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Board Item No. 32

COMMITTEE/BOARD OF SUPERVISORS

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Prepared by: Lisa Lew **Date:** September 5, 2025
Prepared by: _____ **Date:** _____

FILE NO. 250909 RESOLUTION NO.

[Opposing the U.S. Environmental Protection Agency's Proposal to Rescind the 2009 Greenhouse Gas Endangerment Finding]

Resolution opposing the United States (U.S) Environmental Protection Agency's proposal to rescind the 2009 Greenhouse Gas Endangerment Finding; urging the Bay Area Air Quality Management District to adopt a similar position; and reaffirming the City and County of San Francisco's commitment to strong climate action and air quality protections.

WHEREAS, In 2007, the United States Supreme Court decided Massachusetts v. Environmental Protection Agency, holding that greenhouse gases fall within the Clean Air Act's definition of "air pollutant" and requiring EPA to determine whether such pollutants from motor vehicles endanger public health or welfare; and

WHEREAS, In response to that ruling, EPA conducted an extensive scientific review and public process, receiving and considering more than 380,000 public comments and relying on the conclusions of the U.S. Global Change Research Program, the Intergovernmental Panel on Climate Change, and the National Research Council; and

WHEREAS, On December 15, 2009, EPA issued the Greenhouse Gas Endangerment Finding, concluding that six greenhouse gases including carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride, which collectively endanger both the public health and public welfare of current and future generations, thereby triggering EPA's obligation under Section 202 of the Clean Air Act to regulate emissions from new motor vehicles; and

WHEREAS, The Endangerment Finding has since served as the scientific and legal foundation for national greenhouse gas regulations across multiple sectors, including

transportation, power generation, and industry, and has been repeatedly upheld by federal courts of appeals; and

WHEREAS, On July 29, 2025, the United States (U.S.) Environmental Protection Agency (EPA) proposed rescinding the 2009 Greenhouse Gas Endangerment Finding; and

WHEREAS, The Endangerment Finding is a prerequisite for regulating greenhouse gas emissions from new motor vehicles and new motor vehicle engines under Section 202 of the Clean Air Act; and

WHEREAS, Rescinding the Endangerment Finding is a misguided effort to remove requirements for engine and vehicle manufacturers to measure, control, and report greenhouse gas emissions for light-, medium-, and heavy-duty on-highway vehicles, and to undermine decades of federal climate and air quality protections; and

WHEREAS, Transportation is the largest source of greenhouse gas emissions in the United States and a major source of harmful co-pollutants that worsen public health outcomes, particularly for low-income communities and communities of color who already face disproportionate environmental burdens; and

WHEREAS, San Francisco has long advanced policies to reduce carbon emissions, improve air quality, and protect public health through the City's Climate Action Plan, transit-first policies, and clean vehicle programs; and

WHEREAS, The Bay Area Air Quality Management District is a critical regional partner in advancing clean air standards and climate action, and its leadership is vital in opposing federal actions that would weaken protections; and

WHEREAS, The EPA's proposal to rescind the Endangerment Finding disregards the scientific consensus that greenhouse gas emissions are a major driver of climate change and jeopardizes public health and safety; now, therefore, be it

RESOLVED, That the Board of Supervisors of the City and County of San Francisco strongly opposes the U.S. Environmental Protection Agency's proposal to rescind the 2009 Greenhouse Gas Endangerment Finding; and, be it

FURTHER RESOLVED, That the Board of Supervisors urges the Bay Area Air Quality Management District/Bay Area Air District to adopt a similar position, defend the legal and scientific foundation for regulating greenhouse gas emissions, and advocate for continued federal leadership on climate protections; and, be it

FURTHER RESOLVED, That the Board of Supervisors reaffirms San Francisco's commitment to strong climate and environmental justice policies to protect public health, safeguard vulnerable communities, and preserve a livable future; and, be it

FURTHER RESOLVED, That the Clerk of the Board shall transmit copies of this Resolution to the U.S. Environmental Protection Agency, EPA Administrator Lee Zeldin, the Bay Area Air Quality Management District/Bay Area Air District Board of Directors and Executive Officer, the California Air Resources Board, the Governor of California, the California Attorney General, and the San Francisco state and federal legislative representatives no later than September 15, 2025, to ensure inclusion in the EPA's public comment record.

Federal Register

Tuesday,

December 15, 2009

Part V

Environmental Protection Agency

40 CFR Chapter I

Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act; Final Rule

ENVIRONMENTAL PROTECTION AGENCY

40 CFR Chapter I

[EPA–HQ–OAR–2009–0171; FRL–9091–8]

RIN 2060–ZA14

Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act

AGENCY: Environmental Protection Agency (EPA).

ACTION: Final rule.

SUMMARY: The Administrator finds that six greenhouse gases taken in combination endanger both the public health and the public welfare of current and future generations. The Administrator also finds that the combined emissions of these greenhouse gases from new motor vehicles and new motor vehicle engines contribute to the greenhouse gas air pollution that endangers public health and welfare under CAA section 202(a). These Findings are based on careful consideration of the full weight of scientific evidence and a thorough review of numerous public comments received on the Proposed Findings published April 24, 2009.

DATES: These Findings are effective on January 14, 2010.

ADDRESSES: EPA has established a docket for this action under Docket ID No. EPA–HQ–OAR–2009–0171. All documents in the docket are listed on the *www.regulations.gov* Web site. Although listed in the index, some information is not publicly available, *e.g.*, confidential business information (CBI) or other information whose disclosure is restricted by statute. Certain other material, such as copyrighted material, is not placed on the Internet and will be publicly available only in hard copy form. Publicly available docket materials are available either electronically through *www.regulations.gov* or in hard copy at EPA's Docket Center, Public Reading Room, EPA West Building, Room 3334, 1301 Constitution Avenue, NW., Washington, DC 20004. This Docket Facility is open from 8:30 a.m. to 4:30 p.m., Monday through Friday, excluding legal holidays. The telephone number for the Public Reading Room is (202) 566–1744, and the telephone number for the Air Docket is (202) 566–1742.

FOR FURTHER INFORMATION CONTACT: Jeremy Martinich, Climate Change Division, Office of Atmospheric Programs (MC–6207J), Environmental Protection Agency, 1200 Pennsylvania Ave., NW., Washington, DC 20460; telephone number: (202) 343–9927; fax number: (202) 343–2202; e-mail address: *ghgendangerment@epa.gov*. For additional information regarding these Findings, please go to the Web site *http://www.epa.gov/climatechange/endangerment.html*.

SUPPLEMENTARY INFORMATION:

Judicial Review

Under CAA section 307(b)(1), judicial review of this final action is available only by filing a petition for review in the U.S. Court of Appeals for the District of Columbia Circuit by February 16, 2010. Under CAA section 307(d)(7)(B), only an objection to this final action that was raised with reasonable specificity during the period for public comment can be raised during judicial review. This section also provides a mechanism for us to convene a proceeding for reconsideration, '' '[i]f the person raising an objection can demonstrate to EPA that it was impracticable to raise such objection within [the period for public comment] or if the grounds for such objection arose after the period for public comment (but within the time specified for judicial review) and if such objection is of central relevance to the outcome of this rule.' '' Any person seeking to make such a demonstration to us should submit a Petition for Reconsideration to the Office of the Administrator, Environmental Protection Agency, Room 3000, Ariel Rios Building, 1200 Pennsylvania Ave., NW., Washington, DC 20004, with a copy to the person listed in the preceding **FOR FURTHER INFORMATION CONTACT** section, and the Associate General Counsel for the Air and Radiation Law Office, Office of General Counsel (Mail Code 2344A), Environmental Protection Agency, 1200 Pennsylvania Ave., NW., Washington, DC 20004.

Acronyms and Abbreviations. The following acronyms and abbreviations are used in this document.

ACUS Administrative Conference of the United States
ANPR Advance Notice of Proposed Rulemaking
APA Administrative Procedure Act
CAA Clean Air Act
CAFE Corporate Average Fuel Economy
CAIT Climate Analysis Indicators Tool
CASAC Clean Air Scientific Advisory Committee
CBI Confidential Business Information
CCSP Climate Change Science Program
CFCs chlorofluorocarbons
CFR Code of Federal Regulations
CH_4 methane
CO_2 carbon dioxide
CO_2e CO_2-equivalent
CRU Climate Research Unit
DOT U.S. Department of Transportation
EO Executive Order
EPA U.S. Environmental Protection Agency
FR **Federal Register**
GHG greenhouse gas
GWP global warming potential
HadCRUT Hadley Centre/Climate Research Unit (CRU) temperature record
HCFCs hydrochlorofluorocarbons
HFCs hydrofluorocarbons
IA Interim Assessment report
IPCC Intergovernmental Panel on Climate Change
MPG miles per gallon
MWP Medieval Warm Period
N_2O nitrous oxide
NAAQS National Ambient Air Quality Standards
NAICS North American Industry Classification System
NASA National Aeronautics and Space Administration
NF_3 nitrogen trifluoride
NHTSA National Highway Traffic Safety Administration
NOAA National Oceanic and Atmospheric Administration
NOI Notice of Intent
NO_X nitrogen oxides
NRC National Research Council
NSPS new source performance standards
NTTAA National Technology Transfer and Advancement Act of 1995
OMB Office of Management and Budget
PFCs perfluorocarbons
PM particulate matter
PSD Prevention of Significant Deterioration
RFA Regulatory Flexibility Act
SF_6 sulfur hexafluoride
SIP State Implementation Plan
TSD technical support document
U.S. United States
UMRA Unfunded Mandates Reform Act of 1995
UNFCCC United Nations Framework Convention on Climate Change
USGCRP U.S. Global Climate Research Program
VOC volatile organic compound(s)
WCI Western Climate Initiative
WRI World Resources Institute

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I. Introduction

A. Overview

Pursuant to CAA section 202(a), the Administrator finds that greenhouse gases in the atmosphere may reasonably be anticipated both to endanger public health and to endanger public welfare. Specifically, the Administrator is defining the ''air pollution'' referred to in CAA section 202(a) to be the mix of six long-lived and directly-emitted greenhouse gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). In this document, these six greenhouse gases are referred to as ''well-mixed greenhouse gases'' in this document (with more precise meanings of ''long lived'' and ''well mixed'' provided in Section IV.A).

The Administrator has determined that the body of scientific evidence compellingly supports this finding. The major assessments by the U.S. Global Climate Research Program (USGCRP), the Intergovernmental Panel on Climate Change (IPCC), and the National Research Council (NRC) serve as the primary scientific basis supporting the Administrator's endangerment finding.[1] The Administrator reached her determination by considering both observed and projected effects of greenhouse gases in the atmosphere, their effect on climate, and the public health and welfare risks and impacts associated with such climate change. The Administrator's assessment focused on public health and public welfare impacts within the United States. She also examined the evidence with respect to impacts in other world regions, and she concluded that these impacts strengthen the case for endangerment to public health and welfare because impacts in other world regions can in turn adversely affect the United States.

The Administrator recognizes that human-induced climate change has the potential to be far-reaching and multi-dimensional, and in light of existing knowledge, that not all risks and potential impacts can be quantified or characterized with uniform metrics. There is variety not only in the nature and potential magnitude of risks and impacts, but also in our ability to characterize, quantify and project such impacts into the future. The Administrator is using her judgment, based on existing science, to weigh the threat for each of the identifiable risks, to weigh the potential benefits where relevant, and ultimately to assess whether these risks and effects, when viewed in total, endanger public health or welfare.

The Administrator has considered how elevated concentrations of the well-mixed greenhouse gases and associated climate change affect public health by evaluating the risks associated with changes in air quality, increases in temperatures, changes in extreme weather events, increases in food- and water-borne pathogens, and changes in aeroallergens. The evidence concerning adverse air quality impacts provides strong and clear support for an endangerment finding. Increases in ambient ozone are expected to occur over broad areas of the country, and they are expected to increase serious adverse health effects in large population areas that are and may continue to be in nonattainment. The evaluation of the potential risks associated with increases in ozone in attainment areas also supports such a finding.

The impact on mortality and morbidity associated with increases in average temperatures, which increase the likelihood of heat waves, also provides support for a public health endangerment finding. There are uncertainties over the net health impacts of a temperature increase due to decreases in cold-related mortality, but some recent evidence suggests that the net impact on mortality is more likely to be adverse, in a context where heat is already the leading cause of weather-related deaths in the United States.

The evidence concerning how human-induced climate change may alter extreme weather events also clearly supports a finding of endangerment, given the serious adverse impacts that can result from such events and the increase in risk, even if small, of the occurrence and intensity of events such as hurricanes and floods. Additionally, public health is expected to be

[1] Section III of these Findings discusses the science on which these Findings are based. In addition, the Technical Support Document (TSD) accompanying these Findings summarizes the major assessments from the USGCRP, IPCC, and NRC.

adversely affected by an increase in the severity of coastal storm events due to rising sea levels.

There is some evidence that elevated carbon dioxide concentrations and climate changes can lead to changes in aeroallergens that could increase the potential for allergenic illnesses. The evidence on pathogen borne disease vectors provides directional support for an endangerment finding. The Administrator acknowledges the many uncertainties in these areas. Although these adverse effects provide some support for an endangerment finding, the Administrator is not placing primary weight on these factors.

Finally, the Administrator places weight on the fact that certain groups, including children, the elderly, and the poor, are most vulnerable to these climate-related health effects.

The Administrator has considered how elevated concentrations of the well-mixed greenhouse gases and associated climate change affect public welfare by evaluating numerous and far-ranging risks to food production and agriculture, forestry, water resources, sea level rise and coastal areas, energy, infrastructure, and settlements, and ecosystems and wildlife. For each of these sectors, the evidence provides support for a finding of endangerment to public welfare. The evidence concerning adverse impacts in the areas of water resources and sea level rise and coastal areas provides the clearest and strongest support for an endangerment finding, both for current and future generations. Strong support is also found in the evidence concerning infrastructure and settlements, as well ecosystems and wildlife. Across the sectors, the potential serious adverse impacts of extreme events, such as wildfires, flooding, drought, and extreme weather conditions, provide strong support for such a finding.

Water resources across large areas of the country are at serious risk from climate change, with effects on water supplies, water quality, and adverse effects from extreme events such as floods and droughts. Even areas of the country where an increase in water flow is projected could face water resource problems from the supply and water quality problems associated with temperature increases and precipitation variability, as well as the increased risk of serious adverse effects from extreme events, such as floods and drought. The severity of risks and impacts is likely to increase over time with accumulating greenhouse gas concentrations and associated temperature increases and precipitation changes.

Overall, the evidence on risk of adverse impacts for coastal areas provides clear support for a finding that greenhouse gas air pollution endangers the welfare of current and future generations. The most serious potential adverse effects are the increased risk of storm surge and flooding in coastal areas from sea level rise and more intense storms. Observed sea level rise is already increasing the risk of storm surge and flooding in some coastal areas. The conclusion in the assessment literature that there is the potential for hurricanes to become more intense (and even some evidence that Atlantic hurricanes have already become more intense) reinforces the judgment that coastal communities are now endangered by human-induced climate change, and may face substantially greater risk in the future. Even if there is a low probability of raising the destructive power of hurricanes, this threat is enough to support a finding that coastal communities are endangered by greenhouse gas air pollution. In addition, coastal areas face other adverse impacts from sea level rise such as land loss due to inundation, erosion, wetland submergence, and habitat loss. The increased risk associated with these adverse impacts also endangers public welfare, with an increasing risk of greater adverse impacts in the future.

Strong support for an endangerment finding is also found in the evidence concerning energy, infrastructure, and settlements, as well ecosystems and wildlife. While the impacts on net energy demand may be viewed as generally neutral for purposes of making an endangerment determination, climate change is expected to result in an increase in electricity production, especially supply for peak demand. This may be exacerbated by the potential for adverse impacts from climate change on hydropower resources as well as the potential risk of serious adverse effects on energy infrastructure from extreme events. Changes in extreme weather events threaten energy, transportation, and water resource infrastructure. Vulnerabilities of industry, infrastructure, and settlements to climate change are generally greater in high-risk locations, particularly coastal and riverine areas, and areas whose economies are closely linked with climate-sensitive resources. Climate change will likely interact with and possibly exacerbate ongoing environmental change and environmental pressures in settlements, particularly in Alaska where indigenous communities are facing major environmental and cultural impacts on their historic lifestyles. Over the 21st century, changes in climate will cause some species to shift north and to higher elevations and fundamentally rearrange U.S. ecosystems. Differential capacities for range shifts and constraints from development, habitat fragmentation, invasive species, and broken ecological connections will likely alter ecosystem structure, function, and services, leading to predominantly negative consequences for biodiversity and the provision of ecosystem goods and services.

There is a potential for a net benefit in the near term [2] for certain crops, but there is significant uncertainty about whether this benefit will be achieved given the various potential adverse impacts of climate change on crop yield, such as the increasing risk of extreme weather events. Other aspects of this sector may be adversely affected by climate change, including livestock management and irrigation requirements, and there is a risk of adverse effect on a large segment of the total crop market. For the near term, the concern over the potential for adverse effects in certain parts of the agriculture sector appears generally comparable to the potential for benefits for certain crops. However, The body of evidence points towards increasing risk of net adverse impacts on U.S. food production and agriculture over time, with the potential for significant disruptions and crop failure in the future.

For the near term, the Administrator finds the beneficial impact on forest growth and productivity in certain parts of the country from elevated carbon dioxide concentrations and temperature increases to date is offset by the clear risk from the observed increases in wildfires, combined with risks from the spread of destructive pests and disease. For the longer term, the risk from adverse effects increases over time, such that overall climate change presents serious adverse risks for forest productivity. There is compelling reason to find that the support for a positive endangerment finding increases as one considers expected future conditions where temperatures continue to rise.

Looking across all of the sectors discussed above, the evidence provides compelling support for finding that greenhouse gas air pollution endangers the public welfare of both current and

[2] The temporal scope of impacts is discussed in more detail in Section III.C. The phrase ''near term'' as used in this document generally refers to the current time period from and the next few decades. The phrase ''long term'' generally refers to a time frame extending beyond that to approximately the middle to the end of this century.

future generations. The risk and the severity of adverse impacts on public welfare are expected to increase over time.

The Administrator also finds that emissions of well-mixed greenhouse gases from the transportation sources covered under CAA section 202(a) [3] contribute to the total greenhouse gas air pollution, and thus to the climate change problem, which is reasonably anticipated to endanger public health and welfare. The Administrator is defining the air pollutant that contributes to climate change as the aggregate group of the well-mixed greenhouse gases. The definition of air pollutant used by the Administrator is based on the similar attributes of these substances. These attributes include the fact that they are sufficiently long-lived to be well mixed globally in the atmosphere, that they are directly emitted, and that they exert a climate warming effect by trapping outgoing, infrared heat that would otherwise escape to space, and that they are the focus of climate change science and policy.

In order to determine if emissions of the well-mixed greenhouse gases from CAA section 202(a) source categories contribute to the air pollution that endangers public health and welfare, the Administrator compared the emissions from these CAA section 202(a) source categories to total global and total U.S. greenhouse gas emissions, finding that these source categories are responsible for about 4 percent of total global well-mixed greenhouse gas emissions and just over 23 percent of total U.S. well-mixed greenhouse gas emissions. The Administrator found that these comparisons, independently and together, clearly establish that these emissions contribute to greenhouse gas concentrations. For example, the emissions of well-mixed greenhouse gases from CAA section 202(a) sources are larger in magnitude than the total well-mixed greenhouse gas emissions from every other individual nation with the exception of China, Russia, and India, and are the second largest emitter within the United States behind the electricity generating sector. As the Supreme Court noted, ''[j]udged by any standard, U.S. motor-vehicle emissions make a meaningful contribution to greenhouse gas concentrations and hence, * * * to global warming.'' *Massachusetts* v. *EPA,* 549 U.S. 497, 525 (2007).

[3] Section 202(a) source categories include passenger cars, heavy-, medium and light-duty trucks, motorcycles, and buses.

The Administrator's findings are in response to the Supreme Court's decision in *Massachusetts* v. *EPA*. That case involved a 1999 petition submitted by the International Center for Technology Assessment and 18 other environmental and renewable energy industry organizations requesting that EPA issue standards under CAA section 202(a) for the emissions of carbon dioxide, methane, nitrous oxide, and hydrofluorocarbons from new motor vehicles and engines. The Administrator's findings are in response to this petition and are for purposes of CAA section 202(a).

B. Background Information Helpful To Understand These Findings

This section provides some basic information regarding greenhouse gases and the CAA section 202(a) source categories, as well as the ongoing joint-rulemaking on greenhouse gases by EPA and the Department of Transportation. Additional technical and legal background, including a summary of the Supreme Court's *Massachusetts* v. *EPA* decision, can be found in the Proposed Endangerment and Contribution Findings (74 FR 18886, April 24, 2009).

1. Greenhouse Gases and Transportation Sources Under CAA Section 202(a)

Greenhouse gases are naturally present in the atmosphere and are also emitted by human activities. Greenhouse gases trap the Earth's heat that would otherwise escape from the atmosphere, and thus form the greenhouse effect that helps keep the Earth warm enough for life. Human activities are intensifying the naturally-occurring greenhouse effect by adding greenhouse gases to the atmosphere. The primary greenhouse gases of concern that are directly emitted by human activities include carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride. Other pollutants (such as aerosols) and other human activities, such as land use changes that alter the reflectivity of the Earth's surface, also cause climatic warming and cooling effects. In these Findings, the term ''climate change'' generally refers to the global warming effect plus other associated changes (*e.g.,* precipitation effects, sea level rise, changes in the frequency and severity of extreme weather events) being induced by human activities, including activities that emit greenhouse gases. Natural causes also, contribute to climate change and climatic changes have occurred throughout the Earth's history. The concern now, however, is that the changes taking place in our atmosphere as a result of the well-documented buildup of greenhouse gases due to human activities are changing the climate at a pace and in a way that threatens human health, society, and the natural environment. Further detail on the state of climate change science can be found in Section III of these Findings as well as the technical support document (TSD) that accompanies this action (*www.epa.gov/climatechange/endangerment.html*).

The transportation sector is a major source of greenhouse gas emissions both in the United States and in the rest of the world. The transportation sources covered under CAA section 202(a)—the section of the CAA under which these Findings occur—include passenger cars, light- and heavy-duty trucks, buses, and motorcycles. These transportation sources emit four key greenhouse gases: carbon dioxide, methane, nitrous oxide, and hydrofluorocarbons. Together, these transportation sources are responsible for 23 percent of total annual U.S. greenhouse gas emissions, making this source the second largest in the United States behind electricity generation.[4]

Further discussion of the emissions data supporting the Administrator's cause or contribute finding can be found in Section V of these Findings, and the detailed greenhouse gas emissions data for section 202(a) source categories can be found in Appendix B of EPA's TSD.

2. Joint EPA and Department of Transportation Proposed Greenhouse Gas Rule

On September 15, 2009, EPA and the Department of Transportation's National Highway Safety Administration (NHTSA) proposed a National Program that would dramatically reduce greenhouse gas emissions and improve fuel economy for new cars and trucks sold in the United States. The combined EPA and NHTSA standards that make up this proposed National Program would apply to passenger cars, light-duty trucks, and medium-duty passenger vehicles, covering model years 2012 through 2016. They proposed to require these vehicles to meet an estimated combined average

[4] The units for greenhouse gas emissions in these findings are provided in carbon dioxide equivalent units, where carbon dioxide is the reference gas and every other greenhouse gas is converted to its carbon dioxide equivalent by using the 100-year global warming potential (as estimated by the Intergovernmental Panel on Climate Change (IPCC). assigned to each gas. The reference gas used is CO_2, and therefore Global Warming Potential (GWP)-weighted emissions are measured in teragrams of CO_2 equivalent (Tg CO_2 eq.). In accordance with UNFCCC reporting procedures, the United States quantifies greenhouse gas emissions using the 100-year time frame values for GWPs established in the IPCC Second Assessment Report.

emissions level of 250 grams of carbon dioxide per mile, equivalent to 35.5 miles per gallon (MPG) if the automobile industry were to meet this carbon dioxide level solely through fuel economy improvements. Together, these proposed standards would cut carbon dioxide emissions by an estimated 950 million metric tons and 1.8 billion barrels of oil over the lifetime of the vehicles sold under the program (model years 2012–2016). The proposed rulemaking can be viewed at (74 FR 49454, September 28, 2009).

C. Public Involvement

In response to the Supreme Court's decision, EPA has been examining the scientific and technical basis for the endangerment and cause or contribute decisions under CAA section 202(a) since 2007. The science informing the decision-making process has grown stronger since our work began. EPA's approach to evaluating the science, including comments submitted during the public comment period, is further discussed in Section III.A of these Findings. Public review and comment has always been a major component of EPA's process.

1. EPA's Initial Work on Endangerment

As part of the *Advance Notice of Proposed Rulemaking: Regulating Greenhouse Gas Emissions under the Clean Air Act* (73 FR 44353) published in July 2008, EPA provided a thorough discussion of the issues and options pertaining to endangerment and cause or contribute findings under the CAA. The Agency also issued a TSD providing an overview of all the major scientific assessments available at the time and emission inventory data relevant to the contribution finding (Docket ID No. EPA–HQ–OAR–2008–0318). The comment period for that *Advance Notice* was 120 days, and it provided an opportunity for EPA to hear from the public with regard to the issues involved in endangerment and cause or contribute findings as well as the supporting science. EPA received, reviewed and considered numerous comments at that time and this public input was reflected in the Findings that the Administrator proposed in April 2009. In addition, many comments were received on the TSD released with the *Advance Notice* and reflected in revisions to the TSD released in April 2009 to accompany the Administrator's proposal. All public comments on the *Advance Notice* are contained in the public docket for this action (Docket ID No. EPA–HQ–OAR–2008–0318) accessible through *www.regulations.gov.*

2. Public Involvement Since the April 2009 Proposed Endangerment Finding

The Proposed Endangerment and Cause or Contribute Findings for Greenhouse Gases (Proposed Findings) was published on April 24, 2009 (74 FR 18886). The Administrator's proposal was subject to a 60-day public comment period, which ended June 23, 2009, and also included two public hearings. Over 380,000 public comments were received on the Administrator's proposed endangerment and cause or contribute findings, including comments on the elements of the Administrator's April 2009 proposal, the legal issues pertaining to the Administrator's decisions, and the underlying TSD containing the scientific and technical information.

A majority of the comments (approximately 370,000) were the result of mass mail campaigns, which are defined as groups of comments that are identical or very similar in form and content. Overall, about two-thirds of the mass-mail comments received are supportive of the Findings and generally encouraged the Administrator both to make a positive endangerment determination and implement greenhouse gas emission regulations. Of the mass mail campaigns in disagreement with the Proposed Findings most either oppose the proposal on economic grounds (*e.g.,* due to concern for regulatory measures following an endangerment finding) or take issue with the proposed finding that atmospheric greenhouse gas concentrations endanger public health and welfare. Please note that for mass mailer campaigns, a representative copy of the comment is posted in the public docket for this Action (Docket ID No. EPA–HQ–OAR–2009–0171) at *www.regulations.gov*.

Approximately 11,000 other public comments were received. These comments raised a variety of issues related to the scientific and technical information EPA relied upon in making the Proposed Findings, legal and procedural issues, the content of the Proposed Findings, and the implications of the Proposed Findings.

In light of the very large number of comments received and the significant overlap between many comments, EPA has not responded to each comment individually. Rather, EPA has summarized and provided responses to each significant argument, assertion and question contained within the totality of the comments. EPA's responses to some of the most significant comments are provided in these Findings. Responses to all significant issues raised by the comments are contained in the 11 volumes of the Response to Comments document, organized by subject area (found in docket EPA–HQ–OAR–2009–0171).

3. Issues Raised Regarding the Rulemaking Process

EPA received numerous comments on process-related issues, including comments urging the Administrator to delay issuing the final findings, arguing that it was improper for the Administrator to sever the endangerment and cause or contribute findings from the attendant section 202(a) standards, arguing the final decision was preordained by the President's May vehicle announcement, and questioning the adequacy of the comment period. Summaries of key comments and EPA's responses are discussed in this section. Additional and more detailed responses can be found in the Response to Comments document, Volume 11. As noted in the Response to Comments document, EPA also received comments supporting the overall process.

a. It Is Reasonable for the Administrator To Issue the Endangerment and Cause or Contribute Findings Now

Though the Supreme Court did not establish a specific deadline for EPA to act, more than two and a half years have passed since the remand from the Supreme Court, and it has been 10 years since EPA received the original petition requesting that EPA regulate greenhouse gas emissions from new motor vehicles. EPA has a responsibility to respond to the Supreme Court's decision and to fulfill its obligations under current law, and there is good reason to act now given the urgency of the threat of climate change and the compelling scientific evidence.

Many commenters urge EPA to delay making final findings for a variety of reasons. They note that the Supreme Court did not establish a deadline for EPA to act on remand. Commenters also argue that the Supreme Court's decision does not require that EPA make a final endangerment finding, and thus that EPA has discretionary power and may decline to issue an endangerment finding, not only if the science is too uncertain, but also if EPA can provide ''some reasonable explanation'' for exercising its discretion. These commenters interpret the Supreme Court decision not as rejecting all policy reasons for declining to undertake an endangerment finding, but rather as dismissing solely the policy reasons EPA set forth in 2003. Some commenters cite language in the

Supreme Court decision regarding EPA's discretion regarding ''the manner, timing, content, and coordination of its regulations,'' and the Court's declining to rule on ''whether policy concerns can inform EPA's actions in the event that it makes'' a CAA section 202(a) finding to support their position.

Commenters then suggest a variety of policy reasons that EPA can and should make to support a decision not to undertake a finding of endangerment under CAA section 202(a)(1). For example, they argue that a finding of endangerment would trigger several other regulatory programs—such as the Prevention of Significant Deterioration (PSD) provisions—that would impose an unreasonable burden on the economy and government, without providing a benefit to the environment. Some commenters contend that EPA should defer issuing a final endangerment finding while Congress considers legislation. Many commenters note the ongoing international discussions regarding climate change and state their belief that unilateral EPA action would interfere with those negotiations. Others suggest deferring the EPA portion of the joint U.S. Department of Transportation (DOT)/EPA rulemaking because they argue that the new Corporate Average Fuel Economy (CAFE) standards will effectively result in lower greenhouse gas emissions from new motor vehicles, while avoiding the inevitable problems and concerns of regulating greenhouse gases under the CAA.

