Rev.* 791 (2008).

Robert B. McKinstry & Thomas D. Peterson, The Business of Climate Change: Challenges and Opportunities for Multinational Business Enterprises: The Implications of the New “Old” Federalism in Climate-Change Legislation: How to Function in a Global Marketplace When States Take the Lead, 20 *Pac. McGeorge Global Bus. & Dev. L.J.* 61 (2007).

Robert McKinstry et al., The New Climate World: Achieving Economic Efficiency in a Federal System for GHG Regulation Through State Planning Combined with Federal Programs, 34 *N.C.J. Int’l L. & Com. Reg.* 767 (2009).

Malte Meinshausen, What Does a 2°C Target Mean for Greenhouse Gas Concentrations? A Brief Analysis Based on Multi-Gas Emission Pathways and Several Climate Sensitivity Uncertainty Estimates, in *Avoiding Dangerous Climate Change* 268 (2006).

A. Montenegro et al., Long Term Fate of Atmospheric Carbon, 34 *Geophys. Res. Lett.* L19707 (2007).

Thomas D. Peterson et al., Developing a Comprehensive Approach to Climate Change Policy in the United States that Fully Integrates Levels of Government and Economic Sectors, 26 *Vir. Env. L.J.* 227 (2008).

Pew Ctr. On Global Climate Change, U.S. Climate Policy Maps, available at http://www.pewclimate.org/what_s_being_done/in_the_states/state_action_maps.cfm (last visited Nov. 25, 2009).

Jonathan L. Ramseur, Congressional Research Service, *Climate Change: Action by States to Address Greenhouse Gas Emissions* (2007).

Andrew C. Revkin, Why 2007 I.P.C.C. Report Lacked ‘Embers’, *N.Y. Times*, Feb. 26, 2009.

Shindell, D., Local and Remote Contributions to Arctic Warming, *Geophys. Res. Lett.* 34, L14704 (July 20, 2007).

Joel B. Smith et al., Assessing Dangerous Climate Change Through an Update of the Intergovernmental Panel on Climate Change (IPCC) "Reasons for Concern," 106 *Proc. Nat'l Acad. Sci.* 4133 (2009).

S. Solomon et al., Irreversible climate change due to carbon dioxide emissions, 106 *Proc. Nat'l Acad. Sci.* 1704 (2009)

R. Steizer et al., Center for Progressive Reform, A Return to Common Sense: Protecting Health, Safety, and the Environment through 'Pragmatic Regulatory Impact Analysis' (2009).

Sir Nicholas Stern, *Stern Review on the Economics of Climate Change* (Cambridge University Press 2006).

The Economics of Ecosystem Biodiversity, TEEB Climate Issues Update (Sept. 2009).

U.S. Env'tl. Prot. Agency, State and Local Governments, State Planning and Measurement, http://www.epa.gov/climatechange/wycd/stateandlocalgov/state_planning.html#three (last visited Dec. 1, 2009).

U.S. Env'tl. Prot. Agency, The Benefits and Costs of the Clean Air Act: 1970 to 1990 (1997).

U.S. Env'tl. Prot. Agency, The Benefits and Costs of the Clean Air Act: 1990 to 2010 (1999).

U.S. Env'tl. Prot. Agency, Press Release, The Benefits and Costs of the Clean Air Act, First Protective Study (Nov. 16, 1999).

U.S. Global Change Research Program, *Global Climate Change Impacts in the United States* (2009).

Rachel Warren, Impacts of Global Climate Change at Different Annual Mean Global Temperature Increases, in *Avoiding Dangerous Climate Change* (2006).

Henry Waxman with Joshua Green, *the Waxman Report How Congress Really Works* (Twelve/Grand Central Publishing 2009).

R. F. Weiss et al., Nitrogen Trifluoride in the Global Atmosphere, 35 *Geophys. Res. Lett.* L20821 (Oct. 2008).

Wooley, D.R. & E.M. Morss, *The Clean Air Act Handbook a Practical Guide to Compliance*, (Thompson West ed., 8th ed. 2008).

World Meteorological Organization (WMO), WMO Greenhouse Gas Bulletin, No. 5: 23
(November 2009).

Yale Environment 360, Amid Mounting Hope, a Voice of Hope for Copenhagen, Nov. 4, 2009.

APPENDIX A: PETITIONED POLLUTANTS

Table 4: Petitioned Pollutants (data from P. Forster et al., *Changes in Atmospheric Constituents and in Radiative Forcing*, in CLIMATE CHANGE 2007: THE PHYSICAL SCIENCE BASIS. CONTRIBUTION OF WORKING GROUP I TO THE FOURTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (Solomon, S., et al. eds., Cambridge University Press 2007).

Pollutant	Atmospheric Lifetime (years)	GWP1 20-yr	GWP 100-yr	GWP 500-yr
Carbon Dioxide (CO₂)	*	1	1	1
Methane (CH₄)	12	72	25	7.6
Nitrous Oxide (N₂O)	114	289	298	153
Hydrofluorocarbons (HFCs)	1.4-270			
HFC-23	270	12000	14,800	12,200
HFC-32	4.9	2,330	675	205
HFC-125	29	6350	3,500	1,100
HFC-134a	14	3830	1,430	435
HFC-143a	52	3,800	5,890	4,470
HFC-152a	1.4	437	124	38
HFC-227ea	34.2	5,310	3,220	1,040
HFC-236fa	240	8,100	9,810	7,660
HFC-245fa	7.6	3,380	1,030	314
HFC-365mfc	8.6	2,520	794	241
HFC-43-10mee	15.9	4,140	1,640	500
Perfluorocarbons (PFCs)				
PFC-14	50,000	5210	7,390	11,200
PFC-116	10,000	8630	12,200	18,200
PFC-218	2,600	6,130	8,830	12,500
PFC-318	3,200	7,310	10,300	14,700

PFC-3-1-10	2,600	6,330	8,860	12,500
PFC-4-1-12	4,100	6,510	9,160	13,300
PFC-5-1-14	3,200	6,600	9,300	13,300
PFC-9-1-18	>1000	>5,500	>7,500	>9,500
Trifluoromethyl Sulphur Petafluoride	800	13,200	17,700	21,200
Sulfur hexafluoride (SF₆)	3,200	16300	22,800	32,600
Nitrogen trifluoride	740	12300	17,200	20,700