Other commenters argue that the endangerment determination has to be made on the basis of scientific considerations only. These commenters state that the Court was clear that ''[t]he statutory question is whether sufficient information exists to make an endangerment finding,'' and thus, only if ''the scientific uncertainty is so profound that it precludes EPA from making a reasoned judgment as to whether greenhouse gases contribute to global warming,'' may EPA avoid making a positive or negative endangerment finding. Many commenters urge EPA to take action quickly. They note that it has been 10 years since the original petition requesting that EPA regulate greenhouse gas emissions from motor vehicles was submitted to EPA. They argue that climate change is a serious problem that requires immediate action.

EPA agrees with the commenters who argue that the Supreme Court decision held that EPA is limited to consideration of science when undertaking an endangerment finding, and that we cannot delay issuing a finding due to policy concerns if the science is sufficiently certain (as it is here). The Supreme Court stated that ''EPA can avoid taking further action only if it determines that greenhouse gases do not contribute to climate change or if it provides some reasonable explanation as to why it cannot or will not exercise its discretion to determine whether they do'' 549 U.S. at 533. Some commenters point to this last provision, arguing that the policy reasons they provide are a ''reasonable explanation'' for not moving forward at this time. However, this ignores other language in the decision that clearly indicates that the Court interprets the statute to allow for the consideration only of science. For example, in rejecting the policy concerns expressed by EPA in its 2003 denial of the rulemaking petition, the Court noted that ''it is evident [the policy considerations] have nothing to do with whether greenhouse gas emissions contribute to climate change. Still less do they amount to a reasoned justification for declining to form *a scientific judgment'' Id.* at 533–34 (emphasis added).

Moreover, the Court also held that ''[t]he statutory question is whether sufficient information exists to make an endangerment finding'' *Id.* at 534. Taken as a whole, the Supreme Court's decision clearly indicates that policy reasons do not justify the Administrator avoiding taking further action on the question here.

We also note that the language many commenters quoted from the Supreme Court decision about EPA's discretion regarding the manner, timing and content of Agency actions, and the ability to consider policy concerns, relate to the motor vehicle standards required in the event that EPA makes a positive endangerment finding, and not the finding itself. EPA has long taken the position that it does have such discretion in the standard-setting step under CAA section 202(a).

b. The Administrator Reasonably Proceeded With the Endangerment and Cause or Contribute Findings Separate From the CAA Section 202(a) Standard Rulemaking

As discussed in the Proposed Findings, typically endangerment and cause or contribute findings have been proposed concurrently with proposed standards under various sections of the CAA, including CAA section 202(a). EPA received numerous comments on its decision to propose the endangerment and cause or contribute findings separate from any standards under CAA section 202(a).

Commenters argue that EPA has no authority to issue an endangerment determination under CAA section 202(a) separate and apart from the rulemaking to establish emissions standards under CAA section 202(a). According to these commenters, CAA section 202(a) provides only one reason to issue an endangerment determination, and that is as the basis for promulgating emissions standards for new motor vehicles; thus, it does not authorize such a stand-alone endangerment finding, and EPA may not create its own procedural rules completely divorced from the statutory text. They continue by stating that while CAA section 202(a) says EPA may issue emissions standards conditioned on such a finding, it does not say EPA may first issue an endangerment determination and then issue emissions standards. In addition, they contend, the endangerment proposal and the emissions standards proposal need to be issued together so commenters can fully understand the implications of the endangerment determination. Failure to do so, they argue, deprives the commenters of the opportunity to assess the regulations that will presumably follow from an endangerment finding. They also argue that the expected overlap between reductions in emissions of greenhouse gases from CAA section 202(a) standards issued by EPA and CAFE standards issued by DOT calls into question the basis for the CAA section 202(a) standards and the related endangerment finding, and that EPA is improperly motivated by an attempt to trigger a cascade of regulations under the CAA and/or to promote legislation by Congress.

EPA disagrees with the commenters' claims and arguments. The text of CAA section 202(a) is silent on this issue. It does not specify the timing of an endangerment finding, other than to be clear that emissions standards may not be issued unless such a determination has been made. EPA is exercising the procedural discretion that is provided by CAA section 202(a)'s lack of specific direction. The text of CAA section 202(a) envisions two separate actions by the Administrator: (1) A determination on whether emissions from classes or categories of new motor vehicles cause or contribute to air pollution that may reasonably be anticipated to endanger, and (2) a separate decision on issuance of appropriate emissions standards for such classes or categories. The procedure followed in this rulemaking, and the companion rulemaking involving emissions standards for light duty motor vehicles, is consistent with CAA section 202(a). EPA will issue final emissions standards for new motor

vehicles only if affirmative findings are made concerning contribution and endangerment, and such emissions standards will not be finalized prior to making any such determinations. While it would also be consistent with CAA section 202(a) to issue the greenhouse gas endangerment and contribution findings and emissions standards for new light-duty vehicles in the same rulemaking, *e.g.,* a single proposal covering them and a single final rule covering them, nothing in CAA section 202(a) requires such a procedural approach, and nothing in the approach taken in this case violates the text of CAA section 202(a). Since Congress was silent on this issue, and more than one procedural approach may accomplish the requirements of CAA section 202(a), EPA has the discretion to use the approach considered appropriate in this case. Once the final affirmative contribution and endangerment findings are made, EPA has the authority to issue the final emissions standards for new light-duty motor vehicles; however, as the Supreme Court has noted, the agency has 'significant latitude as to the manner, timing, [and] content * * * of its regulations . * * *' *Massachusetts v. EPA,* 549 U.S. at 533. That includes the discretion to issue them in a separate rulemaking.

Commenters' argument would also lead to the conclusion that EPA could not make an endangerment finding for the entire category of new motor vehicles, as it is doing here, unless EPA also conducted a rulemaking that set emissions standards for all the classes and categories of new motor vehicles at the same time. This narrow procedural limitation would improperly remove discretion that CAA section 202(a) provides to EPA.

EPA has the discretion under CAA section 202(a) to consider classes or categories of new motor vehicles separately or together in making a contribution and endangerment determination. This discretion would be removed under commenters' interpretation, by limiting this to only those cases in which EPA was also ready to issue emissions standards for all of the classes or categories covered by the endangerment finding. However, nothing in the text of CAA section 202(a) places such a limit on EPA's discretion in determining how to group classes or categories of new motor vehicles for purposes of the contribution and endangerment findings. This limitation would not be appropriate, because the issues of contribution and endangerment are separate and distinct from the issues of setting emissions standards. EPA, in this case, is fully prepared to go forward with the contribution and endangerment determination, while it is not ready to proceed with rulemaking for each and every category of new motor vehicles in the first rulemaking to set emissions standards. Section 202(a) of the CAA provides EPA discretion with regard to when and how it conducts its rulemakings to make contribution and endangerment findings, and to set emissions standards, and the text of CAA section 202(a) does not support commenters attempt to limit such discretion.

Concerns have been raised that the failure to issue the proposed endangerment finding and the proposed emissions standard together preclude commenters from assessing and considering the implications of the endangerment finding and the regulations that would likely flow from such a finding. However, commenters have failed to explain how this interferes in any way with their ability to comment on the endangerment finding. In fact it does not interfere, because the two proposals address separate and distinct issues. The endangerment finding concerns the contribution of new motor vehicles to air pollution and the effect of that air pollution on public health or welfare. The emissions standards, which have been proposed (74 FR 49454, September 28, 2009), concern the appropriate regulatory emissions standards if affirmative findings are made on contribution and endangerment. These two proposals address different issues. While commenters have the opportunity to comment on the proposed emissions standards in that rulemaking, they have not shown, and cannot show, that they need to have the emissions standards proposal before them in order to provide relevant comments on the proposed contribution or endangerment findings. Further discussion of this issue can be found in Section II of these Findings, and discussion of the timing of this action and its relationship to other CAA provisions and Congressional action can be found in Section III of these Findings and Volume 11 of the Response to Comments document.

c. The Administrator's Final Decision Was Not Preordained by the President's May Vehicle Announcement

EPA received numerous comments arguing that the President's announcement of a new ''National Fuel Efficiency Policy'' on May 19, 2009 seriously undermines EPA's ability to provide objective consideration of and a legally adequate response to comments objecting to the previously proposed endangerment findings.

Commenters' conclusion is based on the view that the President's announced policy requires EPA to promulgate greenhouse gas emissions standards under CAA section 202(a), that the President's and Administrator Jackson's announcement indicated that the endangerment rulemaking was but a formality and that a final endangerment finding was a fait accompli. Commenters argue that this means the result of this rulemaking has been preordained and the merits of the issues have been prejudged.

EPA disagrees. Commenters' arguments wholly exaggerate and mischaracterize the circumstances. In the April 24, 2009 endangerment proposal EPA was clear that the two steps in the endangerment provision have to be satisfied in order for EPA to issue emissions standards for new motor vehicles under CAA section 202(a) (74 FR at 18888, April 24, 2009). This was repeated when EPA issued the Notice of Upcoming Joint Rulemaking to Establish Vehicle GHG Emissions and CAFE Standards (74 FR 24007 May 22, 2009) (Notice of Intent or NOI). This was repeated again when EPA issued proposed greenhouse gas emissions standards for certain new motor vehicles (74 FR 49454, September 28, 2009). EPA has consistently made it clear that issuance of new motor vehicle standards requires and is contingent upon satisfaction of the two-part endangerment test.

On May 19, 2009 EPA issued the joint Notice of Intent, which indicated EPA's intention to propose new motor vehicle standards. All of the major motor vehicle manufacturers, their trade associations, the State of California, and several environmental organizations announced their full support for the upcoming rulemaking. Not surprisingly, on the same day the President also announced his full support for this action. Commenters, however, erroneously equate this Presidential support with a Presidential directive that requires EPA to prejudge and preordain the result of this rulemaking.

The only evidence they point to are simply indications of Presidential support. Commenters point to a press release, which unsurprisingly refers to the Agency's announcement as delivering on the President's commitment to enact more stringent fuel economy standards, by bringing ''all stakeholders to the table and [coming] up with a plan'' for solving a serious problem. The plan that was announced, of course, was a plan to conduct notice and comment

rulemaking. The press release itself states that President Obama ''set in motion a new national policy,'' with the policy ''aimed'' at reducing greenhouse gas emissions for new cars and trucks. What was ''set in motion'' was a notice and comment rulemaking described in the NOI issued by EPA on the same day. Neither the President nor EPA announced a final rule or a final direction that day, but instead did no more than announce a plan to go forward with a notice and comment rulemaking. That is how the plan ''delivers on the President's commitment'' to enact more stringent standards. The announcement was that a notice and comment rulemaking would be initiated with the aim of adopting certain emissions standards.

That is no different from what EPA or any other agency states when it issues a notice of proposed rulemaking. It starts a process that has the aim of issuing final regulations if they are deemed appropriate at the end of the public process. The fact that an Agency proposes a certain result, and expects that a final rule will be the result of setting such a process in motion, is the ordinary course of affairs in notice and comment rulemakings. This does not translate into prejudging the final result or having a preordained result that de facto negates the public comment process. The President's press release of May 19, 2009 was a recognition that this notice and comment rulemaking process would be set in motion, as well as providing his full support for the Agency to go forward in this direction; it was no more than that.

The various stakeholders who announced their support for the plan that had been set in motion all recognized that full notice and comment rulemaking was part of the plan, and they all reserved their rights to participate in such notice and comment rulemaking. For example, see the letter of support from Ford Motor Company, which states that ''Ford fully supports proposal and adoption of such a National Program, which we understand will be subject to full notice-and-comment rulemaking, affording all interested parties including Ford the right to participate fully, comment, and submit information, the results of which are not pre-determined but depend upon processes set by law.''

d. The Notice and Comment Period Was Adequate

Many commenters argue that the 60-day comment period was inadequate. Commenters claim that a 60-day period was insufficient time to fully evaluate the science and other information that informed the Administrator's proposal. Some commenters assert that because the comment period for the Proposed Finding substantially overlapped with the comment period for the Mandatory Greenhouse Gas Reporting Rule, as well as Congress' consideration of climate legislation, their ability to fully participate in the notice and comment period was ''seriously compromised.'' Moreover, they continue, because EPA had not yet proposed CAA section 202(a) standards, there was no valid reason to fail to extend the comment period. Several commenters and other entities had also requested that EPA extend the comment period.

Some commenters assert that the notice provided by this rulemaking was ''defective'' because the **Federal Register** notice announcing the proposal had an error in the e-mail address for the docket. At least one commenter suggests that this error deprives potential commenters of their Due Process under the Fifth Amendment of the Constitution, citing *Armstrong* v. *Manzo,* 380 U.S. 545, 552 (1965), and that failure to ''correct'' the minor typographical error in the e-mail address and extend the comment period would make the rule ''subject to reversal'' in violation of the CAA, Administrative Procedure Act (APA), the Due Process clause of the Constitution, and EO 12866.

Finally, for many of the same reasons that commenters argue a 60-day comment period was inadequate, several commenters request that EPA reopen and/or extend the comment period. One commenter requests that the comment period be reopened because there was new information regarding data used by EPA in the Proposed Findings. In particular, the commenter alleges that it recently became aware that one of the sources of global climate data had destroyed the raw data for its data set of global surface temperatures. The commenter argues that this alleged destruction of raw data violates scientific standards, calls into question EPA's reliance on that data in these Findings, and necessitates a reopening of the proceedings. Other commenters request that the comment period be extended and/or reopened due to the release of a Federal government document on the impact of climate change in the United States near the end of the comment period, as well as the release of an internal EPA staff document discussing the science.

The official public comment period on the proposed rule was adequate. First, a 60-day comment period satisfies the procedural requirements of CAA section 307 of the CAA, which requires a 30-day comment period, and that the docket be kept open to receive rebuttal or supplemental information as follow-up to any hearings for 30 days following the hearings. EPA met those obligations here—the comment period opened on April 24, 2009, the last hearing was on May 21, 2009 and the comment period closed June 23, 2009.

Second, as explained in letters denying requests to extend the comment period, a very large part of the information and analyses for the Proposed Findings had been previously released in July 30, 2008, as part of the *Advance Notice of Proposed Rulemaking: Regulating Greenhouse Gas Emissions under the Clean Air Act (ANPR)* (73 FR 44353). The public comment period for the ANPR is discussed above in Section I.C.1 of these Findings. The Administrator explained that the comment period for that ANPR was 120 days and that the major recent scientific assessments that EPA relied upon in the TSD released with the ANPR had previously each gone through their own public review processes and have been publicly available for some time. In other words, EPA has provided ample time for review, particularly with regard to the technical support for the Findings. See, for example, EPA Letter to Congressman Issa dated June 17, 2009, a copy of which is available at *http://epa.gov/climatechange/endangerment.html*.

Moreover, the comment period was not rendered insufficient merely because other climate-related proceedings were occurring simultaneously.

While one commenter suggests that the convergence of several different climate-related activities has ''seriously compromised'' their ability to participate in the comment process, that commenter was able to submit an 89 page comment on this proposal alone. Moreover, it is hardly rare that more than one rule is out for comment at the same time. As noted above, EPA has received a substantial number of significant comments on the Proposed Findings, and has thoroughly considered and responded to significant comments.

EPA finds no evidence that a typographical error in the docket e-mail address of the **Federal Register** notice announcing the proposal prevented the public from having a meaningful opportunity to comment, and therefore deprived them of due process. Although the minor error—which involved a word processing auto-correction that turned a short dash into a long dash—appeared in the FR version of the Proposed Findings, the e-mail address is correct

in the signature version of the Proposed Findings posted on EPA's Web site until publication in the **Federal Register,** and in the ''Instructions for Submitting Written Comments'' document on the Web site for the rulemaking. EPA has received over 190,000 e-mails to the docket e-mail address to date, so the minor typographical error appearing in only one location has not been an impediment to interested parties' e-mailing comments. Moreover, EPA provided many other avenues for interested parties to submit comments in addition to the docket e-mail address, including via *www.regulations.gov,* mail, and fax; each of these options have been utilized by many commenters. EPA is confident that the minor typographical error did not prevent anyone from submitting written comments, by e-mail or otherwise, and that the public was provided ''meaningful participation in the regulatory process'' as mentioned in EO 12866.

Our response regarding the request to reopen the comment period due to concerns about alleged destruction of raw global surface data is discussed more fully in the Response to Comments document, Volume 11. The commenter did not provide any compelling reason to conclude that the absence of these data would materially affect the trends in the temperature records or conclusions drawn about them in the assessment literature and reflected in the TSD. The Hadley Centre/Climate Research Unit (CRU) temperature record (referred to as HadCRUT) is just one of three global surface temperature records that EPA and the assessment literature refer to and cite. National Oceanic and Atmospheric Administration (NOAA) and National Aeronautics and Space Administration (NASA) also produce temperature records, and all three temperature records have been extensively peer reviewed. Analyses of the three global temperature records produce essentially the same long-term trends as noted in the Climate Change Science Program (CCSP) (2006) report ''Temperature Trends in the Lower Atmosphere,'' IPCC (2007), and NOAA's study [5] ''State of the Climate in 2008''. Furthermore, the commenter did not demonstrate that the allegedly destroyed data would materially alter the HadCRUT record or meaningfully hinder its replication. The raw data, a small part of which has not been public (for reasons described at: *https://www.uea.ac.uk/mac/comm/media/press/2009/nov/CRUupdate*), are available in a quality-controlled (or homogenized, value-added) format and the methodology for developing the quality-controlled data is described in the peer reviewed literature (as documented at *http://www.cru.uea.ac.uk/cru/data/temperature/*).

The release of the U.S. Global Climate Research Program (USGCRP) report on impacts of climate change in the United States in June 2009 also did not necessitate extending the comment period. This report was issued by the USGCRP, formerly the Climate Change Science Program (CCSP), and synthesized information contained in prior CCSP reports and other synthesis reports, many of which had already been published (and were included in the TSD for the Proposed Findings). Further, the USGCRP report itself underwent notice and comment before it was finalized and released.

Regarding the internal EPA staff paper that came to light during the comment period, several commenters submitted a copy of the EPA staff paper with their comments; EPA's response to the issues raised by the staff paper are discussed in the Response to Comments document, Volume 1. The fact that some internal agency deliberations were made public during the comment period does not in and of itself call into question those deliberations. As our responses to comments explain, EPA considered the concerns noted in the staff paper during the proposal stage, as well as when finalizing the Findings. There was nothing about those internal comments that required an extension or reopening of the comment period.

Thus, the opportunity for comment fully satisfies the CAA and Constitutional requirement of Due Process. Cases cited by commenters do not indicate otherwise. The comment period and thorough response to comment documents in the docket indicate that EPA has given people an opportunity to be heard in a ''meaningful time and a meaningful matter.'' *Armstrong* v. *Manzo,* 380 U.S. 545, 552 (1965). Interested parties had full notice of the rulemaking proceedings and a significant opportunity to participate through the comment process and multiple hearings.

For all the above reasons, EPA's denial of the requests for extension or reopening of the comment period was entirely reasonable in light of the extensive opportunity for public comment and heavy amount of public participation during the comment period. EPA has fully complied with all applicable public participation requirements for this rulemaking.

e. These Findings Did Not Necessitate a Formal Rulemaking Under the Administrative Procedure Act

One commenter, with the support of others, requests that EPA undertake a formal rulemaking process for the Findings, on the record, in accordance with the procedures described in sections 556–557 of the Administrative Procedure Act (APA). The commenter requests a multi-step process, involving additional public notice, an on-the-record proceeding (*e.g.,* formal administrative hearing) with the right of appeal, utilization of the Clean Air Scientific Advisory Committee (CASAC) and its advisory proceedings, and designation of representatives from other executive branch agencies to participate in the formal proceeding and any CASAC advisory proceeding.

The commenter asserts that while EPA is not obligated under the CAA to undertake these additional procedures, the Agency nonetheless has the legal authority to engage in such a proceeding. The commenter believes this proceeding would show that EPA is ''truly committed to scientific integrity and transparency.'' The commenter cites several cases to argue that refusal to proceed on the record would be ''arbitrary and capricious'' or would be an ''abuse of discretion.'' The allegation at the core of the commenter's argument is that profound and wide-ranging scientific uncertainties exist in the Proposed Findings and in the impacts on health and welfare discussed in the TSD. To support this argument, the commenter provides lengthy criticisms of the science. The commenter also argues that the regulatory cascade that would be ''unleashed'' by a positive endangerment finding warrants the more formal proceedings.

Finally, the commenter suggests that EPA engage in ''formal rulemaking'' procedures in part due to the Administrative Conference of the United States' (ACUS) recommended factors for engaging in formal rulemaking. The commenter argues that the current action is ''complex,'' ''open-ended,'' and the costs that errors in the action may pose are ''significant.''

EPA is denying the request to undertake an ''on the record'' formal rulemaking. EPA is under no obligation to follow the extraordinarily rarely used formal rulemaking provisions of the APA. First, CAA section 307(d) of the CAA clearly states that the rulemaking provisions of CAA section 307(d), *not* APA sections 553 through 557, apply to certain specified actions, such as this

[5] Peterson, T.C., and M.O. Baringer (Eds.) (2009) State of the Climate in 2008. *Bull. Amer. Meteor. Soc.,* 90, S1–S196.

one. EPA has satisfied all the requirements of CAA section 307(d). Indeed, the commenter itself ''is not asserting that the Clean Air Act expressly requires'' the additional procedures it requests. Moreover, the commenter does not discuss how the suggested formal proceeding would fit into the informal rulemaking requirements of CAA section 307(d) that do apply.

Formal rulemaking is very rarely used by Federal agencies. The formal rulemaking provisions of the APA are only triggered when the statute explicitly calls for proceedings ''on the record after opportunity for an agency hearing.'' *United States* v. *Florida East Coast Ry. Co.,* 410 U.S. 224, 241 (1973). The mere mention of the word ''hearing'' does not trigger the formal rulemaking provisions of the APA. *Id.* The CAA does not include the statutory phrase required to trigger the formal rulemaking provisions of the APA (and as noted above the APA does not apply in the first place). Congress specified that certain rulemakings under the CAA follow the rulemaking procedures outlined in CAA section 307(d) rather than the APA ''formal rulemaking'' commenter suggests.

Despite the inapplicability of the formal rulemaking provisions to this action, commenters suggest that to refuse to voluntarily undertake rulemaking provisions not preferred by Congress would make EPA's rulemaking action an ''abuse of discretion.'' EPA disagrees with this claim, and cases cited by the commenter do not indicate otherwise. To support the idea that an agency decision to engage in informal rulemaking could be an abuse of discretion, commenter cites *Ford Motor Co.* v. *FTC,* 673 F.2d 1008 (9th Cir. 1981). In *Ford Motor Co.,* the court ruled that the FTC's decision regarding an automobile dealership should have been resolved through a rulemaking rather than an individualized adjudication. *Id.* at 1010. In that instance, the court favored ''rulemaking'' over adjudication—not ''formal rulemaking'' over the far more common ''informal rulemaking.'' The case stands only for the non-controversial proposition that sometimes agency use of *adjudications* may rise to an abuse of discretion where a *rulemaking* would be more appropriate—whether formal or informal. The Commenter does not cite a single judicial opinion stating that an agency abused its discretion by following the time-tested and Congressionally-favored informal rulemaking provisions of the CAA or the APA instead of the rarely used formal APA rulemaking provisions.

The commenter also alludes to the possibility that the choice of informal rulemaking may be ''arbitrary and capricious. EPA disagrees that the choice to follow the frequently used, and CAA required, informal rulemaking procedures is arbitrary and capricious. The commenter cites *Vermont Yankee Nuclear Power Corp.* v. *NRDC,* 435 U.S. 519 (1978) for the proposition that ''extremely compelling circumstances'' could lead to a court overturning agency action for declining to follow extraneous procedures. As the commenter notes, in *Vermont Yankee* the Supreme Court overturned a lower court decision for imposing additional requirements not required by applicable statutes. Even if the dicta in *Vermont Yankee* could be applied contrary to the holding of the case in the way the commenter suggests, EPA's decision to follow frequently used informal rulemaking procedures for this action is highly reasonable.

As for the ACUS factors the commenter cites in support of its request, as the commenter notes, the ACUS factors are mere recommendations. While EPA certainly respects the views of ACUS, the recommendations are not binding on the Agency. In addition, EPA has engaged in a thorough, traditional rulemaking process that ensures that any concerns expressed by the commenter have been addressed. EPA has fully satisfied all applicable law in their consideration of this rulemaking.

Finally, as explained in Section III of these Findings and the Response to Comments document, EPA's approach to evaluating the evidence before it was entirely reasonable, and did not require a formal hearing. EPA relied primarily on robust synthesis reports that have undergone peer review and comment. The Agency also carefully considered the comments received on the Proposed Findings and TSD, including review of attached studies and documents. The public has had ample opportunity to provide its views on the science, and the record supporting these final findings indicates that EPA carefully considered and responded to significant public comments. To the extent the commenter's concern is that a formal proceeding will help ensure the *right* action in response to climate change is taken, that is not an issue for these Findings. As discussed in Section III of these Findings, this science-based judgment is not the forum for considering the potential mitigation options or their impact.

II. Legal Framework for This Action

As discussed in the Proposed Findings, two statutory provisions of the CAA govern the Administrator's Findings. Section 202(a) of the CAA sets forth a two-part test for regulatory action under that provision: Endangerment and cause or contribute. Section 302 of the CAA contains definitions of the terms ''air pollutant'' and ''effects on welfare''. Below is a brief discussion of these statutory provisions and how they govern the Administrator's decision, as well as a summary of significant legal comments and EPA's responses to them.

A. Section 202(a) of the CAA—Endangerment and Cause or Contribute

1. The Statutory Framework

Section 202(a)(1) of the CAA states that:

The Administrator shall by regulation prescribe (and from time to time revise) standards applicable to the emission of any air pollutant from any class or classes of new motor vehicles or new motor vehicle engines, which in [her] judgment cause, or contribute to, air pollution which may reasonably be anticipated to endanger public health or welfare.

Based on the text of CAA section 202(a) and its legislative history, the Administrator interprets the two-part test as follows. Further discussion of this two-part test can be found in Section II of the preamble for the Proposed Findings. First, the Administrator is required to protect public health and welfare, but she is not asked to wait until harm has occurred. EPA must be ready to take regulatory action to prevent harm before it occurs. Section 202(a)(1) requires the Administrator to ''anticipate'' ''danger'' to public health or welfare. The Administrator is thus to consider both current and future risks. Second, the Administrator is to exercise judgment by weighing risks, assessing potential harms, and making reasonable projections of future trends and possibilities. It follows that when exercising her judgment the Administrator balances the likelihood and severity of effects. This balance involves a sliding scale; on one end the severity of the effects may be of great concern, but the likelihood low, while on the other end the severity may be less, but the likelihood high. Under either scenario, the Administrator is permitted to find endangerment. If the harm would be catastrophic, the Administrator is permitted to find endangerment even if the likelihood is small.

Because scientific knowledge is constantly evolving, the Administrator may be called upon to make decisions while recognizing the uncertainties and

limitations of the data or information available, as risks to public health or welfare may involve the frontiers of scientific or medical knowledge. At the same time, the Administrator must exercise reasoned decision making, and avoid speculative inquiries. Third, as discussed further below, the Administrator is to consider the cumulative impact of sources of a pollutant in assessing the risks from air pollution, and is not to look only at the risks attributable to a single source or class of sources. Fourth, the Administrator is to consider the risks to all parts of our population, including those who are at greater risk for reasons such as increased susceptibility to adverse health effects. If vulnerable subpopulations are especially at risk, the Administrator is entitled to take that point into account in deciding the question of endangerment. Here too, both likelihood and severity of adverse effects are relevant, including catastrophic scenarios and their probabilities as well as the less severe effects. As explained below, vulnerable subpopulations face serious health risks as a result of climate change.

In addition, by instructing the Administrator to consider whether emissions of an air pollutant cause or contribute to air pollution, the statute is clear that she need not find that emissions from any one sector or group of sources are the sole or even the major part of an air pollution problem. The use of the term ''contribute'' clearly indicates a lower threshold than the sole or major cause. Moreover, the statutory language in CAA section 202(a) does not contain a modifier on its use of the term contribute. Unlike other CAA provisions, it does not require ''significant'' contribution. See, *e.g.,* CAA sections 111(b); 213(a)(2), (4). To be sure, any finding of a ''contribution'' requires some threshold to be met; a truly trivial or de minimis ''contribution'' might not count as such. The Administrator therefore has ample discretion in exercising her reasonable judgment in determining whether, under the circumstances presented, the cause or contribute criterion has been met. Congress made it clear that the Administrator is to exercise her judgment in determining contribution, and authorized regulatory controls to address air pollution even if the air pollution problem results from a wide variety of sources. While the endangerment test looks at the entire air pollution problem and the risks it poses, the cause or contribute test is designed to authorize EPA to identify and then address what may well be many different sectors or groups of sources that are each part of—and thus contributing to—the problem.

This framework recognizes that regulatory agencies such as EPA must be able to deal with the reality that ''[m]an's ability to alter his environment has developed far more rapidly than his ability to foresee with certainty the effects of his alterations.'' See *Ethyl Corp* v. *EPA,* 541 F.2d 1, 6 (DC Cir.), *cert. denied* 426 U.S. 941 (1976). Both ''the Clean Air Act 'and common sense * * * demand regulatory action to prevent harm, even if the regulator is less than certain that harm is otherwise inevitable.' '' See *Massachusetts* v. *EPA,* 549 U.S. at 506, n.7 (citing *Ethyl Corp.*).

The Administrator recognizes that the context for this action is unique. There is a very large and comprehensive base of scientific information that has been developed over many years through a global consensus process involving numerous scientists from many countries and representing many disciplines. She also recognizes that there are varying degrees of uncertainty across many of these scientific issues. It is in this context that she is exercising her judgment and applying the statutory framework. As discussed in the Proposed Findings, this interpretation is based on and supported by the language in CAA section 202(a), its legislative history and case law.

2. Summary of Response to Key Legal Comments on the Interpretation of the CAA Section 202(a) Endangerment and Cause or Contribute Test

EPA received numerous comments regarding the interpretation of CAA section 202(a) set forth in the Proposed Findings. Below is a brief discussion of some of the key adverse legal comments and EPA's responses. Other key legal comments and EPA's responses are provided in later sections discussing the Administrator's findings.

Additional and more detailed summaries and responses can be found in the Response to Comments document. As noted in the Response to Comments document, EPA also received comments supporting its legal interpretations.

a. The Administrator Properly Interpreted the Precautionary and Preventive Nature of the Statutory Language

Various commenters argue either that the endangerment test under CAA section 202(a) is not precautionary and preventive in nature, or that EPA's interpretation and application is so extreme that it is contrary to what Congress intended in 1977, and effectively guarantees an affirmative endangerment finding. Commenters also argue that the endangerment test improperly shifts the burdens to the opponents of an endangerment finding and is tantamount to assuming the air pollution is harmful unless it is shown to be safe.

EPA rejects the argument that the endangerment test in CAA section 202(a) is not precautionary or preventive in nature. As discussed in more detail in the proposal, Congress relied heavily on the en banc decision in Ethyl when it revised section 202(a) and other CAA provisions to adopt the current language on endangerment and contribution. 74 FR 18886, 18891–2. The Ethyl court could not have been clearer on the precautionary nature of a criteria based on endangerment. The court rejected the argument that EPA had to find actual harm was occurring before it could make the required endangerment finding. The court stated that:

> *The Precautionary Nature of ''Will Endanger.''* Simply as a matter of plain meaning, we have difficulty crediting petitioners' reading of the ''will endanger'' standard. The meaning of ''endanger'' is not disputed. Case law and dictionary definition agree that endanger means something less than actual harm. When one is endangered, harm is *threatened;* no actual injury need ever occur. Thus, for example, a town may be ''endangered'' by a threatening plague or hurricane and yet emerge from the danger completely unscathed. A statute allowing for regulation in the face of danger is, necessarily, a precautionary statute. Regulatory action may be taken before the threatened harm occurs; indeed, the very existence of such precautionary legislation would seem to *demand* that regulatory action precede, and, optimally, prevent, the perceived threat. As should be apparent, the ''will endanger'' language of Section 211(c)(1)(A) makes it such a precautionary statute. *Ethyl* at 13 (footnotes omitted).

Similarly, the court stated that ''[i]n sum, based on the plain meaning of the statute, the juxtaposition of CAA section 211 with CAA sections 108 and 202, and the *Reserve Mining* precedent, we conclude that the ''will endanger'' standard is precautionary in nature and does not require proof of actual harm before regulation is appropriate.'' *Ethyl* at 17. It is this authority to act before harm has occurred that makes it a preventive, precautionary provision.

It is important to note that this statement was in the context of rejecting an argument that EPA had to prove actual harm before it could adopt fuel control regulations under then CAA section 211(c)(1). The court likewise rejected the argument that EPA had to show that such harm was ''probable.''

The court made it clear that determining endangerment entails judgments involving both the risk or likelihood of harm and the severity of the harm if it were to occur. Nowhere did the court indicate that the burden was on the opponents of an endangerment finding to show that there was no endangerment. The opinion focuses on describing the burden the statute places on EPA, rejecting *Ethyl's* arguments of a burden to show actual or probable harm.

Congress intentionally adopted a precautionary and preventive approach. It stated that the purpose of the 1977 amendments was to ''emphasize the preventive or precautionary nature of the act, *i.e.,* to assure that regulatory action can effectively prevent harm before it occurs; to emphasize the predominate value of protection to public health.'' [6] Congress also stated that it authorized the Administrator to weigh risks and make projections of future trends, a ''middle road between those who would impose a nearly impossible standard of proof on the Administrator before he may move to protect public health and those who would shift the burden of proof for all pollutants to make the pollutant source prove the safety of its emissions as a condition of operation.'' Leg. His. at 2516.

Thus, EPA rejects commenters' arguments. Congress intended this provision to be preventive and precautionary in nature, however it did not shift the burden of proof to opponents of an endangerment finding to show safety or no endangerment. Moreover, as is demonstrated in the following, EPA has not shifted the burden of proof in the final endangerment finding, but rather is weighing the likelihood and severity of harms to arrive at the final finding. EPA has not applied an exaggerated or dramatically expanded precautionary principle, and instead has exercised judgment by weighing and balancing the factors that are relevant under this provision.

b. The Administrator Does Not Need To Find That the Control Measures Following an Endangerment Finding Would Prevent at Least a Substantial Part of the Danger in Order To Find Endangerment

Several commenters argue that it is unlawful for EPA to make an affirmative endangerment finding unless EPA finds that the regulatory control measures contemplated to follow such a finding would prevent at least a substantial part of the danger from the global climate change at which the regulation is aimed. This hurdle is also described by commenters as the regulation ''achieving the statutory objective of preventing damage'', or ''fruitfully attacking'' the environmental and public health danger at hand by meaningfully and substantially reducing it. Commenters point to *Ethyl Corp.* v. *EPA,* 541 F.2d 1 (DC Cir. 1976) (en banc) as support for this view, as well as portions of the legislative history of this provision.

Commenters contend that EPA has failed to show that this required degree of meaningful reduction of endangerment would be achieved through regulation of new motor vehicles based on an endangerment finding. In making any such showing, commenters argue that EPA would need to account for the following: (1) The fact that any regulation would be limited to *new* motor vehicles, if not the subset of new motor vehicles discussed in the President's May 2009 announcement, (2) any increase in emissions from purchasers delaying purchases of new vehicles subject to any greenhouse gas emissions standards, or increasing the miles traveled of new vehicles with greater fuel economy, (3) the fact that only a limited portion of the new motor vehicle emissions of greenhouse gases would be controlled, (4) the fact that CAFE standards would effectively achieve the same reductions, and (5) the fact that any vehicle standards would not themselves reduce global temperatures. Some commenters refer to EPA's proposal for greenhouse gas emissions standards for new motor vehicles as support for these arguments, claiming the proposed new motor vehicle emission standards are largely duplicative of the standards proposed by the National Highway Traffic Safety Administration (NHTSA), and the estimates of the impacts of the proposed standards confirm that EPA's proposed standards cannot ''fruitfully attack'' global climate change (74 FR 49454, September 28, 2009).

Commenters attempt to read into the statute a requirement that is not there. EPA interprets the endangerment provision of CAA section 202(a) as not requiring any such finding or showing as described by commenters. The text of CAA section 202(a) does not support such an interpretation. The endangerment provision calls for EPA, in its judgment, to determine whether air pollution is reasonably anticipated to endanger public health or welfare, and whether emissions from certain sources cause or contribute to such air pollution. If EPA makes an affirmative finding, then it shall set emissions standards applicable to emissions of such air pollutants from new motor vehicles. There is no reference in the text of the endangerment or cause or contribute provision to anything concerning the degree of reductions that would be achieved by the emissions standards that would follow such a finding. The Administrator's judgment is directed at the issues of endangerment and cause or contribute, not at how effective the resulting emissions control standards will be.

As in the several other similar provisions adopted in the 1977 amendments, in CAA section 202(a) Congress explicitly separated two different decisions to be made, providing different criteria for them. The first decision involves the air pollution and the endangerment criteria, and the contribution to the air pollution by the sources. The second decision involves how to regulate the sources to control the emissions if an affirmative endangerment and contribution finding are made. In all of the various provisions, there is broad similarity in the phrasing of the endangerment and contribution decision. However, for the decision on how to regulate, there are a wide variety of different approaches adopted by Congress. In some case, EPA has discretion whether to issue standards or not, while in other cases, as in CAA section 202(a), EPA is required to issue standards. In some cases, the regulatory criteria are general, as in CAA section 202(a); in others, they provide significantly more direction as to how standards are to be set, as in CAA section 213(a)(4).

As the Supreme Court made clear in *Massachusetts* v. *EPA,* EPA's judgment in making the endangerment and contribution findings is constrained by the statute, and EPA is to decide these issues based solely on the scientific and other evidence relevant to that decision. EPA may not ''rest[] on reasoning divorced from the statutory text,'' and instead EPA's exercise of judgment must relate to whether an air pollutant causes or contributes to air pollution that endangers. *Massachusetts* v. *EPA,* 549 U.S. at 532. As the Supreme Court noted, EPA must ''exercise discretion within defined statutory limits.'' Id. at 533. EPA's belief one way or the other regarding whether regulation of greenhouse gases from new motor vehicles would be ''effective'' is irrelevant in making the endangerment and contribution decisions before EPA. Id. Instead ''[t]he statutory question is

[6] The Supreme Court recognized that the current language in section 202(a), adopted in 1977, is ''more protective'' than the 1970 version that was similar to the section 211 language before the DC Circuit in *Ethyl. Massachusetts* v. *EPA,* 549 U.S. at 506, fn 7.

whether sufficient information exists to make an endangerment finding'' Id. at 534.

The effectiveness of a potential future control strategy is not relevant to deciding whether air pollution levels in the atmosphere endanger. It is also not relevant to deciding whether emissions of greenhouse gases from new motor vehicles contribute to such air pollution. Commenters argue that Congress implicitly imposed a third requirement, that the future control strategy have a certain degree of effectiveness in reducing the endangerment before EPA could make the affirmative findings that would authorize such regulation. There is no statutory text that supports such an interpretation, and the Supreme Court makes it clear that EPA has no discretion to read this kind of additional factor into CAA section 202(a)'s endangerment and contribution criteria. In fact, the Supreme Court rejected similar arguments that EPA had the discretion to consider various other factors besides endangerment and contribution in deciding whether to deny a petition. *Massachusetts* v. *EPA,* 549 U.S. at 532–35.

Commenters point to language from the *Ethyl* case to support their position, noting that the DC Circuit referred to the emissions control regulation adopted by EPA under CAA section 211(c) as one that would ''fruitfully attack'' the environmental and public health danger by meaningfully and substantially reducing the danger. It is important to understand the context for this discussion in *Ethyl.* The petitioner *Ethyl Corp.* argued that EPA had to show that the health threat from the emissions of lead from the fuel additive being regulated had to be considered in isolation, and the threat ''in and of itself'' from the additive had to meet the test of endangerment in CAA section 211(c). EPA had rejected this approach, and had interpreted CAA section 211(c)(1) as calling for EPA to look at the cumulative impact of lead, and to consider the impact of lead from emissions related to use of the fuel additive in the context all other human exposure to lead. The court rejected *Ethyl's* approach and supported EPA's interpretation. The DC Circuit noted that Congress was fully aware that the burden of lead on the body was caused by multiple sources and that it would be of no value to try and determine the effect on human health from the lead automobile emissions by themselves. The court specifically noted that ''the incremental effect of lead emissions on the total body lead burden is of no practical value in determining whether health is endangered,'' but recognized that this incremental effect is of value ''in deciding whether the lead exposure problem can fruitfully be attacked through control of lead additives.'' *Ethyl,* 541 F.2d at 31 fn 62. The court made clear that the factor that was critically important to determining the effectiveness of the resulting control strategy—the incremental effect of automobile lead emissions on total body burden—was irrelevant and of no value in determining whether the endangerment criteria was met. Thus it is clear that the court in *Ethyl* did not interpret then CAA section 211(c)(1)(A) as requiring EPA to make a showing of the effectiveness of the resulting emissions control strategy, and instead found just the opposite, that the factors that would determine effectiveness are irrelevant to determining endangerment.

Commenters also cite to the legislative history, noting that Congress referred to the ''preventive or precautionary nature of the Act, *i.e.,* to assure that regulatory action can effectively prevent harm before it occurs.'' Leg. Hist. at 2516. However, this statement by Congress is presented as an answer to the question on page 2515, ''Should the Administrator act to prevent harm before it occurs or should he be authorized to regulate an air pollutant only if he finds actual harm has already occurred.'' Leg. Hist. at 2515. In this context, the discussion on page 2516 clearly indicates that there is no opportunity for prevention or precaution if the test is one of actual harm already occurring. This discussion does not say or imply that even if the harm has not occurred, you can not act unless you also show that your action will effectively address it. This discussion concerns the endangerment test, not the criteria for standard setting. The criteria for standard setting address how the agency should act to address the harm, and as the *Ethyl* case notes, the factors relevant to how to ''fruitfully attack'' the harm are irrelevant to determining whether the harm is one that endangers the public health or welfare.

As with current CAA section 202(a), there is no basis to conflate these two separate decisions and to read into the endangerment criteria an obligation that EPA show that the resulting emissions control strategy or strategies will have some significant degree of harm reduction or effectiveness in addressing the endangerment. The conflating of the two decisions is not supported in the text of this provision, by the Supreme Court in *Massachusetts* v. *EPA,* by the DC Circuit in *Ethyl,* or by Congress in the legislative history of this provision. It would be an unworkable interpretation, calling for EPA to project out the result of perhaps not one, but even several, future rulemakings stretching over perhaps a decade or decades. Especially in the context of global climate change, the effectiveness of a control strategy for new motor vehicles would have to be viewed in the context of a number of future motor vehicle regulations, as well as in the larger context of the CAA and perhaps even global context. That would be an unworkable and speculative requirement to impose on EPA as a precondition to answering the public health and welfare issues before it, as they are separate and apart from the issues involved with developing, implementing and evaluating the effectiveness of emissions control strategies.

c. The Administrator Does Not Need To Find There Is Significant Risk of Harm

Commenters argue that Congress established a minimum requirement that there be a ''significant risk of harm'' to find endangerment. They contend that this requirement stemmed from the *Ethyl* case, and that Congress adopted this view. According to the commenters, the risk is the function of two variables: the nature of the hazard at issue and the likelihood of its occurrence. Commenters argue that Congress imposed a requirement that this balance demonstrate a ''significant risk of harm'' to strike a balance between the precautionary nature of the CAA and the burdensome economic and societal consequences of regulation.

There are two basic problems with the commenters' arguments. First, commenters equate ''significant risk of harm'' as the overall test for endangerment, however the *Ethyl* case and the legislative history treat the risk of harm as only one of the two components that are to be considered in determining endangerment.—, The two components are the likelihood or risk of a harm occurring, and the severity of harm if it were to occur. Second, commenters equate it to a minimum statutory requirement. However, while the court in the *Ethyl* case made it clear that the facts in that case met the then applicable endangerment criteria, it also clearly said it was not determining what other facts or circumstances might amount to endangerment, including cases where the likelihood of a harm occurring was less than a significant risk of the harm.

In the EPA rulemaking that led to the *Ethyl* case, EPA stated that the requirement to reduce lead in gasoline ''is based on the finding that lead

particle emissions from motor vehicles present a significant risk of harm to the health of urban populations, particularly to the health of city children'' (38 FR 33734, December 6, 1973). The court in *Ethyl* supported EPA's determination, and addressed a variety of issues. First, it determined that the ''will endanger'' criteria of then CAA section 211(c) was intended to be precautionary in nature. It rejected arguments that EPA had to show proof of actual harm, or probable harm. *Ethyl,* 541 F.2d at 13–20. It was in this context, evaluating petitioner's arguments on whether the likelihood of a harm occurring had to rise to the level of actual or probable harm, that the court approved of EPA's view that a significant risk of harm could satisfy the statutory criteria. The precautionary nature of the provision meant that EPA did not need to show that either harm was actually occurring or was probable.

Instead, the court made it clear that the concept of endangerment is ''composed of reciprocal elements of risk and harm,'' *Ethyl* at 18. This means ''the public health may properly be found endangered both by a lesser risk of a greater harm and by a greater risk of lesser harm. Danger depends upon the relation between the risk and harm presented by each case, and cannot legitimately be pegged to 'probable' harm, regardless of whether that harm be great or small.'' The Ethyl court pointed to the decision by the 8th Circuit in *Reserve Mining Co.* v. *EPA,* 514 F.2d 492 (8th Cir, 1975), which interpreted similar language under the Federal Water Pollution Control Act, where the 8th Circuit upheld an endangerment finding in a case involving ''reasonable medical concern,'' or a ''potential'' showing of harm. This was further evidence that a minimum ''probable'' likelihood of harm was not required.

The Ethyl court made it clear that there was no specific magnitude of risk of harm occurring that was required. ''Reserve Mining convincingly demonstrates that the magnitude of risk sufficient to justify regulation is inversely proportional to the harm to be avoided.'' *Ethyl* at 19. This means there is no minimum requirement that the magnitude of risk be ''significant'' or another specific level of likelihood of occurrence. You need to evaluate the risk of harm in the context of the severity of the harm if it were to occur. In the case before it, the Ethyl court noted that ''the harm caused by lead poisoning is severe.'' Even with harm as severe as lead poisoning, EPA did not rely on ''potential'' risk or a ''reasonable medical concern.'' Instead, EPA found that there was a significant risk of this harm to health. This finding of a significant risk was less than the level of ''probable'' harm called for by the petitioner Ethyl Corporation but was ''considerably more certain than the risk that justified regulation in Reserve Mining of a comparably 'fright-laden' harm.'' *Ethyl* at 19–20. The Ethyl court concluded that this combination of risk (likelihood of harm) and severity of harm was sufficient under CAA section 211(c). ''Thus we conclude that however far the parameters of risk and harm inherent in the 'will endanger' standard might reach in an appropriate case, they certainly present a 'danger' that can be regulated when the harm to be avoided is widespread lead poisoning and the risk of that occurrence is 'significant'.'' *Ethyl* at 20.

Thus, the court made it clear that the endangerment criteria was intended to be precautionary in nature, that the risk of harm was one of the elements to consider in determining endangerment, and that the risk of harm needed to be considered in the context of the severity of the potential harm. It also concluded that a significant risk of harm coupled with an appropriate severity of the potential harm would satisfy the statutory criteria, and in the case before it the Administrator was clearly authorized to determine endangerment where there was a significant risk of harm that was coupled with a severe harm such as lead poisoning.

Importantly, the court also made it clear that it was not determining a minimum threshold that always had to be met. Instead, it emphasized that the risk of harm and severity of the potential harm had to be evaluated on a case by case basis. The court specifically said it was not determining ''however far the parameters of risk and harm * * * might reach in an appropriate case.'' *Ethyl* at 20. Also see *Ethyl* fn 17 at 13. The court recognized that this balancing of risk and harm ''must be confined to reasonable limits'' and even absolute certainty of a de minimis harm might not justify government action. However, ''whether a particular combination of slight risk and great harm, or great risk and slight harm constitutes a danger must depend on the facts of each case.'' *Ethyl* at fn 32 at 18.[7]

In some cases, commenters confuse matters by switching the terminology, and instead refer to effects that ''significantly harm'' the public health or welfare. As with the reference to ''significant risk of harm,'' commenters fail to recognize that there are two different aspects that must be considered, risk of harm and severity of harm, and neither of these aspects has a requirement that there be a finding of ''significance.'' The DC Circuit in *Ethyl* makes clear that it is the combination of these two aspects that must be evaluated for purposes of endangerment, and there is no requirement of ''significance'' assigned to either of the two aspects that must instead be evaluated in combination. Congress addressed concerns over burdensome economic and societal consequences in the various statutory provisions that provide the criteria for standard setting or other agency action if there is an affirmative endangerment finding. Those statutory provisions, for example, make standard setting discretionary or specify how cost and other factors are to be taken into consideration in setting standards. However, the issues of risk of harm and severity of harm if it were to occur are separate from the issues of the economic impacts of any resulting regulatory provisions (*see* below).

As is clear in the prior summary of the endangerment findings and the more detailed discussion later, the breadth of the sectors of our society that are affected by climate change and the time frames at issue mean there is a very wide range of risks and harms that need to be considered, from evidence of various harms occurring now to evidence of risks of future harms. The Administrator has determined that the body of scientific evidence compellingly supports her endangerment finding.

B. Air Pollutant, Public Health and Welfare

The CAA defines both ''air pollutant'' and ''effects on welfare.'' We provide both definitions here again for convenience.

Air pollutant is defined as:

[7] Commenters point to *Amer. Farm Bureau Ass'n* v. *EPA,* 559 F.3d 512, 533 (DC Cir. 2009) as supporting their argument. However, in that case the Court made clear that EPA's action was not subject to the endangerment criterion in CAA section 108 but instead was subject to CAA section 109's requirement that the primary NAAQS be requisite to protect the public health with an adequate margin of safety. Under that provision and its case law, the Court upheld EPA's reasoned balancing of the uncertainty regarding the link between non-urban thoracic coarse PM and adverse health effects, the large population groups potentially exposed to these particles, and the nature and degree of the health effects at issue. Citing to EPA's reasoning at 71 FR 61193 in the final PM rule, the court explained that EPA need not wait for conclusive proof of harm before setting a NAAQS under section 109 for this kind of coarse PM. The Court's reference to EPA's belief that there may be a significant risk to public health is not stated as any sort of statutory minimum, but instead refers to the Agency's reasoning at 71 FR 61193, which displays a reasoned balancing of possibility of harm and severity of harm if it were to occur.

''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.'' CAA section 302(g). As the Supreme Court held, greenhouse gases fit well within this capacious definition. *See Massachusetts* v. *EPA,* 549 U.S. at 532. They are ''without a doubt'' physical chemical substances emitted into the ambient air. *Id.* at 529.

''Regarding 'effects on welfare', the CAA states that [a]ll language referring to effects on welfare includes, but is 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, whether caused by transformation, conversion, or combination with other air pollutants.'' CAA section 302(h).

As noted in the Proposed Findings, this definition is quite broad. Importantly, it is not an exclusive list due to the use of the term ''includes, but is not limited to, * * *.'' Effects other than those listed here may also be considered effects on welfare. Moreover, the terms contained within the definition are themselves expansive.

Although the CAA defines ''effects on welfare'' as discussed above, there are no definitions of ''public health'' or ''public welfare'' in the CAA. The Supreme Court has discussed the concept of public health in the context of whether costs of implementation can be considered when setting the health based primary National Ambient Air Quality Standards. *Whitman v. American Trucking Ass'n,* 531 U.S. 457 (2001). In *Whitman,* the Court imbued the term with its most natural meaning: ''the health of the public. *Id.* at 466. In the past, when 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. *See, e.g., Final National Ambient Air Quality Standard for Ozone,* (73 FR 16436, 2007).

EPA received numerous comments regarding its proposed interpretations of air pollutant and public health and welfare. Summaries of key comments and EPA's responses are discussed in Sections IV and V of these Findings. Additional and more detailed summaries and responses can be found in the Response to Comments document. As noted in the Response to Comments document, EPA also received comments supporting its legal interpretations.

III. EPA's Approach for Evaluating the Evidence Before It

This section discusses EPA's approach to evaluating the evidence before it, including the approach taken to the scientific evidence, the legal framework for this decision making, and several issues critical to determining the scope of the evaluation performed.

A. The Science on Which the Decisions Are Based

In 2007, EPA initiated its assessment of the science and other technical information to use in addressing the endangerment and cause or contribute issues before it under CAA section 202(a). This scientific and technical information was developed in the form of a TSD in 2007. An earlier draft of this document was released as part of the ANPR published July 30, 2008 (73 FR 44353). That earlier draft of the TSD relied heavily on the IPCC Fourth Assessment Report of 2007, key NRC reports, and a limited number of then-available synthesis and assessment products of the U.S. Climate Change Science Program (CCSP; now encompassed by USGCRP). EPA received a number of comments specifically focused on the TSD during the 120-day public comment period for the ANPR.

EPA revised and updated the TSD in preparing the Proposed Findings on endangerment and cause or contribute. Many of the comments received on the ANPR were reflected in the draft TSD released in April 2009 that served as the underlying scientific and technical basis for the Administrator's Proposed Findings, published April 24, 2009 (74 FR 18886). The draft TSD released in April 2009 also reflected the findings of 11 new synthesis and assessment products under the U.S. CCSP that had been published since July 2008.

The TSD that summarizes scientific findings from the major assessments of the USGCRP, the IPCC, and the NRC accompanies these Findings. The TSD is available at *www.epa.gov/climatechange/endangerment.html* and in the docket for this action. It also includes the most recent comprehensive assessment of the USGCRP, *Global Climate Change Impacts in the United States*,[8] published in June 2009. In addition, the TSD incorporates up-to-date observational data for a number of key climate variables from the NOAA, and the most up-to-date emissions data from EPA's annual *Inventory of U.S. Greenhouse Gas Emissions and Sinks,* published in April, 2009.[9] And finally, as discussed in Section I.B of these Findings, EPA received a large number of public comments on the Administrator's Proposed Findings, many of which addressed science issues either generally or specifically as reflected in the draft TSD released with the April 2009 proposal. A number of edits and updates were made to the draft TSD as a result of these comments.[10]

EPA is giving careful consideration to all of the scientific and technical information in the record, as discussed below. However, the Administrator is relying on the major assessments of the USGCRP, IPCC, and NRC as the primary scientific and technical basis of her endangerment decision for a number of reasons.

First, these assessments address the scientific issues that the Administrator must examine for the endangerment analysis. When viewed in total, these assessments address the issue of greenhouse gas endangerment by providing data and information on: (1) The amount of greenhouse gases being emitted by human activities; (2) how greenhouse gases have been and continue to accumulate in the atmosphere as a result of human activities; (3) changes to the Earth's energy balance as a result of the buildup of atmospheric greenhouse gases; (4) observed temperature and other climatic changes at the global and regional scales; (5) observed changes in other climate-sensitive sectors and systems of the human and natural environment; (6) the extent to which observed climate change and other changes in climate-sensitive systems can be attributed to the human-induced buildup of atmospheric greenhouse gases; (7) future projected climate change under a range of different scenarios of changing greenhouse gas emission rates; and (8) the projected risks and impacts to

[8] Karl, T., J. Melillo, and T. Peterson (Eds.) (2009) Global Climate Change Impacts in the United States. Cambridge University Press, Cambridge, United Kingdom.

[9] U.S. EPA (2009) *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2007.* EPA–430–R–09–004, Washington, DC.

[10] EPA has placed within the docket a separate memo ''Summary of Major Changes to the Technical Support Document'' identifying where within the TSD such changes were made relative to the draft TSD released in April 2009.

human health, society and the environment.

Second, as indicated above, these assessments are recent and represent the current state of knowledge on the key elements for the endangerment analysis. It is worth noting that the June 2009 assessment of the USGCRP incorporates a number of key findings from the 2007 IPCC Fourth Assessment Report; such findings include the attribution of observed climate change to human emissions of greenhouse gases, and the future projected scenarios of climate change for the global and regional scales. This demonstrates that much of the underlying science that EPA has been utilizing since 2007 has not only been in the public domain for some time, but also has remained relevant and robust.

Third, these assessments are comprehensive in their coverage of the greenhouse gas and climate change problem, and address the different stages of the emissions-to-potential-harm chain necessary for the endangerment analysis. In so doing, they evaluate the findings of numerous individual peer-reviewed studies in order to draw more general and overarching conclusions about the state of science. The USGCRP, IPCC, and NRC assessments synthesize literally thousands of individual studies and convey the consensus conclusions on what the body of scientific literature tells us.

Fourth, these assessment reports undergo a rigorous and exacting standard of peer review by the expert community, as well as rigorous levels of U.S. government review and acceptance. Individual studies that appear in scientific journals, even if peer reviewed, do not go through as many review stages, nor are they reviewed and commented on by as many scientists. The review processes of the IPCC, USGCRP, and NRC (explained in fuller detail in the TSD and the Response to Comments document, Volume 1) provide EPA with strong assurance that this material has been well vetted by both the climate change research community and by the U.S. government. These assessments therefore essentially represent the U.S. government's view of the state of knowledge on greenhouse gases and climate change. For example, with regard to government acceptance and approval of IPCC assessment reports, the USGCRP Web site states that: ''When governments accept the IPCC reports and approve their Summary for Policymakers, they acknowledge the legitimacy of their scientific content.'' [11] It is the Administrator's view that such review and acceptance by the U.S. Government lends further support for placing primary weight on these major assessments.

It is EPA's view that the scientific assessments of the IPCC, USGRCP, and the NRC represent the best reference materials for determining the general state of knowledge on the scientific and technical issues before the agency in making an endangerment decision. No other source of information provides such a comprehensive and in-depth analysis across such a large body of scientific studies, adheres to such a high and exacting standard of peer review, and synthesizes the resulting consensus view of a large body of scientific experts across the world. For these reasons, the Administrator is placing primary and significant weight on these assessment reports in making her decision on endangerment.

A number of commenters called upon EPA to perform a new and independent assessment of all of the underlying climate change science, separate and apart from USGCRP, IPCC, and NRC. In effect, commenters suggest that EPA is either required to or should ignore the attributes discussed above concerning these assessment reports, and should instead perform its own assessment of all of the underlying studies and information.

In addition to the significant reasons discussed above for relying on and placing primary weight on these assessment reports, EPA has been a very active part of the U.S. government climate change research enterprise, and has taken an active part in the review, writing, and approval of these assessments. EPA was the lead agency for three significant reports under the USGCRP [12], and recently completed an assessment addressing the climate change impacts on U.S. air quality—a report on which the TSD heavily relies for that particular issue. EPA was also involved in review of the IPCC Fourth Assessment Report, and in particular took part in the approval of the summary for policymakers for the Working Group II Volume, *Impacts, Adaptation and Vulnerability.*[13] The USGCRP, IPCC, and NRC assessments have been reviewed and formally accepted by, commissioned by, or in some cases authored by, U.S. government agencies and individual government scientists. These reports already reflect significant input from EPA's scientists and the scientists of many other government agencies.

EPA has no reason to believe that the assessment reports do not represent the best source material to determine the state of science and the consensus view of the world's scientific experts on the issues central to making an endangerment decision with respect to greenhouse gases. EPA also has no reason to believe that putting this significant body of work aside and attempting to develop a new and separate assessment would provide any better basis for making the endangerment decision, especially because any such new assessment by EPA would still have to give proper weight to these same consensus assessment reports.

In summary, EPA concludes that its reliance on existing and recent synthesis and assessment reports is entirely reasonable and allows EPA to rely on the best available science.[14] EPA also recognizes that scientific research is very active in many areas addressed in the TSD (*e.g.,* aerosol effects on climate, climate feedbacks such as water vapor, and internal and external climate forcing mechanisms), as well as for some emerging issues (*e.g.,* ocean acidification and climate change effects on water quality). EPA recognizes the potential importance of new scientific research, and the value of an ongoing process to take more recent science into account. EPA reviewed new literature in

[11] *http://www.globalchange.gov/publications/reports/ipcc-reports.*

[12] CCSP (2009) *Coastal Sensitivity to Sea-Level Rise: A Focus on the Mid-Atlantic Region.* A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. [James G. Titus (Coordinating Lead Author), K. Eric Anderson, Donald R. Cahoon, Dean B. Gesch, Stephen K. Gill, Benjamin T. Gutierrez, E. Robert Thieler, and S. Jeffress Williams (Lead Authors)], U.S. Environmental Protection Agency, Washington DC, USA, 320 pp. CCSP (2008) *Preliminary review of adaptation options for climate-sensitive ecosystems and resources.* A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. [Julius, S.H., J.M. West (eds.), J.S. Baron, B. Griffith, L.A. Joyce, P. Kareiva, B.D. Keller, M.A. Palmer, C.H. Peterson, and J.M. Scott (Authors)]. U.S. Environmental Protection Agency, Washington, DC, USA, 873 pp. CCSP (2008) *Analyses of the effects of global change on human health and welfare and human systems.* A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. [Gamble, J.L. (ed.), K.L. Ebi, F.G. Sussman, T.J. Wilbanks, (Authors)]. U.S. Environmental Protection Agency, Washington, DC, USA.

[13] IPCC (2007) Climate Change 2007: *Impacts, Adaptation and Vulnerability.* Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 976pp.

[14] It maintains the highest level of adherence to Agency and OMB guidelines for data and scientific integrity and transparency. This is discussed in greater detail in EPA's Response to Comments document.

preparation of this TSD to evaluate its consistency with recent scientific assessments. We also considered public comments received and studies incorporated by reference. In a number of cases, the TSD was updated based on such information to add context for assessment literature findings, which includes supporting information and/or qualifying statements. In other cases, material that was not incorporated into the TSD is discussed within the Response to Comments document.

EPA reviewed these individual studies that were not considered or reflected in these major assessments to evaluate how they inform our understanding of how greenhouse gas emissions affect climate change, and how climate change may affect public health and welfare. Given the very large body of studies reviewed and assessed in developing the assessment reports, and the rigor and breadth of that review and assessment, EPA placed limited weight on the much smaller number of individual studies that were not considered or reflected in the major assessments. EPA reviewed them largely to see if they would lead EPA to change or place less weight on the judgments reflected in the assessment report. While EPA recognizes that some studies are more useful or informative than others, and gave each study it reviewed the weight it was due, the overall conclusion EPA drew from its review of studies submitted by commenters was that the studies did not change the various conclusions or judgments EPA would draw based on the assessment reports.

Many comments focus on the scientific and technical data underlying the Proposed Findings, such as climate change science and greenhouse gas emissions data. These comments cover a range of topics and are summarized and responded to in the Response to Public Comments document. The responses note those cases where a technical or scientific comment resulted in an editorial or substantive change to the TSD. The final TSD reflects all changes made as a result of public comments.

B. The Law on Which the Decisions Are Based

In addition to grounding these determinations on the science, they are also firmly grounded in EPA's legal authority. Section II of these Findings provides an in-depth discussion of the legal framework for the endangerment and cause or contribute decisions under CAA section 202(a), with additional discussion in Section II of the Proposed Finding (74 FR 18886, 18890, April 24, 2009). A variety of important legal issues are also discussed in Sections III, IV, and V of these Findings, as well as in the Response to Comments document, Volume 11. Section IV and V of these Findings explain the Administrator's decisions, and how she exercised her judgment in making the endangerment and contribution determinations, based on the entire scientific record before her and the legal framework structuring her decision making.

C. Adaptation and Mitigation

Following the language of CAA section 202(a), in which the Administrator, in her judgment, must determine if greenhouse gases constitute the air pollution that may be reasonably anticipated to endanger public health or welfare, EPA evaluated, based primarily on the scientific reports discussed above, how greenhouse gases and other climate-relevant substances are affecting the atmosphere and climate, and how these climate changes affect public health and welfare, now and in the future. Consistent with EPA's scientific approach underlying the Administrator's Proposed Findings, EPA did not undertake a separate analysis to evaluate potential societal and policy responses to any threat (*i.e.,* the endangerment) that may exist due to anthropogenic emissions of greenhouse gases. Risk reduction through adaptation and greenhouse gas mitigation measures is of course a strong focal area of scientists and policy makers, including EPA; however, EPA considers adaptation and mitigation to be potential responses to endangerment, and as such has determined that they are outside the scope of the endangerment analysis.

The Administrator's position is not that adaptation will not occur or cannot help protect public health and welfare from certain impacts of climate change, as some commenters intimated. To the contrary, EPA recognizes that some level of autonomous adaptation [15] will occur, and commenters are correct that autonomous adaptation can affect the severity of climate change impacts. Indeed, there are some cases in the TSD in which some degree of adaptation is accounted for; these cases occur where the literature on which the TSD relies already uses assumptions about autonomous adaptation when projecting the future effects of climate change. Such cases are noted in the TSD. We also view planned adaptation as an important near-term risk-minimizing strategy given that some degree of climate change will continue to occur as a result of past and current emissions of greenhouse gases that remain in the atmosphere for decades to centuries.

However, it is the Administrator's position that projections of adaptation and mitigation in response to risks and impacts associated with climate change are not appropriate for EPA to consider in making a decision on whether the air pollution endangers. The issue before EPA involves evaluating the risks to public health and welfare from the air pollution if we do not take action to address it. Adaptation and mitigation address an important but different issue—how much risk will remain assuming some projection of how people and society will respond to the threat.

Several commenters argue that it is arbitrary not to consider adaptation in determining endangerment. They contend that because endangerment is a forward-looking exercise, the fundamental inquiry concerns the type and extent of harm that is believed likely to occur in the future. Just as the Administrator makes projections of potential harms in the future, these commenters contend that the Administrator needs to consider the literature on adaptation that addresses the likelihood and the severity of potential effects. Commenters also note that since adaption is one of the likely impacts of climate change, it is irrational to exclude it from consideration when the goal is to evaluate the risks and harms in the real world in the future, not the risks and harms in the hypothetical scenario that result if you ignore adaptation.

According to commenters, the Administrator must consider both autonomous adaptation and anticipatory adaptation. They contend that literature on adaptation makes it clear there is a significant potential for adaptation, and that it can reduce the likelihood or severity of various effects, including health effects, and could even avert what might otherwise constitute endangerment. Commenters note that EPA considered the adaptation of species in nature, and it is arbitrary to not also consider adaptation by humans. Moreover, they argue that there is great

[15] The IPCC definition of adaptation: ''Adaptation to climate change takes place through adjustments to reduce vulnerability or enhance resilience in response to observed or expected changes in climate and associated extreme weather events. Adaptation occurs in physical, ecological and human systems. It involves changes in social and environmental processes, perceptions of climate risk, practices and functions to reduce potential damages or to realize new opportunities.'' The IPCC defines autonomous adaptation as ''Adaptation that does not constitute a conscious response to climatic stimuli but is triggered by ecological changes in natural systems and by market or welfare changes in human systems.''

certainty that adaptation will occur, and thus EPA is required to address it and make projections. They recommend that EPA look to historic responses to changes in conditions as an analogue in making projections, recognizing that life in the United States is likely to be quite different 50 or 100 years from now, irrespective of climate change.

Commenters argue that adaption needs to be considered because it is central to the statutory requirements governing the endangerment inquiry. EPA is charged to determine the type and extent of harms that are likely to occur, and they argue that this can not rationally be considered without considering adaptation. Since some degree of adaptation is likely to occur, they continue that such a projection of future actual conditions requires consideration of adaption to evaluate whether the future conditions amount to endangerment from the air pollution.

According to commenters, the issue therefore is focused on human and societal adaptation, which can come in a wide variety of forms, ranging from changes in personal behavioral patterns to expenditures of resources to change infrastructure, such as building and maintaining barriers to protect against sea level rise.

With regard to mitigation, commenters argue that EPA should consider mitigation strategies and their potential to alleviate harm from greenhouse gas emissions. They contend that it is unreasonable for EPA to assume that society will not undertake mitigation.

Section 202(a) of the CAA reflects the basic approach of many CAA sections—the threshold inquiry is whether the endangerment and cause or contribute criteria are satisfied, and only if they are met do the criteria for regulatory action go into effect. This reflects the basic separation of two different decisions—is this a health and welfare problem that should be addressed, and if so what are the appropriate mechanisms to address it? There is a division between identifying the health and welfare problem associated with the air pollution, and identifying the mechanisms used to address or solve the problem.

In evaluating endangerment, EPA is determining whether the risks to health and welfare from the air pollution amount to endangerment. As commenters recognize, that calls for evaluating and projecting the nature and types of risks from the air pollution, including the probability or likelihood of the occurrence of an impact and the degree of adversity (or benefit) of such an impact. This issue focuses on how EPA makes such an evaluation in determining endangerment—does EPA look at the risks assuming no planned adaptation and/or mitigation, although EPA projects some degree is likely to occur, or does EPA look at the risks remaining after some projection of adaptation and/or mitigation?

These two approaches reflect different views of the core question EPA is trying to answer. The first approach most clearly focuses on just the air pollution and its impacts, and aims to separate this from the human and societal responses that may or should be taken in response to the risks from the air pollution. By its nature, this separation means this approach may not reflect the actual conditions in the real world in the future, because adaptation and/or mitigation may occur and change the risks. For example, adaptation would not change the atmospheric concentrations, or the likelihood or probability of various impacts occurring (*e.g.*, it would not change the degree of sea level rise), but adaptation has the potential to reduce the adversity of the effects that do occur from these impacts. Mitigation could reduce the atmospheric concentrations that would otherwise occur, having the potential to reduce the likelihood or probability of various impacts occurring. Under this approach, the evaluation of risk is focused on the risk if we do not address the problem. It does not answer the question of how much risk we project will remain after we do address the problem, through either adaptation or mitigation or some combination of the two.

The second approach, suggested by commenters, would call for EPA to project into the future adaptation and/or mitigation, and the effect of these measures in reducing the risks to health or welfare from the air pollution. Commenters argue this will better reflect likely real world conditions, and therefore is needed to allow for an appropriate determination of whether EPA should, at this time, make an affirmative endangerment finding. However, this approach would not separate the air pollution and its impacts from the human and societal responses to the air pollution. It would intentionally and inextricably intertwine them. It would inexorably change the focus from how serious is the air pollution problem we need to address to how good a job are people and society likely to do in addressing or solving the problem. In addition it would dramatically increase the complexity of the issues before EPA.

The context for this endangerment finding is a time span of several decades into the future. It involves a wide variety of differing health and welfare effects, and almost every sector in our society. This somewhat unique context tends to amplify the differences between the two different approaches. It also means that it is hard to cleanly implement either approach. For example, it is hard under the first approach to clearly separate impacts with and without adaption, given the nature of the scientific studies and information before us. Under the second approach it would be extremely hard to make a reasoned projection of human and societal adaptation and mitigation responses, because these are basically not scientific or technical judgments, but are largely political judgments for society or individual personal judgments.

However, the context for this endangerment finding does not change the fact that at their core the two different approaches are aimed at answering different questions. The first approach is focused on answering the question of what are the risks to public health and welfare from the air pollution if we do not take action to address it. The second approach is focused on answering the question of how much risk will remain assuming some projection of how people and society will respond.

EPA believes that it is appropriate and reasonable to interpret CAA section 202(a) as calling for the first approach. The structure of CAA section 202(a) and the various other similar provisions indicate an intention by Congress to separate the question of what is the problem we need to address from the question of what is the appropriate way to address it. The first approach is clearly more consistent with this statutory structure. The amount of reduction in risk that might be achieved through adaptation and/or mitigation is closely related to the way to address a problem, and is not focused on what is the problem that needs to be addressed. It helps gauge the likelihood of success in addressing a problem, and how good a job society may do in reducing risk; it is not at all as useful in determining the severity of the problem that needs to be addressed.

The endangerment issue at its core is a decision on whether there is a risk to health and welfare that needs to be addressed, and the second approach would tend to indicate that the more likely a society is to solve a problem, the less likely there is a problem that needs to be addressed. This would mask the issue and provide a directionally wrong signal. Assume two different situations, both presenting the same serious risks to

public health or welfare without consideration of adaptation or mitigation. The more successful society is projected to be in solving the serious problem in the future would mean the less likely we would be to make an endangerment finding at the inception identifying it as a problem that needs to be addressed. This is much less consistent with the logic embodied in CAA section 202(a), which separates the issue of whether there is a problem from the issue of what can be done to successfully address it.

In addition, the second approach would dramatically increase the complexity of the issues to resolve, and would do this by bringing in issues that are not the subject of the kind of scientific or technical judgments that Congress envisioned for the endangerment test. The legislative history indicates Congress was focused on issues of science and medicine, including issues at the frontiers of these fields. It referred to data, research resources, science and medicine, chemistry, biology, and statistics. There is no indication Congress envisioned exercising judgment on the very different types of issues involved in projecting the political actions likely to be taken by various local, State, and Federal governments, or judgments on the business or other decisions that are likely to be made by companies or other organizations, or the changes in personal behavior that may be occasioned by the adverse impacts of air pollution. The second approach would take EPA far away from the kind of judgments Congress envisioned for the endangerment test.

D. Geographic Scope of Impacts

It is the Administrator's view that the primary focus of the vulnerability, risk, and impact assessment is the United States. As described in Section IV of these Findings, the Administrator gives some consideration to climate change effects in world regions outside of the United States. Given the global nature of climate change, she has also examined potential impacts in other regions of the world. Greenhouse gases, once emitted, become well mixed in the atmosphere, meaning U.S. emissions can affect not only the U.S. population and environment, but other regions of the world as well. Likewise, emissions in other countries can affect the United States. Furthermore, impacts in other regions of the world may have consequences that in turn raise humanitarian, trade, and national security concerns for the United States.

Commenters argue that EPA does not have the authority to consider international effects. They contend that the burden is on EPA is to show endangerment based on impacts in the United States. They note that EPA proposed this approach, which is the only relevant issue for EPA. The purpose of CAA section 202(a), as the stated purpose of the CAA, commenters note, is to protect the quality of the nation's air resources and to protect the health and welfare of the U.S. population. Thus, they continue, international public health and welfare are not listed or stated, and are not encompassed by these provisions. Moreover, they argue that Congress addressed international impacts expressly in two other provisions of the CAA. They note that under CAA section 115, EPA considers emissions of pollutants that cause or contribute to air pollution that is reasonably anticipated to endanger public health or welfare in a foreign country, and that CAA section 179B addresses emissions of air pollutants in foreign countries that interfere with attainment of a National Ambient Air Quality Standards (NAAQS) in the United States. Because Congress intentionally addressed international impacts in those provision, commenters argue that the absence of this direction in CAA section 202(a) means that EPA is not to consider international effects when assessing endangerment under this provision.

Commenters fail to recognize that EPA's consideration of international effects is directed at evaluating their impact on the public health and welfare of the U.S. population. EPA is not considering international effects to determine whether the health and welfare of the public in a foreign country is endangered. Instead, EPA's consideration of international effects for purposes of determining endangerment is limited to how those international effects impact the health and welfare of the U.S. population.

The Administrator looked first at impacts in the United States itself, and determined that these impacts are reasonably anticipated to endanger the public health and the welfare of the U.S. population. That remains the Administrator's position, and by itself supports her determination of endangerment. The Administrator also considered the effects of global climate change outside the borders of the United States and evaluated them to determine whether these international effects impact the U.S. population, and if so whether it impacts the U.S. population in a manner that supports or does not support endangerment to the health and welfare of the U.S. public. She is not evaluating international effects to determine whether populations in a foreign country are endangered. The Administrator is looking at international effects solely for the purpose of evaluating their effects on the U.S. population.

For example, the U.S. population can be impacted by effects in other countries. These international effects can impact U.S. economic, trade, and humanitarian and national security interests. These would be potential effects on the U.S. population, brought about by the effects of climate change occurring outside the United States. It is fully reasonable and rational to expect that events occurring outside our borders can affect the U.S. population.

Thus, commenters misunderstand the role that international effects played in the proposal. The Administrator is not evaluating the impact of international effects on populations outside the United States; she is considering what impact these international effects could have on the U.S. population. That is fully consistent with the CAA's stated purpose of protecting the health and welfare of this nation's population.

E. Temporal Scope of Impacts

An additional parameter of the endangerment analysis is the timeframe. The Administrator's view is that the timeframe over which vulnerabilities, risks, and impacts are considered should be consistent with the timeframe over which greenhouse gases, once emitted, have an effect on climate. Thus the relevant time frame is decades to centuries for the primary greenhouse gases of concern. Therefore, in addition to reviewing recent observations, the underlying science upon which the Administrator is basing her findings generally considers the next several decades—the time period out to around 2100, and for certain impacts, the time period beyond 2100. How the accumulation of atmospheric greenhouse gases and resultant climate change may affect current and future generations is discussed in section IV in these Findings. By current generations we mean a near-term time frame of approximately the next 10 to 20 years; by future generations we mean a longer-term time frame extending beyond that. Some public comments were received that questioned making an endangerment finding based on current conditions, while others questioned EPA's ability to make an endangerment finding based on future projected conditions. Some of these comments are likewise addressed in Section IV in these Findings; and all comments on these temporal issues are addressed in the Response to Comments document.

F. Impacts of Potential Future Regulations and Processes That Generate Greenhouse Gas Emissions

This action is a stand-alone set of findings regarding endangerment and cause or contribute for greenhouse gases under CAA section 202(a), and does not contain any regulatory requirements. Therefore, this action does not attempt to assess the impacts of any future regulation. Although EPA would evaluate any future proposed regulation, many commenters argue that such a regulatory analysis should be part of the endangerment analysis.

Numerous commenters argue that EPA must fully consider the adverse and beneficial impacts of regulation together with the impacts of inaction, and describe this balancing as ''risk-risk analysis,'' ''health-health analysis,'' and most predominantly ''risk tradeoff analysis.'' Commenters argue that EPA's final endangerment finding would be arbitrary unless EPA undertakes this type of risk trade-off analysis.

Commenters specifically argue that EPA must consider the economic impact of regulation, including the Prevention of Significant Deterioration (PSD) permitting program for major stationary sources because it is triggered by a CAA section 202(a) standard, when assessing whether there is endangerment to public welfare. In other words, they argue that the Administrator should determine if finding endangerment and regulating greenhouse gases under the CAA would be worse for public health and welfare than not regulating. Commenters also argue that the reference to ''public'' health or welfare in CAA section 202, as well as the fact that impacts on the economy should be considered impacts to welfare, especially requires EPA to consider the full range of possible impacts of regulation. Commenters provide various predictions regarding how regulating greenhouse gases under the CAA more broadly will impact the public, industry, states the overall economy, and thus, they conclude, public health and welfare. Examples of commenters' predictions include potential adverse impacts on (1) the housing industry and the availability of affordable housing, (2) jobs and income due to industry moving overseas, (3) the agriculture industry and its ability to provide affordable food, and (4) the nation's energy supply. They also cite to the letter from the Office of Management and Budget provided with the ANPR, as well as interagency comments on the draft Proposed Findings, in support of their argument.

At least one commenter argues that EPA fails to discuss the public health or welfare benefits of the processes that *produce* the emissions. The commenter contends that for purposes of CAA section 202(a), this process would be the combustion of gasoline or other transportation fuel in new motor vehicles, and that for purposes of other CAA provisions with similar endangerment finding triggers, the processes would be the combustion of fossil fuel for electric generation and other activities. The commenter continues that EPA's decision to limit its analysis to the perceived detrimental aspects of emissions after they enter the atmosphere—as opposed to the possible positive aspects of emissions because of the processes that create the emissions—is based on EPA's overly narrow interpretation of both the meaning of the term ''emission'' in CAA section 202(a) (and therefore in other endangerment finding provisions) and the intent of these provisions. The commenter states that logically, it makes little sense to limit the definition of the term ''emission'' to only the ''air pollutants'' that are emitted. The commenter concludes that when EPA assesses whether the emission of greenhouse gases endanger public health and welfare, EPA must assess the dangers and benefits on both sides of the point where the emissions occur: in the atmosphere where the emissions lodge and, on the other side of the emitting stack or structure, in the processes that create the emissions. Otherwise, EPA will not be able to accurately assess whether the fact that society emits greenhouse gases is a benefit or a detriment. The commenter states that because greenhouse gas emissions, particularly carbon dioxide emissions, are so closely tied with all facets of modern life, a finding that greenhouse gas emissions endanger public health and welfare is akin to saying that modern life endangers public health or welfare. The commenter states that simply cannot be true because the lack of industrial activity that causes greenhouse gas emissions would pose other, almost certainly more serious health and welfare consequences.

Finally, some commenters argue that the impact of regulating under CAA section 202(a) supports making a final, negative endangerment finding. These commenters contend that the incredible costs associated with using the inflexible regulatory structure of the CAA will harm public health and welfare, and therefore EPA should exercise its discretion and find that greenhouse gases do not endanger public health and welfare because once EPA makes an endangerment finding under CAA section 202(a), it will be forced to regulate greenhouse gases under a number of other sections of the CAA, resulting in regulatory chaos.

At their core, these comments are not about whether commenters believe greenhouse gases may reasonably be anticipated to endanger public health or welfare, but rather about commenters' dissatisfaction with the decisions that Congress made regarding *the response* to any endangerment finding that EPA makes under CAA section 202(a). These comments do not discuss the science of greenhouse gases or climate change, or the impacts of climate change on public health or welfare. Instead they muddle the rather straightforward scientific judgment about whether there may be endangerment by throwing the potential impact of responding to the danger into the initial question. To use an analogy, the question of whether the cure is worse than the illness is different than the question of whether there is an illness in the first place. The question of whether there is endangerment is like the question of whether there is an illness. Once one knows there is an illness, then the next question is what to do, if anything, in response to that illness.

What these comments object to is that Congress has already made some decisions about next steps after a finding of endangerment, and commenters are displeased with the results. But if this is the case, commenters should take up their concerns with Congress, not EPA. EPA's charge is to issue new motor vehicle standards under CAA section 202(a) applicable to emissions of air pollutants that cause or contribute to air pollution which may reasonably be anticipated to endanger public health or welfare. It is not to find that there is no endangerment in order to avoid issuing those standards, and dealing with any additional regulatory impact.

Indeed, commenters' argument would insert policy considerations into the endangerment decision, an approach already rejected by the Supreme Court. First, as discussed in Section I.B of these Findings, in *Massachusetts* v. *EPA*, the court clearly indicated that the Administrator's decision must be a ''scientific judgment.'' 549 U.S. at 534. She must base her decision about endangerment on the science, and not on policy considerations about the repercussions or impact of such a finding.

Second, in considering whether the CAA allowed for economic considerations to play a role in the promulgation of the NAAQS, the

Supreme Court rejected arguments that because many more factors than air pollution might affect public health, EPA should consider compliance costs that produce health losses in setting the NAAQS. *Whitman* v. *ATA*, 531 U.S. at 457, 466 (2001). To be sure, the language in CAA section 109(b) applicable to the setting of a NAAQS is different than that in CAA section 202(a) regarding endangerment. But the concepts are similar—the NAAQS are about setting standards at a level requisite to protect public health (with an adequate margin of safety) and public welfare, and endangerment is about whether the current or projected future levels may reasonably be anticipated to endanger public health or welfare. In other words, both decisions essentially are based on assessing the harm associated with a certain level of air pollution.

Given this similarity in purpose, as well as the Court's instructions in *Massachusetts* v. *EPA* that the Administrator should base her decision on the science, EPA reasonably interprets the statutory endangerment language to be analogous to setting the NAAQS. Therefore, it is reasonable to interpret the endangerment test as not requiring the consideration of the impacts of implementing the statute in the event of an endangerment finding as part of the endangerment finding itself.[16]

Moreover, EPA does not believe that the impact of regulation under the CAA as a whole, let alone that which will result from this particular endangerment finding, will lead to the panoply of adverse consequences that commenters predict. EPA has the ability to fashion a reasonable and common-sense approach to address greenhouse gas emissions and climate change. The Administrator thinks that EPA has and will continue to take a measured approach to address greenhouse gas emissions. For example, the Agency's recent Mandatory Greenhouse Gas Reporting Rule focuses on only the largest sources of greenhouse gases in order to reduce the burden on smaller facilities.[17]

We also note that commenters' approach also is another version of the argument that EPA must consider adaptation and mitigation in the endangerment determination. Just as EPA should consider whether mitigation would *reduce* endangerment, commenters argue we should consider whether mitigation would *increase* endangerment. But as discussed previously, EPA disagrees and believes its approach better achieves the goals of the statute.

Finally, EPA simply disagrees with the commenter who argues that because we are better off now than before the industrial revolution, greenhouse gases cannot be found to endanger public health or welfare. As the DC Circuit noted in the *Ethyl* decision, ''[m]an's ability to alter his environment has developed far more rapidly than his ability to foresee with certainty the effects of his alterations.'' See *Ethyl Corp.,* 541 F.2d at 6. The fact that we as a society are better off now than 100 years ago, and that processes that produce greenhouse gases are a large part of this improvement, does not mean that those processes do not have unintended adverse impacts. It also was entirely reasonable for EPA to look at ''emissions'' as the pollution once it is emitted from the source into the air, and not also as the process that generates the pollution. Indeed, the definition of ''air pollutant'' talks in terms of substances ''emitted into or otherwise enter[ing] the ambient air'' (CAA section 302(g)). It is entirely appropriate for EPA to consider only the substance being emitted as the air pollution or air pollutant.

IV. The Administrator's Finding That Greenhouse Gases Endanger Public Health and Welfare

The Administrator finds that elevated concentrations of greenhouse gases in the atmosphere may reasonably be anticipated to endanger the public health and to endanger the public welfare of current and future generations. The Administrator is making this finding specifically with regard to six key directly-emitted, long-lived and well-mixed greenhouse gases: Carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride. The Administrator is making this judgment based on both current observations and projected risks and impacts into the future. Furthermore, the Administrator is basing this finding on impacts of climate change within the United States. However, the Administrator finds that when she considers the impacts on the U.S. population of risks and impacts occurring in other world regions, the case for endangerment to public health and welfare is only strengthened.

A. The Air Pollution Consists of Six Key Greenhouse Gases

The Administrator must define the scope and nature of the relevant air pollution for the endangerment finding under CAA section 202(a). In this final action, the Administrator finds that the air pollution is the combined mix of six key directly-emitted, long-lived and well-mixed greenhouse gases (henceforth ''well-mixed greenhouse gases''), which together, constitute the root cause of human-induced climate change and the resulting impacts on public health and welfare. These six greenhouse gases are carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride.

EPA received public comments on this definition of air pollution from the Proposed Findings, and summarizes responses to some of those key comments below; fuller responses to public comments can be found in EPA's Response to Comments document, Volume 9. The Administrator acknowledges that other anthropogenic climate forcers also play a role in climate change. Many public comments either supported or opposed inclusion of other substances in addition to the six greenhouse gases for the definition of air pollution. EPA's responses to those comments are also summarized below, and in volume 9 of the Response to Comments document.

The Administrator explained her rationale for defining air pollution under CAA section 202(a) as the combined mix of the six greenhouse gases in the Proposed Findings. After review of the public comments, the Administrator is using the same definition of the air pollution in the

[16] Indeed, some persons may argue that due to the similarities between setting a NAAQS and making an endangerment finding, EPA cannot consider the impacts of implementation of the statute.

[17] Note that it is EPA's current position that these Final Findings do not make well-mixed greenhouse gases ''subject to regulation'' for purposes of the CAA's Prevention of Significant Deterioration (PSD) and title V programs. *See, e.g.*, memorandum entitled ''EPA's Interpretation of Regulations that Determine Pollutants Covered By Federal Prevention of Significant Deterioration (PSD) Permit Program'' (Dec. 18, 2008). While EPA is reconsidering this memorandum and is seeking public comment on the issues raised in it generally, including whether a final endangerment finding should trigger PSD, the effectiveness of the positions provided in the memorandum was not stayed pending that reconsideration. Prevention of Significant Deterioration (PSD): Reconsideration of Interpretation of Regulations That Determine Pollutants Covered by the Federal PSD Permit Program, 74 FR 515135, 51543–44 (Oct. 7, 2009). In addition, EPA has proposed new temporary thresholds for greenhouse gas emissions that define when PSD and title V permits are required for new or existing facilities. Prevention of Significant Deterioration and Title V Greenhouse Gas Tailoring Rule (74 FR 55292, October 27, 2009). The proposed thresholds would ''tailor'' the permit programs to limit which facilities would be required to obtain PSD and title V permits. As noted in the preamble for the tailoring rule proposal, EPA also intends to evaluate ways to streamline the process for identifying GHG emissions control requirements and issuing permits. See the Response to Comments Document, Volume 11, and the Tailoring Rule, for more information.

final finding, for the following reasons: (1) These six greenhouse gas share common properties regarding their climate effects; (2) these six greenhouse gases have been estimated to be the primary cause of human-induced climate change, are the best understood drivers of climate change, and are expected to remain the key driver of future climate change; (3) these six greenhouse gases are the common focus of climate change science research and policy analyses and discussions; (4) using the combined mix of these gases as the definition (versus an individual gas-by-gas approach) is consistent with the science, because risks and impacts associated with greenhouse gas-induced climate change are not assessed on an individual gas approach; and (5) using the combined mix of these gases is consistent with past EPA practice, where separate substances from different sources, but with common properties, may be treated as a class (*e.g.,* oxides of nitrogen).

1. Common Physical Properties of the Six Greenhouse Gases

The common physical properties relevant to the climate change problem shared by the six greenhouse gases include the fact that they are long-lived in the atmosphere. ''Long-lived'' is used here to mean that the gas has a lifetime in the atmosphere sufficient to become globally well mixed throughout the entire atmosphere, which requires a minimum atmospheric lifetime of about one year.[18] Thus, this definition of air pollution is global in nature because the greenhouse gas emissions emitted from the United States (or from any other region of the world) become globally well mixed, such that it would not be meaningful to define the air pollution as the greenhouse gas concentrations over the United States as somehow being distinct from the greenhouse gas concentrations over other regions of the world.

It is also well established that each of these gases can exert a warming effect on the climate by trapping in heat that would otherwise escape to space. These six gases are directly emitted as greenhouse gases rather than forming as a greenhouse gas in the atmosphere after emission of a pre-cursor gas. Given these properties, the magnitude of the warming effect of each of these gases is generally better understood than other climate forcing agents that do not share these same properties (addressed in more detail below). The ozone-depleting substances that include chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HFCs) also share the same physical attributes discussed here, but for reasons discussed throughout the remainder of this section are not being included in the Administrator's definition of air pollution for this finding.

2. Evidence That the Six Greenhouse Gases Are the Primary Driver of Current and Projected Climate Change

a. Key Observations Driven Primarily by the Six Greenhouse Gases

The latest assessment of the USGCRP, as summarized in EPA's TSD, confirms the evidence presented in the Proposed Findings that current atmospheric greenhouse gas concentrations are now at elevated and essentially unprecedented levels as a result of both historic and current anthropogenic emissions. The global atmospheric carbon dioxide concentration has increased about 38 percent from pre-industrial levels to 2009, and almost all of the increase is due to anthropogenic emissions. The global atmospheric concentration of methane has increased by 149 percent since pre-industrial levels (through 2007); and the nitrous oxide concentration has increased 23 percent (through 2007). The observed concentration increase in these gases can also be attributed primarily to anthropogenic emissions. The industrial fluorinated gases have relatively low concentrations, but these concentrations have also been increasing and are almost entirely anthropogenic in origin.

Historic data show that current atmospheric concentrations of the two most important directly emitted, long-lived greenhouse gases (carbon dioxide and methane) are well above the natural range of atmospheric concentrations compared to at least the last 650,000 years. Atmospheric greenhouse gas concentrations have been increasing because anthropogenic emissions are outpacing the rate at which greenhouse gases are removed from the atmosphere by natural processes over timescales of decades to centuries. It also remains clear that these high atmospheric concentrations of greenhouse gases are the unambiguous result of human activities.

Together the six well-mixed greenhouse gases constitute the largest anthropogenic driver of climate change.[19] Of the total anthropogenic heating effect caused by the accumulation of the six well-mixed greenhouse gases plus other warming agents (that do not meet all of the Administrator's criteria that pertain to the six greenhouse gases) since pre-industrial times, the combined heating effect of the six well-mixed greenhouses is responsible for roughly 75 percent, and it is expected that this share may grow larger over time, as discussed below.

Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level. Global mean surface temperatures have risen by 0.74 °C (1.3 °F) (±0.18 °C) over the last 100 years. Eight of the 10 warmest years on record have occurred since 2001. Global mean surface temperature was higher during the last few decades of the 20th century than during any comparable period during the preceding four centuries.

The global surface temperature record relies on three major global temperature datasets, developed by NOAA, NASA, and the United Kingdom's Hadley Center. All three show an unambiguous warming trend over the last 100 years, with the greatest warming occurring over the past 30 years.[20] Furthermore, all three datasets show that eight of the 10 warmest years on record have occurred since 2001; that the 10 warmest years have all occurred in the past 12 years; and that the 20 warmest years have all occurred since 1981. Though most of the warmest years on record have occurred in the last decade in all available datasets, the rate of warming has, for a short time in the

[18] The IPCC also refers to these six GHGs as long-lived. Methane has an atmospheric lifetime of roughly a decade. One of the most commonly used hydrofluorocarbons (HFC–134a) has a lifetime of 14 years. Nitrous oxide has a lifetime of 114 years; sulfur hexafluoride over 3,000 years; and some PFCs up to 10,000 to 50,000 years. Carbon dioxide in the atmosphere is sometimes approximated as having a lifetime of roughly 100 years, but for a given amount of carbon dioxide emitted a better description is that some fraction of the atmospheric increase in concentration is quickly absorbed by the oceans and terrestrial vegetation, some fraction of the atmospheric increase will only slowly decrease over a number of years, and a small portion of the increase will remain for many centuries or more.

[19] As summarized in EPA's TSD, the global average net effect of the increase in atmospheric greenhouse gas concentrations, plus other human activities (*e.g.,* land use change and aerosol emissions), on the global energy balance since 1750 has been one of warming. This total net heating effect, referred to as forcing, is estimated to be +1.6 (+0.6 to +2.4) Watts per square meter (W/m^2), with much of the range surrounding this estimate due to uncertainties about the cooling and warming effects of aerosols. The combined radiative forcing due to the cumulative (*i.e.,* 1750 to 2005) increase in atmospheric concentrations of CO_2, CH_4, and N_2O is estimated to be +2.30 (+2.07 to +2.53) W/m^2. The rate of increase in positive radiative forcing due to these three GHGs during the industrial era is very likely to have been unprecedented in more than 10,000 years.

[20] *See* section 4 of the TSD for more detailed information about the three global temperature datasets.

Hadley Center record, slowed. However, the NOAA and NASA trends do not show the same marked slowdown for the 1999–2008 period. Year-to-year fluctuations in natural weather and climate patterns can produce a period that does not follow the long-term trend. Thus, each year may not necessarily be warmer than every year before it, though the long-term warming trend continues.[21]

The scientific evidence is compelling that elevated concentrations of heat-trapping greenhouse gases are the root cause of recently observed climate change. The IPCC conclusion from 2007 has been re-confirmed by the June 2009 USGCRP assessment that most of the observed increase in global average temperatures since the mid-20th century is very likely [22] due to the observed increase in anthropogenic greenhouse gas concentrations. Climate model simulations suggest natural forcing alone (*e.g.,* changes in solar irradiance) cannot explain the observed warming.

The attribution of observed climate change to anthropogenic activities is based on multiple lines of evidence. The first line of evidence arises from our basic physical understanding of the effects of changing concentrations of greenhouse gases, natural factors, and other human impacts on the climate system. The second line of evidence arises from indirect, historical estimates of past climate changes that suggest that the changes in global surface temperature over the last several decades are unusual.[23] The third line of evidence arises from the use of computer-based climate models to simulate the likely patterns of response of the climate system to different forcing mechanisms (both natural and anthropogenic).

The claim that natural internal variability or known natural external forcings can explain most (more than half) of the observed global warming of the past 50 years is inconsistent with the vast majority of the scientific literature, which has been synthesized in several assessment reports. Based on analyses of widespread temperature increases throughout the climate system and changes in other climate variables, the IPCC has reached the following conclusions about external climate forcing: ''It is extremely unlikely (<5 percent) that the global pattern of warming during the past half century can be explained without external forcing, and very unlikely that it is due to known natural external causes alone'' (Hegerl *et al.,* 2007). With respect to internal variability, the IPCC reports the following: ''The simultaneous increase in energy content of all the major components of the climate system as well as the magnitude and pattern of warming within and across the different components supports the conclusion that the cause of the [20th century] warming is extremely unlikely (<5 percent) to be the result of internal processes'' (Hegerl *et al.,* 2007). As noted in the TSD, the observed warming can only be reproduced with models that contain both natural and anthropogenic forcings, and the warming of the past half century has taken place at a time when known natural forcing factors alone (solar activity and volcanoes) would likely have produced cooling, not warming.

United States temperatures also warmed during the 20th and into the 21st century; temperatures are now approximately 0.7 °C (1.3 °F) warmer than at the start of the 20th century, with an increased rate of warming over the past 30 years. Both the IPCC and CCSP reports attributed recent North American warming to elevated greenhouse gas concentrations. The CCSP (2008g) report finds that for North America, ''more than half of this warming [for the period 1951–2006] is likely the result of human-caused greenhouse gas forcing of climate change.''

Observations show that changes are occurring in the amount, intensity, frequency, and type of precipitation. Over the contiguous United States, total annual precipitation increased by 6.1 percent from 1901–2008. It is likely that there have been increases in the number of heavy precipitation events within many land regions, even in those where there has been a reduction in total precipitation amount, consistent with a warming climate.

There is strong evidence that global sea level gradually rose in the 20th century and is currently rising at an increased rate. It is very likely that the response to anthropogenic forcing contributed to sea level rise during the latter half of the 20th century. It is not clear whether the increasing rate of sea level rise is a reflection of short-term variability or an increase in the longer-term trend. Nearly all of the Atlantic Ocean shows sea level rise during the last 50 years with the rate of rise reaching a maximum (over 2 mm per year) in a band along the U.S. east coast running east-northeast.

Satellite data since 1979 show that annual average Arctic sea ice extent has shrunk by 4.1 percent per decade. The size and speed of recent Arctic summer sea ice loss is highly anomalous relative to the previous few thousands of years.

Widespread changes in extreme temperatures have been observed in the last 50 years across all world regions including the United States. Cold days, cold nights, and frost have become less frequent, while hot days, hot nights, and heat waves have become more frequent.

Observational evidence from all continents and most oceans shows that many natural systems are being affected by regional climate changes, particularly temperature increases. However, directly attributing specific regional changes in climate to emissions of greenhouse gases from human activities is difficult, especially for precipitation.

Ocean carbon dioxide uptake has lowered the average ocean pH (increased the acidity) level by approximately 0.1 since 1750. Consequences for marine ecosystems may include reduced calcification by shell-forming organisms, and in the longer term, the dissolution of carbonate sediments.

Observations show that climate change is currently affecting U.S. physical and biological systems in significant ways. The consistency of these observed changes in physical and biological systems and the observed significant warming likely cannot be explained entirely due to natural variability or other confounding non-climate factors.

b. Key Projections Based Primarily on Future Scenarios of the Six Greenhouse Gases

There continues to be no reason to expect that, without substantial and near-term efforts to significantly reduce emissions, atmospheric levels of greenhouse gases will not continue to climb, and thus lead to ever greater rates of climate change. Given the long atmospheric lifetime of the six greenhouse gases, which range from roughly a decade to centuries, future atmospheric greenhouse gas

[21] Karl T. *et al.,* (2009).

[22] The IPCC Fourth Assessment Report uses specific terminology to convey likelihood and confidence. Likelihood refers to a probability that the statement is correct or that something will occur. ''Virtually certain'' conveys greater than 99 percent probability of occurrence; ''very likely'' 90 to 99 percent; ''likely'' 66 to 90 percent. IPCC assigns confidence levels as to the correctness of a statement. ''Very high confidence'' conveys at least 9 out of 10 chance of being correct; ''high confidence'' about 8 out of 10 chance; ''medium confidence'' about 5 out of 10 chance. The USGCRP uses the same or similar terminology in its reports. See also Box 1.2 of the TSD. Throughout this document, this terminology is used in conjunction with statements from the IPCC and USGCRP reports to convey the same meaning that those reports intended. In instances where a word such as ''likely'' may appear outside the context of a specific IPCC or USGCRP statement, it is not meant to necessarily convey the same quantitative meaning as the IPCC terminology.

[23] Karl T. *et al.* (2009).

concentrations for the remainder of this century and beyond will be influenced not only by future emissions but indeed by present-day and near-term emissions. Consideration of future plausible scenarios, and how our current greenhouse gas emissions essentially commit present and future generations to cope with an altered atmosphere and climate, reinforces the Administrator's judgment that it is appropriate to define the combination of the six key greenhouse gases as the air pollution.

Most future scenarios that assume no explicit greenhouse gas mitigation actions (beyond those already enacted) project increasing global greenhouse gas emissions over the century, which in turn result in climbing greenhouse gas concentrations. Under the range of future emission scenarios evaluated by the assessment literature, carbon dioxide is expected to remain the dominant anthropogenic greenhouse gas, and thus driver of climate change, over the course of the 21st century. In fact, carbon dioxide is projected to be the largest contributor to total radiative forcing in all periods and the radiative forcing associated with carbon dioxide is projected to be the fastest growing. For the year 2030, projections of the six greenhouse gases show an increase of 25 to 90 percent compared with 2000 emissions. Concentrations of carbon dioxide and the other well-mixed gases increase even for those scenarios where annual emissions toward the end of the century are assumed to be lower than current annual emissions. The radiative forcing associated with the non-carbon dioxide well-mixed greenhouse gases is still important and increasing over time. Emissions of the ozone-depleting substances are projected to continue decreasing due to the phase-out schedule under the Montreal Protocol on Substances that Deplete the Ozone Layer. Considerable uncertainties surround the estimates and future projections of anthropogenic aerosols; future atmospheric concentrations of aerosols, and thus their respective heating or cooling effects, will depend much more on assumptions about future emissions because of their short atmospheric lifetimes compared to the six well-mixed greenhouse gases.

Future warming over the course of the 21st century, even under scenarios of low emissions growth, is very likely to be greater than observed warming over the past century. According to climate model simulations summarized by the IPCC, through about 2030, the global warming rate is affected little by the choice of different future emission scenarios. By the end of the century, projected average global warming (compared to average temperature around 1990) varies significantly depending on emissions scenario and climate sensitivity assumptions, ranging from 1.8 to 4.0 °C (3.2 to 7.2 °F), with an uncertainty range of 1.1 to 6.4 °C (2.0 to 11.5 °F).

All of the United States is very likely to warm during this century, and most areas of the United States are expected to warm by more than the global average. The largest warming is projected to occur in winter over northern parts of Alaska. In western, central and eastern regions of North America, the projected warming has less seasonal variation and is not as large, especially near the coast, consistent with less warming over the oceans.

3. The Six Greenhouse Gases Are Currently the Common Focus of the Climate Change Science and Policy Communities

The well-mixed greenhouse gases are currently the common focus of climate science and policy analyses and discussions. For example, the United Nations Framework Convention on Climate Change (UNFCCC), signed and ratified by the United States in 1992, requires its signatories to ''develop, periodically update, publish and make available * * * national inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, using comparable methodologies * * *'' [24] [25] To date, the focus of UNFCCC actions and discussions has been on the six greenhouse gases that are the same focus of these Findings.

Because of these common properties, it has also become common practice to compare these gases on a carbon dioxide equivalent basis, based on each gas's warming effect relative to carbon dioxide (the designated reference gas) over a specified timeframe. For example, both the annual *Inventory of U.S. Greenhouse Gases and Sinks* published by EPA and the recently finalized EPA Mandatory Greenhouse Gas Reporting Rule (74 FR 56260), use the carbon dioxide equivalent metric to sum and compare these gases, and thus accept the common climate-relevant properties of these gases for their treatment as a group. This is also common practice internationally as the UNFCCC reporting guidelines for developed countries, and the Clean Development Mechanism procedures for developing countries both require the use of global warming potentials published by the IPCC to convert the six greenhouse gases into their respective carbon dioxide equivalent units.

4. Defining Air Pollution as the Aggregate Group of Six Greenhouse Gases Is Consistent With Evaluation of Risks and Impacts Due to Human-Induced Climate Change

Because the well-mixed greenhouse gases are collectively the primary driver of current and projected human-induced climate change, all current and future risks due to human-induced climate change—whether these risks are associated with increases in temperature, changes in precipitation, a rise in sea levels, changes in the frequency and intensity of weather events, or more directly with the elevated greenhouse gas concentrations themselves—can be associated with this definition of air pollution.

5. Defining the Air Pollution as the Aggregate Group of Six Greenhouse Gases Is Consistent With Past EPA Practice

Treating the air pollution as the aggregate of the well-mixed greenhouse gases is consistent with other provisions of the CAA and previous EPA practice under the CAA, where separate emissions from different sources but with common properties may be treated as a class (*e.g.,* particulate matter (PM)). This approach addresses the total, cumulative effect that the elevated concentrations of the six well-mixed greenhouse gases have on climate, and thus on different elements of health, society and the environment.[24]

EPA treats, for example, PM as a common class of air pollution; PM is a complex mixture of extremely small particles and liquid droplets. Particle pollution is made up of a number of components, including acids (such as nitrates and sulfates), organic chemicals, metals, and soil or dust particles.

6. Other Climate Forcers Not Being Included in the Definition of Air Pollution for This Finding

Though the well-mixed greenhouse gases that make up the definition of air pollution for purposes of making the endangerment decision under CAA section 202(a) constitute the primary

[24] Due to the cumulative purpose of the statutory language, even if the Administrator were to look at the atmospheric concentration of each greenhouse gas individually, she would still consider the impact of the concentration of a single greenhouse gas in combination with that caused by the other greenhouse gases.

[25] The range of uncertainty in the current magnitude of black carbon's climate forcing effect is evidenced by the ranges presented by the IPCC Fourth Assessment Report (2007) and the more recent study by Ramanathan, V. and Carmichael, G. (2008) Global and regional climate changes due to black carbon. Nature Geoscience, 1(4): 221–227.

driver of human-induced climate change, there are other substances emitted from human activities that contribute to climate change and deserve careful attention, but are not being included in the air pollution definition for this particular action. These substances are discussed immediately below.

a. Black Carbon

Several commenters request that black carbon be included in the definition of air pollution because of its warming effect on the climate. Black carbon is not a greenhouse gas, rather, it is an aerosol particle that results from the incomplete combustion of carbon contained in fossil fuels and biomass, and remains in the atmosphere for only about a week. Unlike any of the greenhouse gases being addressed by this action, black carbon is a component of particulate matter (PM), where PM is a criteria air pollutant under section 108 of the CAA. The extent to which black carbon makes up total PM varies by emission source, where, for example, diesel vehicle PM emissions contain a higher fraction of black carbon compared to most other PM emission sources. Black carbon causes a warming effect primarily by absorbing incoming and reflected sunlight (whereas greenhouse gases cause warming by trapping outgoing, infrared heat), and by darkening bright surfaces such as snow and ice, which reduces reflectivity. This latter effect, in particular, has been raising concerns about the role black carbon may be playing in observed warming and ice melt in the Arctic.

As stated in the April 2009 Proposed Findings, there remain some significant scientific uncertainties about black carbon's total climate effect,[25] as well as concerns about how to treat the short-lived black carbon emissions alongside the long-lived, well-mixed greenhouse gases in a common framework (*e.g.,* what are the appropriate metrics to compare the warming and/or climate effects of the different substances, given that, unlike greenhouse gases, the magnitude of aerosol effects can vary immensely with location and season of emissions). Nevertheless, the Administrator recognizes that black carbon is an important climate forcing agent and takes very seriously the emerging science on black carbon's contribution to global climate change in general and the high rates of observed climate change in the Arctic in particular. As noted in the Proposed Findings, EPA has various pending petitions under the CAA calling on the Agency to make an endangerment finding and regulate black carbon emissions.

b. Other Climate Forcers

There are other climate forcers that play a role in human-induced climate change that were mentioned in the Proposed Findings, and were the subject of some public comments. These include the stratospheric ozone-depleting substances, nitrogen trifluoride (NF_3), water vapor, and tropospheric ozone.

As mentioned above, the ozone-depleting substances (CFCs and HCFCs) do share the same physical, climate-relevant attributes as the six well-mixed greenhouse gases; however, emissions of these substances are playing a diminishing role in human-induced climate change. They are being controlled and phased out under the Montreal Protocol on Substances that Deplete the Ozone Layer. Because of this, the major scientific assessment reports such as those from IPCC focus primarily on the same six well-mixed greenhouse gases included in the definition of air pollution in these Findings. It is also worth noting that the UNFCCC, to which the United States is a signatory, addresses ''all greenhouse gases not controlled by the Montreal Protocol.'' [26] One commenter noted that because the Montreal Protocol controls production and consumption of ozone-depleting substances, but not existing banks of the substances, that CFCs should be included in the definition of air pollution in this finding, which might, in turn, create some future action under the CAA to address the banks of ozone-depleting substances as a climate issue. However, the primary criteria for defining the air pollution in this finding is the focus on the core of the climate change problem, and concerns over future actions to control depletion of stratospheric ozone are separate from and not central to the air pollution causing climate change.

Nitrogen trifluoride also shares the same climate-relevant attributes as the six well-mixed greenhouse gases, and it is also included in EPA's Mandatory Greenhouse Gas Reporting Rule (FR 74 56260). However, the Administrator is maintaining the reasoning laid out in the Proposed Findings to not include NF_3 in the definition of air pollution for this finding because the overall magnitude of its forcing effect on climate is not yet well quantified. EPA will continue to track the science on NF_3.

A number of public comments question the exclusion of water vapor from the definition of air pollution because it is the most important greenhouse gas responsible for the natural, background greenhouse effect. The Administrator's reasoning for excluding water vapor, was described in the Proposed Findings and is summarized here with additional information in Volume 10 of the Response to Comments document. First, climate change is being driven by the buildup in the atmosphere of greenhouse gases. The direct emissions primarily responsible for this are the six well-mixed greenhouse gases. Direct anthropogenic emissions of water vapor, in general, have a negligible effect and are thus not considered a primary driver of human-induced climate change. EPA plans to further evaluate the issues of emissions of water that are implicated in the formation of contrails and also changes in water vapor due to local irrigation. At this time, however, the findings of the IPCC state that the total forcing from these sources is small and that the level of understanding is low.

Water produced as a byproduct of combustion at low altitudes has a negligible contribution to climate change. The residence time of water vapor is very short (days) and the water content of the air in the long term is a function of temperature and partial pressure, with emissions playing no role. Additionally, the radiative forcing of a given mass of water at low altitudes is much less than the same mass of carbon dioxide. Water produced at higher altitudes could potentially have a larger impact. The IPCC estimated the contribution of changes in stratospheric water vapor due to methane and other sources, as well as high altitude contributions from contrails, but concluded that both contributions were small, with a low level of understanding. The report also addressed anthropogenic contributions to water vapor arising from large scale irrigation, but assigned it a very low level of understanding, and suggested that the cooling from evaporation might outweigh the warming from its small radiative contribution.

Increases in tropospheric ozone concentrations have exerted a significant anthropogenic warming effect since pre-industrial times. However, as explained in the Proposed Findings, tropospheric ozone is not a long-lived, well-mixed greenhouse gas, and it is not directly emitted. Rather it forms in the atmosphere from emissions of pre-cursor gases. There is increasing attention in climate change research and the policy community about the extent to which further reductions in tropospheric ozone levels may help

[26] UNFCCC, Art. 4.1(b).

slow down climate change in the near term. The Administrator views this issue seriously but maintains that tropospheric ozone is sufficiently different such that it deserves an evaluation and treatment separate from this finding.

7. Summary of Key Comments on Definition of Air Pollution

a. It Is Reasonable for the Administrator To Define the Air Pollution as Global Concentrations of the Well-Mixed Greenhouse Gases

Many commenters argue that EPA does not have the authority to establish domestic rights and obligations based on environmental conditions that are largely attributed to foreign nations and entities that are outside the jurisdiction of EPA under the CAA. They contend that in this case, the bulk of emissions that would lead to mandatory emissions controls under the CAA would not and could not be regulated under the CAA. They state that CAA requirements cannot be enforced against foreign sources of air pollution, and likewise domestic obligations under the CAA cannot be caused by foreign emissions that are outside the United States. The commenters argue that EPA committed procedural error by not addressing this legal issue of authority in the proposal.

Commenters cite no statutory text or judicial authority for this argument, and instead rely entirely on an analogy to the issues concerning the exercise of extra-territorial jurisdiction. The text of CAA section 202(a), however, does not support this claim. Nothing in CAA section 202(a) limits the term air pollution to those air pollution matters that are caused solely or in large part by domestic emissions. The only issue under CAA section 202(a) is whether the air pollution is reasonably anticipated to endanger, and whether emissions from one domestic source category—new motor vehicles—cause or contribute to this air pollution. Commenters would read into this an additional cause or contribute test—whether foreign sources cause or contribute to the air pollution in such a way that the air pollution is largely attributable to the foreign emissions, or the bulk of emissions causing the air pollution are from foreign sources. There is no such provision in CAA section 202(a). Congress was explicit about the contribution test it imposed, and the only source that is relevant for purposes of contribution is new motor vehicles. Commenters suggest an ill-defined criterion that is not in the statute.

In addition, as discussed in Section II of these Findings, Congress intentionally meant the agency to judge the air pollution endangerment criteria based on the ''cumulative impact of all sources of a pollutant,'' and not an incremental look at just the endangerment from a subset of sources. Commenters' arguments appear to lead to this result. Under the commenters' approach, in those cases where the bulk of emissions which form the air pollution come from foreign sources, EPA apparently would have no authority to make an endangerment finding. Logically, EPA would be left with the option of identifying and evaluating the air pollution attributable to domestic sources alone, and determining whether that narrowly defined form of air pollution endangers public health or welfare. This is the kind of unworkable, incremental approach that was rejected by the court in *Ethyl* and by Congress in the 1977 amendments adopting this provision.

The analogy to extra-territorial jurisdiction is also not appropriate. The endangerment finding itself does not exercise jurisdiction over any source, domestic or foreign. It is a judgment that is a precondition for exercising regulatory authority. Under CAA section 202(a), any exercise of regulatory authority following from this endangerment finding would be for new motor vehicles either manufactured in the United States or imported into the United States. There would be no extra-territorial exercise of jurisdiction. The core issues for endangerment focus on impacts inside the United States, not outside the United States. In addition, the contribution finding is based solely on the contribution from new motor vehicles built in or imported to the United States. The core judgments that need to be made under CAA section 202(a) are all focused on actions and impacts inside the United States. This does not raise any concerns about an extra-territorial exercise of jurisdiction. The basis for the endangerment and contribution findings is fully consistent with the principles underlying the desire to avoid exercises of extra-territorial jurisdiction. Any limitations on the ability to exercise control over foreign sources of emissions does not, however, call into question the authority under CAA section 202 to exercise control over domestic sources of emissions based on their contribution to an air pollution problem that is judged to endanger public health or welfare based on impacts occurring in the United States or otherwise affecting the United States and its citizens.

In essence, commenters are concerned about the effectiveness of the domestic control strategies that can be adopted to address a global air pollution problem that is caused only in part by domestic sources of emissions. While that is a quite valid and important policy concern, it does not translate into a legal limitation on EPA's authority to make an endangerment finding. Neither the text nor the legislative history of CAA section 202(a) support such an interpretation and Congress explicitly separated the decision on endangerment from the decision on what controls are required or appropriate once an affirmative endangerment finding has been made. The effectiveness of the resulting regulatory controls is not a relevant factor to determining endangerment.

EPA also committed no procedural flaw as argued by commenters. The proposal fully explored the interpretation of endangerment and cause or contribution under CAA section 202(a), and was very clear that EPA was considering air pollution to mean the elevated global concentration of greenhouse gases in the atmosphere, recognizing that these atmospheric concentrations were the result of world wide emissions, not just or even largely U.S. emissions. The separation of the effectiveness of the control strategy from the endangerment criteria, and the need to consider the cumulative impact of all sources in evaluating endangerment was clearly discussed. Commenters received fair notice of EPA's proposal and the basis for it.

Similarly, some commenters argue that EPA's proposal defines air pollution as global air pollution, but EPA is limited to evaluating domestic air only; in other words that EPA may only regulate domestic emissions with localized effects. They argue this limitation derives from the purpose of the CAA—to enhance the quality of the Nation's air resources, recognizing that air pollution prevention and control focus on the sources of the emissions, and are the primary responsibility of States and local governments. Therefore, commenters continue, that ''air pollution'' has to be air pollution that originates domestically and is to be addressed only at the domestic source. Sections 115 and 179B of the CAA, as discussed below, reflect this intention as well. The result, they conclude, is that ''air pollution'' as used in CAA section 202(a), includes only pollution that originates domestically, where the effects occur locally. They argue EPA has improperly circumvented this by a ''local-global-local'' analysis that injects

global air pollution into the middle of the endangerment test.

The statutory arguments made by the commenters attempt to read an unrealistic limitation into the general provisions discussed. The issues are similar in nature to those raised by the commenters arguing that EPA has no authority to establish domestic rights and obligations based on environmental conditions that are largely attributable to emissions from foreign nations and entities that are outside the jurisdiction of EPA under the CAA. In both cases, the question is whether EPA has authority to make an endangerment finding when the air pollution of concern is a relatively homogenous atmospheric concentration of greenhouse gases. According to the commenters, although this global pool includes the air over the United States, and leads to impacts in the United States and on the U.S. population, Congress prohibited EPA from addressing this air pollution problem because of its global aspects.

The text of the CAA does not specifically address this, as the term air pollution is not defined. EPA interprets this term as including the air pollution problem involved in this case—elevated atmospheric concentration of greenhouse gases that occur in the air above the United States as well as across the globe, and where this pool of global gases leads to impacts in the United States and on the U.S. population. This is fully consistent with the statutory provisions discussed by commenters. This approach seeks to protect the Nation's air resources, as clearly the Nation's air resources are an integral part of this global pool. The Nation's air resources by definition are not an isolated atmosphere that only contains molecules emitted within the United States, or an atmosphere that bears no relationship to the rest of the globe's atmosphere. There is no such real world body of air. Protecting the Nation's resources of clean air means to protect the air in the real world, not an artificial construct of ''air'' that ignores the many situations where the air over our borders includes compounds and pollutants emitted outside our borders, and in this case to ignore the fact that the air over our borders will by definition have elevated concentrations of greenhouse gases only when the air around the globe also has such concentrations. The suggested narrow view of ''air pollution'' does not further the protection of the Nation's air resources, but instead attempts to limit such protection by defining these resources in a scientifically artificial way that does not comport with how the air in the atmosphere is formed or changes over time, how it relates to and interacts with air around the globe, and how the result of this can affect the U.S. population.

The approach suggested by commenters fails to provide an actual definition for EPA to follow—for example, would U.S. or domestic ''air pollution'' be limited to only those air concentrations composed of molecules that originated in the United States? Is there a degree of external gases or compounds that could be allowed? Would it ignore the interaction and relationship between the air over the U.S. borders and the air around the rest of the globe? The latter approach appears to be the one suggested by commenters. Commenters' approach presumably would call for EPA to only consider the effects that derive solely from the air over our borders, and to ignore any effects that occur within the United States that are caused by air around the globe. However the air over the United States will by definition affect climate change only in circumstances where the air around the world is also doing so. The impacts of the air over the United States cannot be assessed separately from the impacts from the global pool, as they occur together and work together to affect the climate. Ignoring the real world nature of the Nation's air resources, in the manner presumably suggested by the commenters, would involve the kind of unworkable, incremental, and artificially isolating approach that was rejected by the court in *Ethyl* and by Congress in 1977. Congress intended EPA to interpret this provision by looking at air pollutants and air pollution problems in a broad manner, not narrowly, to evaluate problems within their broader context and not to attempt to isolate matters in an artificial way that fails to account for the real world context that lead to health and welfare impacts on the public. Commenters' suggested interpretation fails to implement this intention of Congress.

Commenters in various places refer to the control of the pollution, and the need for it to be aimed at local sources. That is addressed in the standard setting portion of CAA section 202(a), as in other similar provisions. The endangerment provision does not address how the air pollution problem should be addressed—who should be regulated and how they should be regulated. The endangerment provision addresses a different issue—is there an air pollution problem that should be addressed? In that context, EPA rejects the artificially narrow interpretation suggested by the commenters, and believes its broader interpretation in this case is reasonable and consistent with the intention of Congress.

b. Consideration of Greenhouse Gases as Air Pollution Given Their Impact Is Through Climate Rather Than Direct Toxic Effects

A number of commenters argue that carbon dioxide and the other greenhouse gases should not be defined as the air pollution because these gases do not cause direct human health effects, such as through inhalation. Responses to such comments are summarized in Section IV.B.1 of these Findings in the discussion of the public health and welfare nature of the endangerment finding.

c. The Administrator's Reliance on the Global Temperature Data Is a Reasonable Indicator of Human-Induced Climate Change

We received many comments suggesting global temperatures have stopped warming. The commenters base this conclusion on temperature trends over only the last decade. While there have not been strong trends over the last seven to ten years in global surface temperature or lower troposphere temperatures measured by satellites, this pause in warming should not be interpreted as a sign that the Earth is cooling or that the science supporting continued warming is in error. Year-to-year variability in natural weather and climate patterns make it impossible to draw any conclusions about whether the climate system is warming or cooling from such a limited analysis. Historical data indicate short-term trends in long-term time series occasionally run counter to the overall trend. All three major global surface temperature records show a continuation of long-term warming. Over the last century, the global average temperature has warmed at the rate of about 0.13 °F (0.072 °C) per decade in all three records. Over the last 30 years, the global average surface temperature has warmed by about 0.30 °F (0.17 °C) per decade. Eight of the 10 warmest years on record have occurred since 2001 and the 20 warmest years have all occurred since 1981. Satellite measurements of the troposphere also indicate warming over the last 30 years at a rate of 0.20 to 0.27 °F (0.11 °C to 0.15 °C) per decade. Please see the relevant volume of the Response to Comments document for more detailed responses.

Some commenters indicate the global surface temperature records are biased by urbanization, poor siting of instruments, observation methods, and

other factors. Our review of the literature suggests that these biases have in many cases been corrected for, are largely random where they remain, and therefore cancel out over large regions. Furthermore, we note that though the three global surface temperature records use differing techniques to analyze much of the same data, they produce almost the same results, increasing our confidence in their legitimacy. The assessment literature has concluded that warming of the climate system is unequivocal. The warming trend that is evident in all of the temperature records is confirmed by other independent observations, such as the melting of Arctic sea ice, the retreat of mountain glaciers on every continent, reductions in the extent of snow cover, earlier blooming of plants in the spring, and increased melting of the Greenland and Antarctic ice sheets. Please see the relevant volume of the Response to Comments document for more detailed responses.

A number of commenters argue that the warmth of the late 20th century is not unusual relative to the past 1,000 years. They maintain temperatures were comparably warm during the Medieval Warm Period (MWP) centered around 1000 A.D. We agree there was a Medieval Warm Period in many regions but find the evidence is insufficient to assess whether it was globally coherent. Our review of the available evidence suggests that Northern Hemisphere temperatures in the MWP were probably between 0.1 °C and 0.2 °C below the 1961–1990 mean and significantly below the level shown by instrumental data after 1980. However, we note significant uncertainty in the temperature record prior to 1600 A.D. Please see the relevant volume of the Response to Comments document for more detailed responses.

d. Ability To Attribute Observed Climate Change to Anthropogenic, Well-Mixed Greenhouse Gases

Many commenters question the link between observed temperatures and anthropogenic greenhouse gas emissions. They suggest internal variability of the climate system and natural forcings explain observed temperature trends and that anthropogenic greenhouse gases play, at most, a minor role. However, the attribution of most of the recent warming to anthropogenic activities is based on multiple lines of evidence. The first line of evidence arises from our basic physical understanding of the effects of changing concentrations of greenhouse gases, natural factors, and other human impacts on the climate system. Greenhouse gas concentrations have indisputably increased and their radiative properties are well established. The second line of evidence arises from indirect, historical estimates of past climate changes that suggest that the changes in global surface temperature over the last several decades are unusual. The third line of evidence arises from the use of computer-based climate models to simulate the likely patterns of response of the climate system to different forcing mechanisms (both natural and anthropogenic). These models are unable to replicate the observed warming unless anthropogenic emissions of greenhouse gases are included in the simulations. Natural forcing alone cannot explain the observed warming. In fact, the assessment literature [27] indicates the sum of solar and volcanic forcing in the past half century would likely have produced cooling, not warming. Please see the relevant volume of the Response to Comments for more detailed responses.

B. The Air Pollution Is Reasonably Anticipated To Endanger Both Public Health and Welfare

The Administrator finds that the elevated atmospheric concentrations of the well-mixed greenhouse gases may reasonably be anticipated to endanger the public health and welfare of current and future generations. This section describes the major pieces of scientific evidence supporting the Administrator's endangerment finding, discusses both the public health and welfare nature of the endangerment finding, and addresses a number of key issues the Administrator considered when evaluating the state of the science as well as key public comments on the Proposed Findings. Additional detail can be found in the TSD and the Response to Comments document.

As described in Section II of these Findings, the endangerment test under CAA section 202(a) does not require the Administrator to identify a bright line, quantitative threshold above which a positive endangerment finding can be made. The statutory language explicitly calls upon the Administrator to use her judgment. This section describes the general approach used by the Administrator in reaching the judgment that a positive endangerment finding should be made, as well as the specific rationale for finding that the greenhouse gas air pollution may reasonably be anticipated to endanger both public health and welfare.

First, the Administrator finds the scientific evidence linking human emissions and resulting elevated atmospheric concentrations of the six well-mixed greenhouse gases to observed global and regional temperature increases and other climate changes to be sufficiently robust and compelling. This evidence is briefly explained in more detail in Section V of these Findings. The Administrator recognizes that the climate change associated with elevated atmospheric concentrations of carbon dioxide and the other well-mixed greenhouse gases have the potential to affect essentially every aspect of human health, society and the natural environment. The Administrator is therefore not limiting her consideration of potential risks and impacts associated with human emissions of greenhouse gases to any one particular element of human health, sector of the economy, region of the country, or to any one particular aspect of the natural environment. Rather, the Administrator is basing her finding on the total weight of scientific evidence, and what the science has to say regarding the nature and potential magnitude of the risks and impacts across all climate-sensitive elements of public health and welfare, now and projected out into the foreseeable future.

The Administrator has considered the state of the science on how human emissions and the resulting elevated atmospheric concentrations of well-mixed greenhouse gases may affect each of the major risk categories, *i.e.,* those that are described in the TSD, which include human health, air quality, food production and agriculture, forestry, water resources, sea level rise and coastal areas, the energy sector, infrastructure and settlements, and ecosystems and wildlife. The Administrator understands that the nature and potential severity of impacts can vary across these different elements of public health and welfare, and that they can vary by region, as well as over time.

The Administrator is therefore aware that, because human-induced climate change has the potential to be far-reaching and multi-dimensional, not all

[27] Solomon, S., D. Qin, M. Manning, R.B. Alley, T. Berntsen, N.L. Bindoff, Z. Chen, A. Chidthaisong, J.M. Gregory, G.C. Hegerl, M. Heimann, B. Hewitson, B.J. Hoskins, F. Joos, J. Jouzel, V. Kattsov, U. Lohmann, T. Matsuno, M. Molina, N. Nicholls, J. Overpeck, G. Raga, V. Ramaswamy, J. Ren, M. Rusticucci, R. Somerville, T.F. Stocker, P. Whetton, R.A. Wood and D. Wratt (2007) Technical Summary. 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., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor, and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. Karl, T. et al. (2009).

risks and potential impacts can be characterized with a uniform level of quantification or understanding, nor can they be characterized with uniform metrics. Given this variety in not only the nature and potential magnitude of risks and impacts, but also in our ability to characterize, quantify and project into the future such impacts, the Administrator must use her judgment to weigh the threat in each of the risk categories, weigh the potential benefits where relevant, and ultimately judge whether these risks and benefits, when viewed in total, are judged to be endangerment to public health and/or welfare.

This has a number of implications for the Administrator's approach in assessing the nature and magnitude of risk and impacts across each of the risk categories. First, the Administrator has not established a specific threshold metric for each category of risk and impacts. Also, the Administrator is not necessarily placing the greatest weight on those risks and impacts which have been the subject of the most study or quantification.

Part of the variation in risks and impacts is the fact that climbing atmospheric concentrations of greenhouse gases and associated temperature increases can bring about some potential benefits to public health and welfare in addition to adverse risks. The current understanding of any potential benefits associated with human-induced climate change is described in the TSD and is taken into consideration here. The potential for both adverse and beneficial effects are considered, as well as the relative magnitude of such effects, to the extent that the relative magnitudes can be quantified or characterized. Furthermore, given the multiple ways in which the buildup of atmospheric greenhouse gases can cause effects (*e.g.,* via elevated carbon dioxide concentrations, via temperature increases, via precipitation increases, via sea level rise, and via changes in extreme events), these multiple pathways are considered. For example, elevated carbon dioxide concentrations may be beneficial to crop yields, but changes in temperature and precipitation may be adverse and must also be considered. Likewise, modest temperature increases may have some public health benefits as well as harms, and other pathways such as changes in air quality and extreme events must also be considered.

The Administrator has balanced and weighed the varying risks and effects for each sector. She has judged whether there is a pattern across the sector that supports or does not support an endangerment finding, and if so whether the support is of more or less weight. In cases where there is both a potential for benefits and risks of harm, the Administrator has balanced these factors by determining whether there appears to be any directional trend in the overall evidence that would support placing more weight on one than the other, taking into consideration all that is known about the likelihood of the various risks and effects and their seriousness. In all of these cases, the judgment is largely qualitative in nature, and is not reducible to precise metrics or quantification.

Regarding the timeframe for the endangerment test, it is the Administrator's view that both current and future conditions must be considered. The Administrator is thus taking the view that the endangerment period of analysis extend from the current time to the next several decades, and in some cases to the end of this century. This consideration is also consistent with the timeframes used in the underlying scientific assessments. The future timeframe under consideration is consistent with the atmospheric lifetime and climate effects of the six well-mixed greenhouse gases, and also with our ability to make reasonable and plausible projections of future conditions.

The Administrator acknowledges that some aspects of climate change science and the projected impacts are more certain than others. Our state of knowledge is strongest for recently observed, large-scale changes. Uncertainty tends to increase in characterizing changes at smaller (regional) scales relative to large (global) scales. Uncertainty also increases as the temporal scales move away from present, either backward, but more importantly forward in time. Nonetheless, the current state of knowledge of observed and past climate changes and their causes enables projections of plausible future changes under different scenarios of anthropogenic forcing for a range of spatial and temporal scales.

In some cases, where the level of sensitivity to climate of a particular sector has been extensively studied, future impacts can be quantified whereas in other instances only a qualitative description of a directional change, if that, may be possible. The inherent uncertainty in the direction, magnitude, and/or rate of certain future climate change impacts opens up the possibility that some changes could be more or less severe than expected, and the possibility of unanticipated outcomes. In some cases, low probability, high impact outcomes (*i.e.,* known unknowns) are possibilities but cannot be explicitly assessed.

1. The Air Pollution Is Reasonably Anticipated To Endanger Public Health

The Administrator finds that the well-mixed greenhouse gas air pollution is reasonably anticipated to endanger public health, for both current and future generations. The Administrator finds that the public health of current generations is endangered and that the threat to public health for both current and future generations will likely mount over time as greenhouse gases continue to accumulate in the atmosphere and result in ever greater rates of climate change.

After review of public comments, the Administrator continues to believe that climate change can increase the risk of morbidity and mortality and that these public health impacts can and should be considered when determining endangerment to public health under CAA section 202(a). As described in Section IV.B.1 of these Findings, the Administrator is not limited to only considering whether there are any direct health effects such as respiratory or toxic effects associated with exposure to greenhouse gases.

In making this public health finding, the Administrator considered direct temperature effects, air quality effects, the potential for changes in vector-borne diseases, and the potential for changes in the severity and frequency of extreme weather events. In addition, the Administrator considered whether and how susceptible populations may be particularly at risk. The current state of science on these effects from the major assessment reports is described in greater detail in the TSD, and our responses to public comments are provided in the Response to Comments Documents.

a. Direct Temperature Effects

It has been estimated that unusually hot days and heat waves are becoming more frequent, and that unusually cold days are becoming less frequent, as noted above. Heat is already the leading cause of weather-related deaths in the United States. In the future, severe heat waves are projected to intensify in magnitude and duration over the portions of the United States where these events already occur. Heat waves are associated with marked short-term increases in mortality. Hot temperatures have also been associated with increased morbidity. The projected warming is therefore projected to increase heat related mortality and

morbidity, especially among the elderly, young and frail. 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 socially isolated persons. As warming increases over time, these adverse effects would be expected to increase as the serious heat events become more serious.

Increases in temperature are also expected to lead to some reduction in the risk of death related to extreme cold. Cold waves continue to pose health risks in northern latitudes in temperature regions where very low temperatures can be reached in a few hours and extend over long periods. Globally, the IPCC projects reduced human mortality from cold exposure through 2100. It is not clear whether reduced mortality in the United States from cold would be greater or less than increased heat-related mortality in the United States due to climate change. However, there is a risk that projections of cold-related deaths, and the potential for decreasing their numbers due to warmer winters, can be overestimated unless they take into account the effects of season and influenza, which is not strongly associated with monthly winter temperature. In addition, the latest USGCRP report refers to a study that analyzed daily mortality and weather data in 50 U.S. cities from 1989 to 2000 and found that, on average, cold snaps in the United States increased death rates by 1.6 percent, while heat waves triggered a 5.7 percent increase in death rates. The study concludes that increases in heat-related mortality due to global warming in the United States are unlikely to be compensated for by decreases in cold-related mortality.

b. Air Quality Effects

Increases in regional ozone pollution relative to ozone levels without climate change are expected due to higher temperatures and weaker circulation in the United States relative to air quality levels without climate change. Climate change is expected to increase regional ozone pollution, with associated risks in respiratory illnesses and premature death. In addition to human health effects, tropospheric ozone has significant adverse effects on crop yields, pasture and forest growth, and species composition. The directional effect of climate change on ambient particulate matter levels remains less certain.

Climate change can affect ozone by modifying emissions of precursors, atmospheric chemistry, and transport and removal. There is now consistent evidence from models and observations that 21st century climate change will worsen summertime surface ozone in polluted regions of North America compared to a future with no climate change.

Modeling studies discussed in EPA's Interim Assessment [28] show that simulated climate change causes increases in summertime ozone concentrations over substantial regions of the country, though this was not uniform, and some areas showed little change or decreases, though the decreases tend to be less pronounced than the increases. For those regions that showed climate-induced increases, the increase in maximum daily 8-hour average ozone concentration, a key metric for regulating U.S. air quality, was in the range of 2 to 8 ppb, averaged over the summer season. The increases were substantially greater than this during the peak pollution episodes that tend to occur over a number of days each summer. The overall effect of climate change was projected to increase ozone levels, compared to what would occur without this climate change, over broad areas of the country, especially on the highest ozone days and in the largest metropolitan areas with the worst ozone problems. Ozone decreases are projected to be less pronounced, and generally to be limited to some regions of the country with smaller population.

c. Effects on Extreme Weather Events

In addition to the direct effects of temperature on heat- and cold-related mortality, the Administrator considers the potential for increased deaths, injuries, infectious diseases, and stress-related disorders and other adverse effects associated with social disruption and migration from more frequent extreme weather. The Administrator notes that the vulnerability to weather disasters depends on the attributes of the people at risk (including where they live, age, income, education, and disability) and on broader social and environmental factors (level of disaster preparedness, health sector responses, and environmental degradation). The IPCC finds the following with regard to extreme events and human health:

Increases in the frequency of heavy precipitation events are associated with increased risk of deaths and injuries as well as infectious, respiratory, and skin diseases. Floods are low-probability, high-impact events that can overwhelm physical infrastructure, human resilience, and social organization. Flood health impacts include deaths, injuries, infectious diseases, intoxications, and mental health problems.

Increases in tropical cyclone intensity are linked to increases in the risk of deaths, injuries, waterborne and food borne diseases, as well as post-traumatic stress disorders. Drowning by storm surge, heightened by rising sea levels and more intense storms (as projected by IPCC), is the major killer in coastal storms where there are large numbers of deaths. Flooding can cause health impacts including direct injuries as well as increased incidence of waterborne diseases due to pathogens such as *Cryptosporidium and Giardia.*

d. Effects on Climate-Sensitive Diseases and Aeroallergens

According to the assessment literature, there will likely be an increase in the spread of several food and water-borne pathogens among susceptible populations depending on the pathogens' survival, persistence, habitat range and transmission under changing climate and environmental conditions. Food borne diseases show some relationship with temperature, and the range of some zoonotic disease carriers such as the Lyme disease carrying tick may increase with temperature.

Climate change, including changes in carbon dioxide concentrations, could impact the production, distribution, dispersion and allergenicity of aeroallergens and the growth and distribution of weeds, grasses, and trees that produce them. These changes in aeroallergens and subsequent human exposures could affect the prevalence and severity of allergy symptoms. However, the scientific literature does not provide definitive data or conclusions on how climate change might impact aeroallergens and subsequently the prevalence of allergenic illnesses in the United States.

It has generally been observed that the presence of elevated carbon dioxide concentrations and temperatures stimulate plants to increase photosynthesis, biomass, water use efficiency, and reproductive effort. The IPCC concluded that pollens are likely to increase with elevated temperature and carbon dioxide.

[28] U.S. EPA (2009) *Assessment of the Impacts of Global Change on Regional U.S. Air Quality: A Synthesis of Climate Change Impacts on Ground-Level Ozone.* An Interim Report of the U.S. EPA Global Change Research Program. U.S. Environmental Protection Agency, Washington, DC, EPA/600/R–07/094.

e. Summary of the Administrator's Finding of Endangerment to Public Health

The Administrator has considered how elevated concentrations of the well-mixed greenhouse gases and associated climate change affect public health by evaluating the risks associated with changes in air quality, increases in temperatures, changes in extreme weather events, increases in food and water borne pathogens, and changes in aeroallergens. The evidence concerning adverse air quality impacts provides strong and clear support for an endangerment finding. Increases in ambient ozone are expected to occur over broad areas of the country, and they are expected to increase serious adverse health effects in large population areas that are and may continue to be in nonattainment. The evaluation of the potential risks associated with increases in ozone in attainment areas also supports such a finding.

The impact on mortality and morbidity associated with increases in average temperatures which increase the likelihood of heat waves also provides support for a public health endangerment finding. There are uncertainties over the net health impacts of a temperature increase due to decreases in cold-related mortality, but there is some recent evidence that suggests that the net impact on mortality is more likely to be adverse, in a context where heat is already the leading cause of weather-related deaths in the United States.

The evidence concerning how human-induced climate change may alter extreme weather events also clearly supports a finding of endangerment, given the serious adverse impacts that can result from such events and the increase in risk, even if small, of the occurrence and intensity of events such as hurricanes and floods. Additionally, public health is expected to be adversely affected by an increase in the severity of coastal storm events due to rising sea levels.

There is some evidence that elevated carbon dioxide concentrations and climate changes can lead to changes in aeroallergens that could increase the potential for allergenic illnesses. The evidence on pathogen borne disease vectors provides directional support for an endangerment finding. The Administrator acknowledges the many uncertainties in these areas. Although these adverse effects, provide some support for an endangerment finding, the Administrator is not placing primary weight on these factors.

Finally, the Administrator places weight on the fact that certain groups, including children, the elderly, and the poor, are most vulnerable to these climate-related health effects.

f. Key Comments on the Finding of Endangerment to Public Health

EPA received many comments on public health issues and the proposed finding of endangerment to public health.

i. EPA's Consideration of the Climate Impacts as Public Health Issues Is Reasonable

Several commenters argue that EPA may only consider the health effects from direct exposure to pollutants in determining whether a pollutant endangers public health. The commenters state that EPA's proposal acknowledges that there is no evidence that greenhouse gases directly cause health effects, citing 74 FR 18901. To support their claim that EPA can only consider health effects that result from direct exposure to a pollutant, commenters cite several sources, discussed below.

Clean Air Act and Legislative History. Several commenters argue that the text of the CAA and the legislative history of the 1977 amendments demonstrate that Congress intended public health effects to relate to risks from direct exposure to a pollutant. They also argue that by considering health effects that result from welfare effects, EPA was essentially combining the two categories into one, contrary to the statute and Congressional intent.

Commenters state that the CAA, including CAA section 202(a)(1), requires EPA to consider endangerment of public health separately from endangerment of public welfare. Commenters note that while the CAA does not provide a definition of public health, CAA section 302(h) addresses the meaning of ''welfare,'' which includes weather and climate. Thus, they argue, Congress has instructed that effects on weather and climate are to be considered as potentially endangering welfare—not human health. They continue that Congress surely knew that weather and climatic events such as flooding and heat waves could affect human health, but Congress nonetheless classified air pollutants' effects on weather and climate as effects on welfare.

Commenters also argue that the legislative history confirms that Congress intended for the definition of ''public health'' to only include the consequences of direct human exposure to ambient air pollutants. They note an early version of section 109(b) would have required only a single NAAQS standard to protect ''public health,'' with the protection of ''welfare'' being a co-benefit of the single standard. Commenters note that the proponents of this early bill explained, ''[i]n many cases, a level of protection of health would take care of the welfare situation'' Sen. Hearing, Subcommittee on Air and Water Pollution, Comm. On Public Works (Mar. 17, 1970) (statement of Dr. Middleton, Comm'r, Nat'l Air Pollution Control Admin., HEW), 1970 Leg. Hist. 1194. Commenters state that the Senate bill that ultimately passed rejected this combined standard, requiring separate national ambient air quality standards and national ambient air quality goals. Commenters contend that Congress intended that the national ambient air quality goals be set ''to protect the public health and welfare from any known or anticipated effects associated with'' air pollution, including the list of ''welfare'' effects currently found in CAA section 302(h), such as effects on water, vegetation, animals, wildlife, weather and climate. Commenters note the Senate Committee Report stated that the national ambient air quality *standards* were created to protect public health, while the national ambient air quality *goals* were intended to address broader issues because ''the Committee also recognizes that man's natural and man-made environment must be preserved and protected. Therefore, the bill provides for the setting of national ambient air quality goals at levels necessary to protect public health and welfare from any known or anticipated adverse effects of air pollution—including effects on soils, water, vegetation, man-made materials, animals, wildlife, visibility, climate, and economic values.'' Commenters argue this statement is clearly the source of the current definition of welfare effects in CAA section 302(h), which also includes ''personal comfort and well being.'' They argue the Senate bill contemplated the NAAQS would include only direct health effects, while the *goals* would encompass effects on both the public health and welfare. Commenters continue that considering both public health effects and welfare effects under a combined standard, as the Administrator attempts to do in the proposed endangerment finding, would resurrect the combined approach to NAAQS that the Senate emphatically rejected.

The commenters also cite language from the House Report in support of their view that Congress only intended that EPA consider direct health effects

when assessing endangerment to public health: ''By the words 'cause or contribute to air pollution,' the committee intends to require the Administrator to consider all sources of the contaminant which contributes to air pollution and to consider all sources of exposure to the contaminant—food, water, air, etc.—in determining health risks'' 7 H.R. Rep. No. 95–294, at 49–50 (1977). Commenters also cite language in the Senate Report: ''Knowledge of the relationship between the exposure to many air pollution agents and acute and chronic health effects is sufficient to develop air quality criteria related to such effects'' S. Rep. No. 91–1196, at 7 (1970).

The specific issue here is whether an effect on human health that results from a change in climate should be considered when EPA determines whether the air pollution of well-mixed greenhouse gases is reasonably anticipated to endanger public health. In this case, the air pollution has an effect on climate. For example the air pollution raises surface, air, and water temperatures. Among the many effects that flow from this is the expectation that there will be an increase in the risk of mortality and morbidity associated with increased intensity of heat waves. In addition, there is an expectation that there will be an increase in levels of ambient ozone, leading to increased risk of morbidity and mortality from exposure to ozone. All of these are effects on human health, and all of them are associated with the effect on climate from elevated atmospheric concentrations of greenhouse gases. None of these human health effects are associated with direct exposure to greenhouse gases.

In the past, EPA has not had to resolve the issue presented here, as it has been clear whether the effects relate to public health or relate to public welfare, with no confusion over what category was at issue. In those cases EPA has routinely looked at what effect the air pollution has on people. If the effect on people is to their health, we have considered it an issue of public health. If the effect on people is to their interest in matters other than health, we have considered it public welfare.

For example, there are serious health risks associated with inhalation of ozone, and they have logically been considered as public health issues. Ambient levels of ozone have also raised the question of indirect health benefits through screening of harmful UVB rays. EPA has also considered this indirect health effect of ozone to be a public health issue.[29] Ozone pollution also affects people by impacting their interests in various vegetation through foliar damage to trees, reduced crop yield, adverse impacts on horticultural plants, and the like. EPA has consistently considered these issues when evaluating the public welfare based NAAQS standards under CAA section 109.

In all of these situations the use of the term ''public'' has focused EPA on how people are affected by the air pollution. If the effect on people is to their health then we have considered it a public health issue. If the effect on people is to their interest in matters other than health, then we have treated it as a public welfare issue.

The situation presented here is somewhat unique. The focus again is on the effect the air pollution has on people. Here the effect on people is to their health. However this effect flows from the change in climate and effects on climate are included in the definition of effects on welfare. That raises the issue of how to categorize the health effects—should we consider them when evaluating endangerment to public health? When we evaluate endangerment to public welfare? Or both?

The text of the CAA does not resolve this question. While Congress defined ''effects on welfare,'' it did not define either ''public health'' or ''public welfare''. In addition, the definition of ''effects on welfare'' does not clearly address how to categorize health effects that flow from effects on soils, water, crops, vegetation, weather, climate, or any of the other factors listed in CAA section 302(h). It is clear that effects on climate are an effect on welfare, but the definition does not address whether health impacts that are caused by these changes in climate are also effects on welfare. The health effects at issue are not themselves effects on soils, water, crops, vegetation, weather, or climate. They are instead effects on health. They derive from the effects on climate, but they are not themselves effects on climate or on anything else listed in CAA section 302(h). So the definition of effects on welfare does not address whether an effect on health, which is not itself listed in CAA section 302(h), is also an effect on welfare if it results from an effect on welfare. The text of the CAA also does not address the issue of direct and indirect health effects. Contrary to commenters' assertions, the legislative history does not address or resolve this issue.

In this context, EPA is interpreting the endangerment provision in CAA section 202(a) as meaning that the effects on peoples' health from changes to climate can and should be included in EPA's evaluation of whether the air pollution at issue endangers public health. EPA is not deciding whether these health effects also could or should be considered in evaluating endangerment to public welfare.

The stating of the issue makes the answer seem straightforward. If air pollution causes sickness or death, then these health effects should be considered when evaluating whether the air pollution endangers public health. The term public health is undefined, and by itself this is an eminently reasonable way to interpret it. This focuses on the actual effect on people, as compared to ignoring that and focusing on the pathway from the air pollution to the effect. The question then becomes whether there is a valid basis in the CAA to take the different approach suggested by commenters, an approach contrary to the common sense meaning of public health.

Notably, the term ''public welfare'' is undefined. While it clearly means something other than public health, there is no obvious indication whether Congress intended there to be a clear boundary between the two terms or whether there might be some overlap where some impacts could be considered both a public health and a public welfare impact. Neither the text nor the legislative history resolves this issue. Under either approach, EPA believes the proper interpretation is that these effects on health should be considered when evaluating endangerment to public health.

If we assume Congress intended that effects on public welfare could not include effects on public health and vice versa, then the effects at issue here should most reasonably be considered in the public health category. Indisputably they are health effects, and the plain meaning of the term public health would call for their inclusion in that term. The term public welfare is

[29] As discussed later, in the past EPA took the position that this kind of potential indirect beneficial impact on public health should not be considered when setting the primary health based NAAQS for ozone. This was not based on the view that it was not a potential public health impact, or that it was a public welfare impact instead of a public health impact. Instead EPA was interpreting the NAAQS standard setting provisions of section 109, and argued that they were intended to address only certain public health impacts, those that were adverse, and were not intended to address indirect, beneficial public health impacts. This interpretation of section 109 was rejected in *ATA* v. *EPA*, 175 F.3d 1027 (1999) *reh'g granted in part and denied in part*, 195 F.3d 4 (DC Cir. 1999). The court made it clear that the potential indirect beneficial impact of ambient ozone on public health from screening UVB rays needed to be considered when setting the NAAQS to protect public health.

undefined. If Congress intended that public welfare not include matters included in the public health category, then a reasonable interpretation of this undefined term would include those effects on welfare that impact people in ways other than impacting their health.

The definition of ''effects on welfare'' does not clearly address how to categorize health effects that flow from effects on water, soil, land, climate, or weather. As noted above, the definition does not address whether health impacts that are caused by these changes in climate are also ''effects on welfare.'' Certainly effects on health are not included in the list in CAA section 302(h). The lack of clarity in the definition of effects on welfare, combined with the lack of definition of public welfare, do not warrant interpreting the term public health differently from its straightforward and common sense meaning.

The inclusion of the phrase ''effects on * * * personal comfort and well-being'' as an effect on welfare supports this view. The term would logically mean something other than the different term public health. The term ''well-being'' is not defined, and generally has a broader and different connotation of positive physical, emotional, and mental status. The most straightforward meaning of this term, in a context where Congress used the different term public health in a wide variety of other provisions, would be to include effects on people that do not rise to the level of health effects, but otherwise impact their physical, emotional, and mental status. This gives full meaning to both terms.

The term well-being is a general term, and in isolation arguably could include health effects. However there is no textual basis to say it would include some health effects but not others, as argued by commenters. If sickness impacts your well-being, then it impacts your well-being whether it results directly or indirectly from the pollution in the air. Nothing in CAA section 302(h) limits the term well-being to indirect impacts on people, or to health effects that occur because of other welfare effects, such as climate change. It is listed as its own effect on welfare. Instead of interpreting well-being as including all health effects, or some health effects, the much more logical way to interpret this provision in the context of all of the other provisions of the CAA is to interpret it as meaning effects on people other than health effects.

Thus, if Congress intended to draw a strict line between the two categories of public health and public welfare, for purposes of determining endangerment under CAA section 202(a), then EPA believes that its interpretation is a reasonable and straightforward way to categorize the health effects at issue here. This gives weight to the common sense meaning of the term public health, where the terms public health and public welfare are undefined and the definition of effects on welfare is at best ambiguous on this issue.

In the alternative, if Congress did not intend any such bright line between these two categories and there could be an overlap, then it is also reasonable for EPA to include these health effects in its consideration of whether the air pollution endangers public health. Neither approach condenses or conflates the two different terms. Under either approach EPA's interpretation, as demonstrated in this rulemaking, would still consider numerous and varied effects from climate change as indisputable impacts on public welfare and not impacts on public health. In addition, this interpretation will not change the fact that in almost all cases impacts on public health would not also be considered impacts on public welfare.

Prior EPA actions. Several commenters argue that EPA's decision to include health impacts that occur because of climate change is inconsistent with its past approach, which has been to treat indirect health effects as welfare effects. Commenters contend that in the latest Criteria Document for ozone EPA listed tropospheric ozone's effects on UVB-induced human diseases, as well as its effects on climate change, as welfare effects, even though the agency acknowledged significant health effects such as sunburn and skin cancer. Commenters also argue that EPA listed ''risks to human health'' from toxins released by algal blooms due to excess nitrogen as ''ecological and other welfare effects'' in the recent Criteria Document for oxides of nitrogen and sulfur. Finally, commenters argue that EPA's proposed action was contrary to the Agency decision to list new municipal solid waste landfills as a source category under CAA section 111. Commenters state that EPA listed climate change as a welfare effect in that action, (citing 56 FR 24469).

The Agency's recent approach regarding UVB-induced health effects is consistent with the endangerment findings, and demonstrates that the Agency considers indirect effects on human health as public health issues rather than public welfare issues. While the ozone Criteria Document may have placed the discussion of UV–B related health effects among chapters on welfare effects, in evaluating the evidence presented in the Criteria Document for purposes of preparing the policy assessment document, EPA staff clearly viewed UVB-induced effects as human health effects that were relevant in determining the public health based primary NAAQS for ozone, rather than welfare effects, regardless of which chapter in the Criteria Document described those effects. The evaluation of the UVB-related evidence is discussed with other human health effects evidence. The policy assessment document noted that Chapter 10 of the Criteria Document, ''provides a thorough analysis of the current understanding of the relationship between reducing tropospheric [ozone] concentrations and the potential impact these reductions might have on UV–B surface fluxes and *indirectly contributing to increased UV–B related health effects.'' See*, *Review of the National Ambient Air Quality Standards for Ozone: Policy Assessment of Scientific and Technical Information*, p 3–36 (January 2007) (emphasis added).

EPA repeated this view in the 2007 proposed ozone NAAQS rule. In presenting its evaluation of the human health evidence for purposes of setting the public health based primary NAAQS, EPA stated: ''This section also summarizes the uncertainty about the *potential indirect effects on public health* associated with changes due to increases in UV–B radiation exposure, such as UV–B radiation-related skin cancers, that may be associated with reductions in ambient levels of ground-level [ozone], as discussed in chapter 10 of the Criteria Document and chapter 3 of the Staff Paper.'' 72 FR 37818, 37827. *See* also, 72 FR 37837 (''* * * the Criteria Document also assesses the potential indirect effects related to the presence of [ozone] in the ambient air by considering the role of ground-level [ozone] in mediating human health effects that may be directly attributable to exposure to solar ultraviolet radiation (UV–B).'')

Thus, EPA's approach to UV–B related health effects clearly shows the Agency has treated indirect health effects not as welfare effects, as commenters suggest, but as human health effects that need to be evaluated when setting the public health based primary NAAQS. In this ozone NAAQS rulemaking, EPA did not draw a line between direct and indirect health effects for purposes of evaluating UV–B related health effects and the public health based primary NAAQS.

Similarly, the NO_X/SO_X criteria document does not establish a precedent that indirect human health effects are welfare effects. Toxic algal blooms themselves are a welfare effect, so it is not surprising a discussion of algal blooms appears in sections dealing with welfare effects. The more relevant question is how EPA evaluated information regarding human health risks resulting from algal blooms. In the case of the Criteria Document, the role of nitrogen in causing algal blooms was unclear. As a result, the Agency did not have occasion to evaluate any resulting human health effects and the Criteria Document does not support the view that EPA treats indirect health effects as anything other than a public health issue.

Finally, EPA disagrees that its action here is at odds with the listing of municipal solid waste landfills under CAA section 111. In the landfills New Source Performance Standard (NSPS) EPA did not consider health effects resulting from climate change much less draw any conclusions about health effects from climate change being health or welfare effects. If anything, the landfills NSPS is consistent with EPA's approach. In the proposed rule, EPA stated: ''The EPA has documented many cases of acute injury and death caused by explosions and fires related to municipal landfill gas emissions. In addition to these health effects, the associated property damage is a welfare effect'' (56 FR 24474). EPA considered injury and death from fires resulting from landfill gasses to be health effects. Yet the injury did not result from direct exposure to the pollutant (landfill gas). Instead, the injury resulted from the combustion of the pollutant—the injury is essentially an indirect effect of the pollutant. Yet, as with this action, EPA considered the injury as a human health effect.

Case law. Several commenters argue that EPA's proposed endangerment finding was inconsistent with *NRDC* v. *EPA*, 902 F.2d 962 (DC Cir 1990). Commenters argue that in rejecting the argument that EPA must consider the health effects of increased unemployment that could result from a more stringent primary NAAQS standard, the DC Circuit explained that, ''[i]t is only the health effects relating to pollutants in the air that EPA may consider.'' *Id.* at 973. Several commenters further argue that EPA later relied on that holding to defend its decision to set a primary NAAQS for ozone based solely on direct health effects of ozone. Citing, *EPA Pet'n for Rehearing, Am. Trucking Ass'n* v. *EPA*, No. 97–1440 (DC Cir. June 28, 1999) (''ATA I'') (arguing that the primary NAAQS should be set through consideration of only ''direct adverse effects on public health, and not indirect, allegedly beneficial effects.'')

The *NRDC* case is not contrary to EPA's endangerment finding. In *NRDC*, petitioner American Iron and Steel Institute argued that EPA had to consider the costs of health consequences that might arise from increased unemployment. The court ruled that, ''[c]onsideration of costs associated with alleged health risks from unemployment would be flatly inconsistent with the statute, legislative history and case law on this point.'' 902 F.2d at 973. The cases cited by the court in support of its decision all hold that EPA may not consider economic or technological feasibility in establishing a NAAQS. The *NRDC* decision does not establish a precedent that the CAA prohibits EPA from considering indirect health effects as a public health issue rather than a public welfare issue.

EPA also believes reliance on the Agency's petition for rehearing in noted above is misplaced. In that case, EPA did not argue that indirect beneficial health effects were not public health issues. Instead EPA argued that under the CAA, it did not have to consider such indirect beneficial health effects of an air pollutant when setting the health based primary NAAQS. EPA was interpreting the NAAQS standard setting provisions of CAA section 109, and argued that they were intended to address only certain public health impacts, those that were adverse, and were not intended to address indirect, beneficial public health impacts. The issue in the case was not whether indirect health effects are relevant for purposes of making an endangerment decision concerning public health, but rather whether EPA must consider such beneficial health effects in establishing a primary NAAQS under CAA section 109. EPA's interpretation of CAA section 109 was rejected in *ATA* v. *EPA*, 175 F.3d at 1027 (1999) *reh'g granted in part and denied in part*, 195 F.3d at 4 (DC Cir. 1999). The court made it clear that the potential indirect beneficial impact of ambient ozone on public health from screening UVB rays needed to be considered when setting the NAAQS to protect public health. As discussed above, EPA has done just that as noted above in the UV–B context. Moreover, as discussed in Section II of these Findings, EPA is doing that here as well (*e.g.*, considering any benefits from reduced cold weather related deaths).

ii. EPA's Treatment and Balancing of Heat- vs. Cold-Related Public Health Risks Was Reasonable

A number of public commenters maintain that the risk of heat waves in the future will be modulated by adaptive measures. The Administrator is aware of the potential benefits of adaptation in reducing heat-related morbidity and mortality and recognizes most heat-related deaths are preventable. Nonetheless, the Administrator notes the assessment literature [30] indicates heat is the leading weather-related killer in the United States even though countermeasures have been employed in many vulnerable areas. Given projections for heat waves of greater frequency, magnitude, and duration coupled with a growing population of older adults (among the most vulnerable groups to this hazard), the risk of adverse health outcomes from heat waves is expected to increase. Intervention and response measures could certainly reduce the risk, but as we have noted, the need to adapt supports an increase in risk or endangerment. For a general discussion about EPA's treatment of adaptation see Section III.C of these Findings.

Several commenters also suggest cold-related mortality will decrease more than heat-related mortality will increase, which indicates a net reduction in temperature-related mortality. Some commenters point to research suggesting migration to warmer climates has contributed to the increased longevity of some Americans, implying climate warming will have benefits for health. The Administrator is very clear that the exact balance of how heat- versus cold-related mortality will change in the future is uncertain; however, the assessment literature points to evidence suggesting that the increased risk from heat would exceed the decreased risk from cold in a warming climate. The Administrator does not dispute research indicating the benefits of migration to a warmer climate and nor that average climate warming may indeed provide health benefits in some areas. These points are reflected in the TSD's statement projecting less cold-related health effects. The Administrator considers these potential warming benefits independent of the potential negative effects of extreme heat events which are projected to increase under future climate change scenarios affecting vulnerable groups and communities.

[30] Karl *et al.* (2009).

iii. EPA Was Reasonable To Find That the Air Quality Impacts of Climate Change Contribute to the Endangerment of Public Health

Several commenters suggest that air quality effects of climate change will be addressed through the CAA's NAAQS process, as implemented by the State Implementation Plans (SIP) and national regulatory programs. According to these commenters, these programs will ensure no adverse impact on public health due to climate change. Though climate change may cause certain air pollutant ambient concentrations to increase, States will continue to be compelled to meet the standards. So, while additional measures may be necessary, and result in increased costs, these commenters assert that, ultimately, public health will be protected by the continued existence of the NAAQS and therefore no endangerment with respect to this particular climate change-related impact will occur. One commenter states that EPA inappropriately assigns air quality risk to climate change that will be addressed through other programs. The CAA provides a mechanism to meet the standards and additional control measures consistent with the CAA will be adopted in the future, keeping pollution below unhealthy levels. The commenters state that the fact that NAAQS are in place that require EPA to fulfill its legal obligation to prevent this particular form of endangerment to public health.

EPA does have in place NAAQS for ozone, which are premised on the harmfulness of ozone to public health and welfare. These standards and their accompanying regulatory regime have helped to reduce the dangers from ozone in the United States. However, substantial challenges remain with respect to achieving the air quality protection promised by the NAAQS for ozone. It is the Administrator's view that these challenges will be exacerbated by climate change.

In addition, the control measures to achieve attainment with a NAAQS are a mitigation measure aimed at reducing emissions of ozone precursors. As discussed in Section III.C of these Findings, EPA is not considering the impacts of mitigation with respect to future reductions in emissions of greenhouse gases. For the same reasons, EPA is reasonably not considering mitigation in the form of the control measures that will need to be adopted in the future to reduce emissions of ozone precursors and thereby address the increased ambient ozone levels that can occur because of climate change.

It is important to note that controls to meet the NAAQS are typically put in place only *after* air quality concentrations exceeding the standard are detected. Furthermore, implementation of controls to reduce ambient concentrations of pollutants occurs over an extended time period, ranging from three years to more than twenty years depending on the pollutant and the seriousness of the nonattainment problem. Thus, while the CAA provides mechanisms for addressing adverse health effects and the underlying air quality exacerbation over time, it will not prevent the adverse impacts in the interim. Given the serious nature of the health effects at issue—including respiratory and cardiovascular disease leading to hospital admissions, emergency department visits, and premature mortality—this increase in adverse impacts during the time before additional controls can be implemented is a serious public health concern. Historically, a large segment of the U.S. population has lived in areas exceeding the NAAQS, despite the CAA and its implementation efforts. Half of all Americans, 158 million people, live in counties where air pollution exceeds national health standards.[31] Where attainment of the NAAQS is especially difficult, leading to delays in meeting attainment deadlines, the health effects of increased ozone due to climate change may be substantial.

It is also important to note that it may not be possible for States and Tribes to plan accurately for the impacts of climate change in developing control strategies for nonattainment areas. As noted in the TSD and EPA's 2009 Interim Assessment report (IA), climate change is projected to lead to an increase in the variability of weather, and this may increase peak pollution events including increases in ozone exceedances. While the modeling studies in the IA all show significant future changes in meteorological quantities, there is also significant variability across the simulations in the spatial patterns of these future changes, making it difficult to select a set of future meteorological data for planning purposes. At this time, models used to develop plans to attain the NAAQS do not take potential changes in future meteorology into consideration. Inability to predict the frequency and magnitude of such events could lead to an underestimation of the controls needed to bring areas into attainment, and a prolonged period during which adverse health impacts continue to occur.

Even in areas that meet the NAAQS currently, air quality may deteriorate sufficiently to cause adverse health effects for some individuals. Some at-risk individuals, for example those with preexisting health conditions or other characteristics which increase their risk for adverse effects upon exposure to PM or ozone, may experience health effects at levels below the standard. Current evidence suggests that there is no threshold for PM or ozone concentrations below which no effects can be observed. Therefore, increases in ozone or PM in locations that currently meet the standards would likely result in additional adverse health effects for some individuals, even though the pollution increase might not be sufficient to cause the area to be designated nonattainment. While the NAAQS is set to protect public health with an adequate margin of safety, it is recognized that in attainment areas there may be individuals who remain at greater risk from an increase in ozone levels. The clear risk to the public from ozone increases in nonattainment areas, in combination with the risk to some individuals in attainment areas, supports the finding that overall the public health is endangered by increases in ozone resulting from climate change.

Finally, it is also important to note that not all air pollution events are subject to CAA controls under the NAAQS implementation provisions. ''Exceptional events'' are events for which the normal planning and regulatory process established by the CAA is not appropriate (72 FR 13561). Emissions from some events, including some wildfires, are not reasonably controllable or preventable. Such emissions, however, can adversely impact public health and welfare and are expected to increase due to climate change. As described in the TSD, PM emissions from wildfires can contribute to acute and chronic illnesses of the respiratory system, particularly in children, including pneumonia, upper respiratory diseases, asthma and chronic obstructive pulmonary disease. The IPCC (Field et al., 2007) reported with very high confidence that in North America, disturbances like wildfires are increasing and are likely to intensify in a warmer future with drier soils and longer growing seasons.

2. The Air Pollution Is Reasonably Anticipated to Endanger Public Welfare

The Administrator also finds that the well-mixed greenhouse gas air pollution may reasonably be anticipated to

[31] U.S. EPA (2008) National Air Quality: Status and Trends Through 2007. EPA–454/R–08–006, November 2008.

endanger public welfare, both for current and future generations.

As with public health, the Administrator considered the multiple pathways in which the greenhouse gas air pollution and resultant climate change affect climate-sensitive sectors, and the impact this may have on public welfare. These sectors include food production and agriculture; forestry; water resources; sea level rise and coastal areas; energy, infrastructure, and settlements; and ecosystems and wildlife. The Administrator also considered impacts on the U.S. population from climate change effects occurring outside of the United States, such as national security concerns for the United States that may arise as a result of climate change impacts in other regions of the world. The Administrator examined each climate-sensitive sector individually, informed by the summary of the scientific assessments contained in the TSD, and the full record before EPA, and weighed the extent to which the risks and impacts within each sector support or do not support a positive endangerment finding in her judgment. The Administer then viewed the full weight of evidence looking across all sectors to reach her decision regarding endangerment to public welfare.

a. Food Production and Agriculture

Food production and agriculture within the United States is a sector that will be affected by the combined effects of elevated carbon dioxide concentrations and associated climate change. The Administrator considered how these effects, both adverse and beneficial, are affecting the agricultural sector now and in the future, and over different regions of the United States, taking into account that different regions of the country specialize in different agricultural products with varying degrees of sensitivity and vulnerability to elevated carbon dioxide levels and associated climate change.

Elevated carbon dioxide concentrations can have a stimulatory effect on grain and oilseed crop yield, as may modest temperature increases and a longer growing season that results. A report under the USGCRP concluded that, with increased carbon dioxide and temperature, the life cycle of grain and oilseed crops will likely progress more rapidly. However, such beneficial influences need to be considered in light of various other effects. For example, the literature indicates that elevated carbon dioxide concentrations may also enhance pest and weed growth. Pests and weeds can reduce crop yields, cause economic losses to farmers, and require management control options. How climate change (elevated carbon dioxide, increased temperatures, altered precipitation patterns, and changes in the frequency and intensity of extreme events) may affect the prevalence of pests and weeds is an issue of concern for food production and the agricultural sector. Research on the combined effects of elevated carbon dioxide and climate change on pests, weeds, and disease is still limited. In addition, higher temperature increases, changing precipitation patterns and variability, and any increases in ground-level ozone induced by higher temperatures, can work to counteract any direct stimulatory carbon dioxide effect, as well as lead to their own adverse impacts. There may be large regional variability in the response of food production and agriculture to climate change.

For grain and oilseed crop yields, there is support for the view that in the near term climate change may have a beneficial effect, largely through increased temperature and increased carbon dioxide levels. However there are also factors noted above, some of which are less well studied and understood, which would tend to offset any near term benefit, leaving significant uncertainty about the actual magnitude of any overall benefit. The USGCRP report also concluded that as temperature rises, these crops will increasingly begin to experience failure, especially if climate variability increases and precipitation lessens or becomes more variable.

A key uncertainty is how human-induced climate change may affect the intensity and frequency of extreme weather events such as droughts and heavy storms. These events have the potential to have serious negative impact on U.S. food production and agriculture, but are not always taken into account in studies that examine how average conditions may change as a result of carbon dioxide and temperature increases. Changing precipitation patterns, in addition to increasing temperatures and longer growing seasons, can change the demand for irrigation requirements, potentially increasing irrigation demand.

Another key uncertainty concerns the many horticultural crops (*e.g.,* tomatoes, onions, fruits), which make up roughly 40 percent of total crop value in the United States. There is relatively little information on their response to carbon dioxide, and few crop simulation models, but according to the literature, they are very likely to be more sensitive to the various effects of climate change than grain and oilseed crops.

With respect to livestock, higher temperatures will very likely reduce livestock production during the summer season in some areas, but these losses will very likely be partially offset by warmer temperatures during the winter season. The impact on livestock productivity due to increased variability in weather patterns will likely be far greater than effects associated with the average change in climatic conditions. Cold-water fisheries will likely be negatively affected; warm-water fisheries will generally benefit; and the results for cool-water fisheries will be mixed, with gains in the northern and losses in the southern portions of ranges.

Finally, with respect to irrigation requirements, the adverse impacts of climate change on irrigation water requirements may be significant.

There is support for the view that there may be a benefit in the near term in the crop yield for certain crops. This potential benefit is subject to significant uncertainty, however, given the offsetting impact on the yield of these crops from a variety of other climate change impacts that are less well understood and more variable. Any potential net benefit is expected to change to a disbenefit in the longer term. In addition, there is clear risk that the sensitivity of a major segment of the total crop market, the horticultural sector, may lead to adverse affects from climate change. With respect to livestock production and irrigation requirements, climate change is likely to have adverse effects in both the near and long terms. The impact on fisheries varies, and would appear to be best viewed as neutral overall.

There is a potential for a net benefit in the near term for certain crops, but there is significant uncertainty about whether this benefit will be achieved given the various potential adverse impacts of climate change on crop yield, such as the increasing risk of extreme weather events. Other aspects of this sector are expected to be adversely affected by climate change, including livestock management and irrigation requirements, and there is a risk of adverse effect on a large segment of the total crop market. For the near term, the concern over the potential for adverse effects in certain parts of the agriculture sector appears generally comparable to the potential for benefits for certain crops.

However, considering the trend over near- and long-term future conditions, the Administrator finds that the body of evidence points towards increasing risk

of net adverse impacts on U.S. food production and agriculture, with the potential for significant disruptions and crop failure in the future.

b. Forestry

The factors that the Administrator considered for the U.S. forest sector are similar to those for food production and agriculture. There is the potential for beneficial effects due to elevated concentrations of carbon dioxide and increased temperature, as well as the potential for adverse effects from increasing temperatures, changing precipitation patterns, increased insects and disease, and the potential for more frequent and severe extreme weather events. The potential beneficial effects are better understood and studied, and are limited to certain areas of the country and types of forests. The adverse effects are less certain, more variable, and also include some of the most serious adverse effects such as increased wildfire, drought, and major losses from insects and disease. As with food production and agriculture, the judgment to be made is largely a qualitative one, balancing impacts that vary in certainty and magnitude, with the end result being a judgment as to the overall direction and general level of concern.

According to the underlying science assessment reports, climate change has very likely increased the size and number of wildfires, insect outbreaks, and tree mortality in the Interior West, the Southwest, and Alaska, and will continue to do so. Rising atmospheric carbon dioxide levels will very likely increase photosynthesis for forests, but the increased photosynthesis will likely only increase wood production in young forests on fertile soils. Nitrogen deposition and warmer temperatures have very likely increased forest growth where water is not limiting and will continue to do so in the near future.

An increased frequency of disturbance (such as drought, storms, insect-outbreaks, and wildfire) is at least as important to forest ecosystem function as incremental changes in temperature, precipitation, atmospheric carbon dioxide, nitrogen deposition, and ozone pollution. Disturbances partially or completely change forest ecosystem structure and species composition, cause short-term productivity and carbon storage loss, allow better opportunities for invasive alien species to become established, and command more public and management attention and resources. The combined effects of expected increased temperature, carbon dioxide, nitrogen deposition, ozone, and forest disturbance on soil processes and soil carbon storage remain unclear.

Precipitation and weather extremes are key to many forestry impacts, accounting for part of the regional variability in forest response. If existing trends in precipitation continue, it is expected that forest productivity will likely decrease in the Interior West, the Southwest, eastern portions of the Southeast, and Alaska, and that forest productivity will likely increase in the northeastern United States, the Lake States, and in western portions of the Southeast. An increase in drought events will very likely reduce forest productivity wherever such events occur.

Changes in disturbance patterns are expected to have a substantial impact on overall gains or losses. More prevalent wildfire disturbances have recently been observed in the United States. Wildfires and droughts, among other extreme events (*e.g.,* hurricanes) that can cause forest damage, pose the largest threats over time to forest ecosystems.

For the near term, the Administrator believes the beneficial impact on forest growth and productivity in certain parts of the country from climate change to be more than offset by the clear risk from the more significant and serious adverse effects from the observed increases in wildfires, combined with the adverse impacts on growth and productivity in other areas of the country and the serious risks from the spread of destructive pests and disease. Increased wildfires can also increase particulate matter and thus create public health concerns as well. For the longer term, the Administrator views the risk from adverse effects to increase over time, such that overall climate change presents serious adverse risks for forest productivity. The Administrator therefore finds there is compelling reason to find that the greenhouse gas air pollution endangers U.S. forestry in both the near and long term, with the support for a positive endangerment finding only increasing as one considers expected future conditions in which temperatures continue to rise.

c. Water Resources

The sensitivity of water resources to climate change is very important given the increasing demand for adequate water supplies and services for agricultural, municipal, and energy and industrial uses, and the current strains on this resource in many parts of the country.

According to the assessment literature, climate change has already altered, and will likely continue to alter, the water cycle, affecting where, when, and how much water is available for all uses. With higher temperatures, the water-holding capacity of the atmosphere and evaporation into the atmosphere increase, and this favors increased climate variability, with more intense precipitation and more droughts.

Climate change is causing and will increasingly cause shrinking snowpack induced by increasing temperature. In the western United States, there is already well-documented evidence of shrinking snowpack due to warming. Earlier meltings, with increased runoff in the winter and early spring, increase flood concerns and also result in substantially decreased summer flows. This pattern of reduced snowpack and changes to the flow regime pose very serious risks to major population regions, such as California, that rely on snowmelt-dominated watersheds for their water supply. While increased precipitation is expected to increase water flow levels in some eastern areas, this may be tempered by increased variability in the precipitation and the accompanying increased risk of floods and other concerns such as water pollution.

Warmer temperatures and decreasing precipitation in other parts of the country, such as the Southwest, can sustain and amplify drought impacts. Although drought has been more frequent and intense in the western part of the United States, the East is also vulnerable to droughts and attendant reductions in water supply, changes in water quality and ecosystem function, and challenges in allocation. The stress on water supplies on islands is expected to increase.

The impact of climate change on groundwater as a water supply is regionally variable; efforts to offset declining surface water availability due to increasing precipitation variability may be hampered by the fact that groundwater recharge will decrease considerably in some already water-stressed regions. In coastal areas, the increased salinization from intrusion of salt water is projected to have negative effects on the supply of fresh water.

Climate change is expected to have adverse effects on water quality. The IPCC concluded with high confidence that higher water temperatures, increased precipitation intensity, and longer periods of low flows exacerbate many forms of water pollution and can impact ecosystems, human health, and water system reliability and operating costs. These changes will also exacerbate many forms of water pollution, potentially making attainment of water quality goals more

difficult. Water pollutants of concern that are particularly relevant to climate change effects include sediment, nutrients, organic matter, pathogens, pesticides, salt, and thermal pollution. As waters become warmer, the aquatic life they now support will be replaced by other species better adapted to warmer water. In the long term, warmer water, changing flows, and decreased water quality may result in deterioration of aquatic ecosystems.

Climate change will likely further constrain already over-allocated water resources in some regions of the United States, increasing competition among agricultural, municipal, industrial, and ecological uses. Although water management practices in the United States are generally advanced, particularly in the West, the reliance on past conditions as the basis for current and future planning may no longer be appropriate, as climate change increasingly creates conditions well outside of historical observations. Increased incidence of extreme weather and floods may also overwhelm or damage water treatment and management systems, resulting in water quality impairments. In the Great Lakes and major river systems, lower water levels are likely to exacerbate challenges relating to water quality, navigation, recreation, hydropower generation, water transfers, and bi-national relationships.

The Administrator finds that the total scientific literature provides compelling support for finding that greenhouse gas air pollution endangers the water resources important for public welfare in the United States, both for current and future generations. The adequacy of water supplies across large areas of the country is at serious risk from climate change. Even areas of the country where an increase in water flow is projected could face water resource problems from the variability of the supply and water quality problems associated with precipitation variability, and could face the serious adverse effects from risks from floods and drought. Climate change is expected to adversely affect water quality. There is an increased risk of serious adverse effects from extreme events of flooding and drought. The severity of risks and impacts may only increase over time with accumulating greenhouse gas concentrations and associated temperature increases and precipitation changes.

d. Sea Level Rise and Coastal Areas

A large percentage of the U.S. population lives in coastal areas, which are particularly vulnerable to the risks posed by climate change. The most vulnerable areas are the Atlantic and Gulf Coasts, the Pacific Islands, and parts of Alaska.

According to the assessment literature, sea level is rising along much of the U.S. coast, and the rate of change will very likely increase in the future, exacerbating the impacts of progressive inundation, storm-surge flooding, and shoreline erosion. Cities such as New Orleans, Miami, and New York are particularly at risk, and could have difficulty coping with the sea level rise projected by the end of the century under a higher emissions scenario. Population growth and the rising value of infrastructure increases the vulnerability to climate variability and future climate change in coastal areas. Adverse impacts on islands present concerns for Hawaii and the U.S. territories. Reductions in Arctic sea ice increases extreme coastal erosion in Alaska, due to the increased exposure of the coastline to strong wave action. In the Great Lakes, where sea level rise is not a concern, both extremely high and low water levels resulting from changes to the hydrological cycle have been damaging and disruptive to shoreline communities.

Coastal wetland loss is being observed in the United States where these ecosystems are squeezed between natural and artificial landward boundaries and rising sea levels. Up to 21 percent of the remaining coastal wetlands in the U.S. mid-Atlantic region are potentially at risk of inundation between 2000 and 2100. Coastal habitats will likely be increasingly stressed by climate change impacts interacting with development and pollution.

Although increases in mean sea level over the 21st century and beyond will inundate unprotected, low-lying areas, the most devastating impacts are likely to be associated with storm surge. Superimposed on expected rates of sea level rise, projected storm intensity, wave height, and storm surge suggest more severe coastal flooding and erosion hazards. Higher sea level provides an elevated base for storm surges to build upon and diminishes the rate at which low-lying areas drain, thereby increasing the risk of flooding from rainstorms. In New York City and Long Island, flooding from a combination of sea level rise and storm surge could be several meters deep. Projections suggest that the return period of a 100-year flood event in this area might be reduced to 19–68 years, on average, by the 2050s, and to 4–60 years by the 2080s. Additionally, some major urban centers in the United States, such as areas of New Orleans are situated in low-lying flood plains, presenting increased risk from storm surges.

The Administrator finds that the most serious risk of adverse effects is presented by the increased risk of storm surge and flooding in coastal areas from sea level rise. Current observations of sea level rise are now contributing to increased risk of storm surge and flooding in coastal areas, and there is reason to find that these areas are now endangered by human-induced climate change. The conclusion in the assessment literature that there is the potential for hurricanes to become more intense with increasing temperatures (and even some evidence that Atlantic hurricanes have already become more intense) reinforces the judgment that coastal communities are now endangered by human-induced climate change, and may face substantially greater risk in the future. The Administrator has concluded that even if there is a low probability of raising the destructive power of hurricanes, this threat is enough to support a finding that coastal communities are endangered by greenhouse gas air pollution.

In addition, coastal areas face other adverse impacts from sea level rise such as shoreline retreat, erosion, wetland loss and other effects. The increased risk associated with these adverse impacts also endangers the welfare of current and future generations, with an increasing risk of greater adverse impacts in the future.

Overall, the evidence on risk of adverse impacts for coastal areas from sea level rise provides clear support for finding that greenhouse gas air pollution endangers the welfare of current and future generations.

e. Energy, Infrastructure and Settlements

The Administrator also considered the impacts of climate change on energy consumption and production, and on key climate-sensitive aspects of the nation's infrastructure and settlements.

For the energy sector, the Administrator finds clear evidence that temperature increases will change heating and cooling demand, and to varying degrees across the country; however, under current conditions it is unclear whether or not net demand will increase or decrease. While the impacts on net energy demand may be viewed as generally neutral for purposes of making an endangerment determination, climate change is expected to call for an increase in electricity production, especially supply for peak demand. The U.S. energy sector, which relies heavily on water for cooling capacity and

hydropower, may be adversely impacted by changes to water supply in reservoirs and other water bodies.

With respect to infrastructure, climate change vulnerabilities of industry, settlement and society are mainly related to extreme weather events rather than to gradual climate change. The significance of gradual climate change, *e.g.*, increases in the mean temperature, lies mainly in changes in the intensity and frequency of extreme events. Extreme weather events could threaten U.S. energy infrastructure (transmission and distribution), transportation infrastructure (roads, bridges, airports and seaports), water infrastructure, and other built aspects of human settlements. Moreover, soil subsidence caused by the melting of permafrost in the Arctic region is a risk to gas and oil pipelines, electrical transmission towers, roads, and water systems. Vulnerabilities for industry, infrastructures, settlements, and society to climate change are generally greater in certain high-risk locations, particularly coastal and riverine areas, and areas whose economies are closely linked with climate-sensitive resources. Additionally, infrastructures are often connected, meaning that an impact on one can also affect others.

A significant fraction of U.S. infrastructure is located in coastal areas. In these locations, rising sea levels are likely to lead to direct losses (*e.g.,* equipment damage from flooding) as well as indirect effects such as the costs associated with raising vulnerable assets to higher levels. Water infrastructure, including drinking water and wastewater treatment plants, and sewer and storm water management systems, may be at greater risk of flooding, sea level rise and storm surge, low flows, saltwater intrusion, and other factors that could impair performance and damage costly investments.

Within settlements experiencing climate change stressors, certain parts of the population may be especially vulnerable based on their circumstances. These include the poor, the elderly, the very young, those already in poor health, the disabled, those living alone, and/or indigenous populations dependent on one or a few resources. In Alaska, indigenous communities are likely to experience disruptive impacts, including shifts in the range or abundance of wild species crucial to their livelihoods and well-being.

Overall, the evidence strongly supports the view that climate change presents risks of serious adverse impacts on public welfare from the risk to energy production and distribution as well as risks to infrastructure and settlements.

f. Ecosystems and Wildlife

The Administrator considered the impacts of climate change on ecosystems and wildlife and the services they provide. The Administrator finds clear evidence that climate change is exerting major influences on natural environments and biodiversity, and these influences are generally expected to grow with increased warming. Observed changes in the life cycles of plants and animals include shifts in habitat ranges, timing of migration patterns, and changes in reproductive timing and behavior.

The underlying assessment literature finds with high confidence that substantial changes in the structure and functioning of terrestrial ecosystems are very likely to occur with a global warming greater than 2 to 3 °C above pre-industrial levels, with predominantly negative consequences for biodiversity and the provisioning of ecosystem goods and services. With global average temperature changes above 2 °C, many terrestrial, freshwater, and marine species (particularly endemic species) are at a far greater risk of extinction than in the geological past. Climate change and ocean acidification will likely impair a wide range of planktonic and other marine calcifiers such as corals. Even without ocean acidification effects, increases in sea surface temperature of about 1–3 °C are projected to result in more frequent coral bleaching events and widespread mortality. In the Arctic, wildlife faces great challenges from the effects of climatic warming, as projected reductions in sea ice will drastically shrink marine habitat for polar bears, ice-inhabiting seals, and other animals.

Some common forest types are projected to expand, such as oak-hickory, while others are projected to contract, such as maple-beech-birch. Still others, such as spruce-fir, are likely to disappear from the contiguous United States. Changes in plant species composition in response to climate change can increase ecosystem vulnerability to other disturbances, including wildfires and biological invasion. Disturbances such as wildfires and insect outbreaks are increasing in the United States and are likely to intensify in a warmer future with warmer winters, drier soils and longer growing seasons. The areal extent of drought-limited ecosystems is projected to increase 11 percent per °C warming in the United States. In California, temperature increases greater than 2 °C may lead to conversion of shrubland into desert and grassland ecosystems and evergreen conifer forests into mixed deciduous forests. Greater intensity of extreme events may alter disturbance regimes in coastal ecosystems leading to changes in diversity and ecosystem functioning. Species inhabiting salt marshes, mangroves, and coral reefs are likely to be particularly vulnerable to these effects.

The Administrator finds that the total scientific record provides compelling support for finding that the greenhouse gas air pollution leads to predominantly negative consequences for biodiversity and the provisioning of ecosystem goods and services for ecosystems and wildlife important for public welfare in the U.S., both for current and future generations. The severity of risks and impacts may only increase over time with accumulating greenhouse gas concentrations and associated temperature increases and precipitation changes.

g. Summary of the Administrator's Finding of Endangerment to Public Welfare

The Administrator has considered how elevated concentrations of the well-mixed greenhouse gases and associated climate change affect public welfare by evaluating numerous and far-ranging risks to food production and agriculture, forestry, water resources, sea level rise and coastal areas, energy, infrastructure, and settlements, and ecosystems and wildlife. For each of these sectors, the evidence provides support for a finding of endangerment to public welfare. The evidence concerning adverse impacts in the areas of water resources and sea level rise and coastal areas provide the clearest and strongest support for an endangerment finding, both for current and future generations. Strong support is also found in the evidence concerning infrastructure and settlements, as well ecosystems and wildlife. Across the sectors, the potential serious adverse impacts of extreme events, such as wildfires, flooding, drought, and extreme weather conditions provide strong support for such a finding.

Water resources across large areas of the country are at serious risk from climate change, with effects on water supplies, water quality, and adverse effects from extreme events such as floods and droughts. Even areas of the country where an increase in water flow is projected could face water resource problems from the supply and water quality problems associated with temperature increases and precipitation variability, and could face the increased risk of serious adverse effects from extreme events, such as floods and

drought. The severity of risks and impacts is likely to increase over time with accumulating greenhouse gas concentrations and associated temperature increases and precipitation changes.

Overall, the evidence on risk of adverse impacts for coastal areas provides clear support for a finding that greenhouse gas air pollution endangers the welfare of current and future generations. The most serious potential adverse effects are the increased risk of storm surge and flooding in coastal areas from sea level rise and more intense storms. Observed sea level rise is already increasing the risk of storm surge and flooding in some coastal areas. The conclusion in the assessment literature that there is the potential for hurricanes to become more intense (and even some evidence that Atlantic hurricanes have already become more intense) reinforces the judgment that coastal communities are now endangered by human-induced climate change, and may face substantially greater risk in the future. Even if there is a low probability of increasing the destructive power of hurricanes, this threat is enough to support a finding that coastal communities are endangered by greenhouse gas air pollution. In addition, coastal areas face other adverse impacts from sea level rise such as land loss due to inundation, erosion, wetland submergence, and habitat loss. The increased risk associated with these adverse impacts also endangers public welfare, with an increasing risk of greater adverse impacts in the future.

Strong support for an endangerment finding is also found in the evidence concerning energy, infrastructure, and settlements, as well ecosystems and wildlife. While the impacts on net energy demand may be viewed as generally neutral for purposes of making an endangerment determination, climate change is expected to result in an increase in electricity production, especially to meet peak demand. This increase may be exacerbated by the potential for adverse impacts from climate change on hydropower resources as well as the potential risk of serious adverse effects on energy infrastructure from extreme events. Changes in extreme weather events threaten energy, transportation, and water resource infrastructure. Vulnerabilities of industry, infrastructure, and settlements to climate change are generally greater in high-risk locations, particularly coastal and riverine areas, and areas whose economies are closely linked with climate-sensitive resources. Climate change will likely interact with and possibly exacerbate ongoing environmental change and environmental pressures in settlements, particularly in Alaska where indigenous communities are facing major environmental and cultural impacts on their historic lifestyles. Over the 21st century, changes in climate will cause some species to shift north and to higher elevations and fundamentally rearrange U.S. ecosystems. Differential capacities for range shifts and constraints from development, habitat fragmentation, invasive species, and broken ecological connections will likely alter ecosystem structure, function, and services, leading to predominantly negative consequences for biodiversity and the provision of ecosystem goods and services.

With respect to food production and agriculture, there is a potential for a net benefit in the near term for certain crops, but there is significant uncertainty about whether this benefit will be achieved given the various potential adverse impacts of climate change on crop yield, such as the increasing risk of extreme weather events. Other aspects of this sector may be adversely affected by climate change, including livestock management and irrigation requirements, and there is a risk of adverse effect on a large segment of the total crop market. For the near term, the concern over the potential for adverse effects in certain parts of the agriculture sector appears generally comparable to the potential for benefits for certain crops. However, the body of evidence points towards increasing risk of net adverse impacts on U.S. food production and agriculture over time, with the potential for significant disruptions and crop failure in the future.

For the near term, the Administrator finds the beneficial impact on forest growth and productivity in certain parts of the country from elevated carbon dioxide concentrations and temperature increases to date is offset by the clear risk from the observed increases in wildfires, combined with risks from the spread of destructive pests and disease. For the longer term, the risk from adverse effects increases over time, such that overall climate change presents serious adverse risks for forest productivity. There is compelling reason to find that the support for a positive endangerment finding increases as one considers expected future conditions where temperatures continue to rise.

Looking across all of the sectors discussed above, the evidence provides compelling support for finding that greenhouse gas air pollution endangers the public welfare of both current and future generations. The risk and the severity of adverse impacts on public welfare are expected to increase over time.

h. Impacts in Other World Regions That Can Affect the U.S Population

While the finding of endangerment to public health and welfare discussed above is based on impacts in the United States, the Administrator also considered how human-induced climate change in other regions of the world may in turn affect public welfare in the United States. According to the USGCRP report of June 2009 and other sources, climate change impacts in certain regions of the world may exacerbate problems that raise humanitarian, trade, and national security issues for the United States.[32] The IPCC identifies the most vulnerable world regions as the Arctic, because of the effects of high rates of projected warming on natural systems; Africa, especially the sub-Saharan region, because of current low adaptive capacity 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, such as the Ganges-Brahmaputra and the Zhujiang, due to large populations and high exposure to sea level rise, storm surge, and river flooding. Climate change has been described as a potential threat multiplier with regard to national security issues.

The Administrator acknowledges these kinds of risks do not readily lend themselves to precise analyses or future projections. However, given the unavoidable global nature of the climate change problem, it is appropriate and prudent to consider how impacts in other world regions may present risks to the U.S. population. Because human-induced climate change has the potential to aggravate natural resource, trade, and humanitarian issues in other world regions, which in turn may contribute to the endangerment of public welfare in the United States, this provides additional support for the Administrator's finding that the greenhouse gas air pollution is reasonably anticipated to endanger the public welfare of current and future

[32] ''In an increasingly interdependent world, U.S. vulnerability to climate change is linked to the fates of other nations. For example, conflicts or mass migrations of people resulting from food scarcity and other resource limits, health impacts or environmental stresses in other parts of the world could threaten U.S. national security.'' (Karl *et al.,* 2009).

generations of the United States population.

i. Summary of Key Public Comments on Endangerment to Public Welfare

Several public commenters point out the anticipated benefits that increasing carbon dioxide levels and temperatures will have on agricultural crops. In addition, commenters note how U.S. agricultural productivity, in particular, has been steadily rising over the last 100 years. Responses to major comments are found here and more detailed responses are found in the Response to Comments document.

The Administrator acknowledges that plants including agricultural crops respond to carbon dioxide positively based on numerous well-documented studies. However, previous assessments of food production and agriculture have been modified to highlight increasing vulnerability, stress, and adverse impacts from climate change over time, based on improvements in the understanding of plant physiology, concern over impacts on plant pests and pathogens, and the implications of changes in average temperatures for temperature extremes and for changes in the patterns of precipitation and evaporation. While it is still the case today and for the next few years that climate change benefits agriculture in some places and harms them in others, the Administrator considers that the far larger temperature increases expected over coming decades and beyond on the ''business as usual'' trajectory will put significant stresses on agriculture and land resources in all regions of the United States. The Administrator prudently considers increased climate variability associated with a warming climate, which may overwhelm the positive plant responses from elevated carbon dioxide over time. Further, the effects of climate change on weeds, insect pests, and pathogens are recognized as key factors in determining plant damage in future decades. The Administrator also notes that scientific literature clearly supports the finding that drought frequency and severity are projected to increase in the future over much of the United States, which will likely reduce crop yields because of excesses or deficits of water. Vulnerability to extended drought, according to IPCC, has been documented as already increasing across North America. Further, based on review of the assessment literature, the Administrator considers multiple stresses, such as limited availability of water resources, loss of biodiversity, and air pollution, which are likely to increase sensitivity and reduce resilience in the agricultural sector to climate change over time.

Similar to food production and agriculture, public commenters often noted that forest productivity is projected to increase in the coming years due to the direct stimulatory effect of carbon dioxide on plant growth combined with warmer temperatures and thus extended growing seasons. The Administrator notes this phenomenon has been well documented by numerous studies but recognizes that increased productivity will be associated with significant variation at local and regional scales. The Administrator considers that climate strongly influences forest productivity and composition, and the frequency and magnitude of disturbances that impact forests. Based on the most recent IPCC assessment of the scientific literature, several recent studies confirm previous findings that temperature and precipitation changes in future decades will modify, and often limit, direct carbon dioxide effects on plants. For example, increased temperatures may reduce carbon dioxide effects indirectly, by increasing water demand. The Administrator also considers that new research more firmly establishes the negative impacts of increased climate variability. Projected changes in the frequency and severity of extreme climate events have significant consequences for forestry production and amplify existing stresses to land resources in the future.

Several public commenters maintain that wildfires are primarily the result of natural climatic factors and not climate change and dispute that they are or will increase in the future. The Administrator notes the scientific literature and assessment reports provide several lines of evidence that suggest wildfires will likely increase in frequency over the next several decades because of climate warming. Wildfires and droughts, among other extreme events (*e.g.,* hurricanes) that cause forest damage, pose the largest threats over time to forest ecosystems. The assessment literature suggests that large, stand-replacing wildfires will likely increase in frequency over the next several decades because of climate warming and general climate warming encourages wildfires by extending the summer period that dries fuels, promoting easier ignition and faster spread. Furthermore, current climate modeling studies suggest that increased temperatures and longer growing seasons will elevate wildfire risk in connection with increased aridity.

V. The Administrator's Finding That Emissions of Greenhouse Gases From CAA Section 202(a) Sources Cause or Contribute to the Endangerment of Public Health and Welfare

As discussed in Section IV.A of these Findings, the Administrator is defining the air pollution for purposes of the endangerment finding to be the elevated concentration of well-mixed greenhouse gases in the atmosphere. The second step of the two-part endangerment test is for the Administrator to determine whether the emission of any air pollutant emitted from new motor vehicles cause or contribute to this air pollution. This is referred to as the cause or contribute finding, and is the second finding by the Administrator in this action.

Section V.A of these Findings describes the Administrator's definition and scope of the air pollutant ''well-mixed greenhouse gases.'' Section V.B of these Findings puts forth the Administrator's finding that emissions of well-mixed greenhouse gases from new motor vehicles contribute to the air pollution which is reasonably anticipated to endanger public health and welfare. Section V.C of these Findings provides responses to some of the key comments on these issues. See Response to Comments document Volume 10 for responses to other significant comments on the cause or contribute finding. More detailed emissions data summarized in the discussion below can be found in Appendix B of the TSD.

A. The Administrator's Definition of the ''Air Pollutant''

As discussed in the Proposed Findings, to help appreciate the distinction between air pollution and air pollutant, the *air pollution* can be thought of as the total, cumulative stock in the atmosphere, while the *air pollutant,* can be thought of as the flow that changes the size of the total stock. Given this relationship, it is not surprising that the Administrator is defining the air pollutant similar to the air pollution; while the air pollution is the concentration (*e.g.,* stock) of the well-mixed greenhouse gases in the atmosphere, the air pollutant is the same combined grouping of the well-mixed greenhouse gases, the emissions of which are analyzed for contribution (*e.g.,* the flow into the stock).

Thus, the Administrator is defining the air pollutant as the aggregate group of the same six long-lived and directly-emitted greenhouse gases: Carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons,

and sulfur hexafluoride. As noted above, this definition of a single air pollutant made up of these well-mixed greenhouse gases is similar to definitions of other air pollutants that are comprised of substances that share common attributes with similar effects on public health or welfare (*e.g.,* particulate matter and volatile organic compounds).

The common attributes shared by these six greenhouse gases are discussed in detail in Section IV.A of these Findings, where the Administrator defined the ''air pollution'' for purposes of the endangerment finding. These same common attributes support the Administrator grouping these six greenhouse gases for purposes of defining a single air pollutant as well. These attributes include the fact that they are all greenhouse gases that are directly emitted (*i.e.,* they are not formed through secondary processes in the atmosphere from precursor emissions); they are sufficiently long-lived in the atmosphere such that, once emitted, concentrations of each gas become well mixed throughout the entire global atmosphere; and they exert a climate warming effect by trapping outgoing, infrared heat that would otherwise escape to space. Moreover, the radiative forcing effect of these six greenhouse gases is well understood.

Furthermore, these six greenhouse gases are currently the common focus of climate science and policy. For example, the UNFCCC, signed and ratified by the U.S. in 1992, requires its signatories to ''develop, periodically update, publish and make available * * * national inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol [33], using comparable methodologies * * * '' [34] To date, the focus of UNFCCC actions and discussions has been on the six greenhouse gases that are the same focus of these findings. As a Party to the UNFCCC, EPA annually submits the *Inventory of U.S. Greenhouse Gas Emissions and Sinks* to the Convention, which reports on national emissions of anthropogenic emissions of the well-mixed greenhouse gases. International discussions about a post-Kyoto agreement also focus on the well-mixed greenhouse gases.

As noted above, grouping of many substances with common attributes as a single pollutant is common practice under the CAA. Thus, doing so here is not novel. Indeed CAA section 302(g) defines air pollutant as ''any air pollutant agent or *combination of such agents,* * * * '' CAA § 302(g) (emphasis added). Thus, it is clear that the term ''air pollutant'' is not limited to individual chemical compounds. In determining that greenhouse gases are within the scope of this definition, the Supreme Court described section 302(g) as a ''sweeping'' and ''capacious'' definition that unambiguously included greenhouse gases, that are ''unquestionably 'agents' of air pollution.'' *Massachusetts* v. *EPA,* 549 U.S. at 528, 532, 529 n.26. Although the Court did not interpret the term ''combination of'' air pollution agents, there is no reason this phrase would be interpreted any less broadly. Congress used the term ''any'', and did not qualify the kind of combinations that the agency could define as a single air pollutant. Congress provided EPA broad discretion to determine appropriate combinations of compounds that should be treated as a singe air pollutant.[35]

For the same reasons discussed in Section IV.A above, at this time, only carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride share all of these common attributes and thus they are the only substances that the Administrator finds to meet the definition of ''well-mixed greenhouse gas'' at this time.[36] Also as noted above, if in the future other substances are shown to meet the same criteria they may be added to the definition of this single air pollutant.

The Administrator is aware that CAA section 202(a) source categories do not emit all of the substances meeting the definition of well-mixed greenhouse gases. But that does not change the fact that all of these greenhouse gases share the attributes that make grouping them as a single air pollutant reasonable. As discussed further below, the reasonableness of this grouping does not turn on the particular source category being evaluated in a contribution finding.

B. The Administrator's Finding Regarding Whether Emissions of the Air Pollutant From Section 202(a) Source Categories Cause or Contribute to the Air Pollution That May Be Reasonably Anticipated To Endanger Public Health and Welfare

The Administrator finds that emissions of the well-mixed greenhouse gases from new motor vehicles contribute to the air pollution that may reasonably be anticipated to endanger public health and welfare. This contribution finding is for all of the CAA section 202(a) source categories and the Administrator considered emissions from all of these source categories. The relevant mobile sources under CAA section 202 (a)(1) are ''any class or classes of new motor vehicles or new motor vehicle engines, * * *.'' CAA section 202(a)(1) (emphasis added). The new motor vehicles and new motor vehicle engines (hereinafter ''CAA section 202(a) source categories'') addressed are: Passenger cars, light-duty trucks, motorcycles, buses, and medium and heavy-duty trucks. Detailed combined greenhouse gas emissions data for CAA section 202(a) source categories are presented in Appendix B of the TSD.[37]

The Administrator reached her decision after reviewing emissions data on the contribution of CAA section 202(a) source categories relative to both global greenhouse gas emissions and U.S. greenhouse gas emissions. Given that CAA section 202(a) source categories are responsible for about 4 percent of total global greenhouse gas emissions, and for just over 23 percent of total U.S. greenhouse gas emissions, the Administrator finds that both of these comparisons, independently and together, support a finding that CAA section 202(a) source categories contribute to the air pollution that may be reasonably anticipated to endanger public health and welfare. The Administrator is not placing primary weight on either approach; rather she finds that both approaches clearly establish that emissions of the well-mixed greenhouse gases from section 202(a) source categories contribute to air pollution with may reasonably be anticipated to endanger public health and welfare. As the Supreme Court noted, ''[j]udged by any standard, U.S.

[33] The Montreal Protocol covers ozone-depleting substances which may also share physical attributes of the six key greenhouse gases in this action, but they do not share other attributes such as being the focus of climate science and policy. See section * * *.

[34] UNFCCC Art. 4.1(b).

[35] Indeed, the greenhouse gases hydrofluorocarbons and perfluorocarbons each are already a combination of multiple compounds.

[36] The term ''well-mixed greenhouse gases'' is based on one of the shared attributes discussed above—these greenhouse gases are sufficiently long-lived in the atmosphere such that, once emitted, concentrations of each gas become well mixed throughout the entire global atmosphere. Defining the air pollutant to be the combination of these six well-mixed greenhouse gases is based in part on this attribute—after the gases are emitted, they are sufficiently long-lived in the atmosphere to become well mixed as part of the air pollution.

[37] For section 202(a) source categories, only the hydrofluorocarbon emissions related to passenger compartment cooling are included. Emissions from refrigeration units that may be attached to trucks are considered emissions from nonroad engines under CAA section 213.

motor-vehicle emissions make a meaningful contribution to greenhouse gas concentrations and hence, * * * to global warming.'' *Massachusetts v. EPA,* 549 U.S. at 525.[38]

1. Administrator's Approach in Making This Finding

Section 202(a) of the CAA source categories consist of passenger cars, light-duty trucks, motorcycles, buses, and heavy- and medium-duty trucks. As noted in the Proposed Findings, in the past the requisite contribution findings have been proposed concurrently with proposing emission standards for the relevant mobile source category. Thus, prior contribution findings often focused on a subset of the CAA section 202(a) (or other section) source categories. This final cause or contribute finding, however, is for all of the CAA section 202(a) source categories. The Administrator is considering emissions from all of these source categories in the determination.

Section 202(a) source categories emit the following well-mixed greenhouse gases: carbon dioxide, methane, nitrous oxide, and hydrofluorocarbons. As the basis for the Administrator's determination, EPA analyzed historical data of emissions of the well-mixed greenhouse gases for motor vehicles and motor vehicle engines in the United States from 1990 to 2007.

The Proposed Findings discussed a number of possible ways of assessing cause or contribute and the point was made that no single approach is required by the statute or has been used exclusively in previous determinations under the CAA. The Administrator also discussed how, consistent with prior cause or contribute findings and the science, she is using emissions as a proxy for contributions to atmospheric concentrations. This approach is reasonable for the well-mixed greenhouse gases, because cumulative emissions are responsible for the cumulative change in the concentrations in the atmosphere. Similarly, annual emissions are a perfectly reasonable proxy for annual incremental changes in atmospheric concentrations.

In making a judgment about the contribution of emissions from CAA section 202(a) source categories, the Administrator focused on making a reasoned overall comparison of emissions from the CAA section 202(a) source categories to emissions from other sources of greenhouse gases. This allows a determination of how the CAA section 202(a) source categories compare to all of the other sources that together as a group make up the total emissions contributors to the air pollution problem. The relative importance of the CAA section 202(a) source categories is central to making the contribution determination. Both the magnitude of these emissions and the comparison of these emissions to other sources provide the basis to determine whether the CAA section 202(a) source categories may reasonably be judged as contributing to the air pollution problem.

In many cases EPA makes this kind of comparison of source categories by a simple percentage calculation that compares the emissions from the source category at issue to a larger total group of emissions. Depending on the circumstances, a larger percentage often means a greater relative impact from that source category compared to the other sources that make up the total of emissions, and vice versa. However, the actual numerical percentages may have little meaning when viewed in isolation. The context of the comparison is needed to ensure the information is useful in evaluating the relative impact of one source compared to others. For example, the number of sources involved and the distribution of emissions across all of the sources can make a significant difference when evaluating the results of a percentage calculation. In some cases a certain percentage might mean almost all other sources are larger or much larger than the source at issue, while in other circumstances the same percentage could mean that the source at issue is in fact one of the larger contributors to the total.

The Administrator therefore considered the totality of the circumstances in order to best understand the role played by CAA section 202(a) source categories. This is consistent with Congress' intention for EPA to consider the cumulative impact of all sources of pollution. In that context, the global nature of the air pollution problem and the breadth of countries and sources emitting greenhouse gases means that no single country and no single source category dominate or are even close to dominating on a global scale. For example, the United States as a country is the second largest emitter of greenhouse gases, and emits approximately 18 percent of the world's total greenhouse gases. The total emissions of greenhouse gases worldwide are from numerous sources and countries, with each country and each source category contributing a relatively small percentage of the total emissions. That means that the relative ranking of countries or sources is not at all obvious from the magnitude of the percentage by itself. A country or a source may be a large contributor, in comparison to other countries or sources, even though its percentage contribution may appear relatively small.

In this situation, addressing a global air pollution problem may call for many different sources and countries to address emissions even if none by itself dominates or comes close to dominating the global inventory. A somewhat analogous situation can be found in the ozone air pollution problem in the United States. Emissions of NOx and volatile organic compounds (VOCs) often come from numerous small sources, as well as certain large source categories. We have learned that successful ozone control strategies often need to take this into account, and address both the larger sources of NOx and VOCs as well as the many smaller sources, given the breadth of sources that as a group lead to the total inventory of VOCs and NOx.

The global aspects of the greenhouse gas air pollution problem amplify this kind of situation many times over, where no single country or source category dominates or comes close to dominating the global inventory of greenhouse gas emissions. These unique, global aspects of the climate change problem tend to support consideration of contribution at lower percentage levels of emissions than might otherwise be considered appropriate when addressing a more typical local or regional air pollution problem. In this situation it is quite reasonable to consider emissions from source categories that are more important in relation to other sources, even if their absolute contribution initially may appear to be small.

In addition, the Administrator is aware of the fact that the United States is the second largest emitter of well-mixed greenhouse gases in the world. As the United States evaluates how to address climate change, the Administrator will analyze the various sources of emissions and the source's share of U.S. emissions. Thus, when analyzing whether a source category that emits well-mixed greenhouse gases in the United States contributes to the global problem, it is appropriate for the Administrator to consider how that source category fits into the larger picture of U.S. emissions. This ranking process within the United States allows the importance of the source category to

[38] Because the Administrator is defining the air pollutant as the combination of well-mixed greenhouse gases, she is not issuing a final contribution finding based on the alternative definition discussed in the proposed findings (*e.g.,* each greenhouse gas as an individual air pollutant).

be seen compared to other U.S. sources, informing the judgment of the importance of emissions from this source category in any overall national strategy to address greenhouse gas emissions.

It is in this broader context that EPA considered the contribution of CAA section 202(a) sources. This provides useful information in determining the importance that should be attached to the emissions from the CAA section 202(a) sources.

In reaching her determination, the Administrator used two simple and straightforward comparisons to assess cause or contribute for CAA section 202(a) source categories: (1) As a share of total current global aggregate emissions of the well-mixed greenhouse gases; and (2) as a share of total current U.S. aggregate emissions of the well-mixed greenhouse gases.

Total well-mixed greenhouse gas emissions from CAA section 202(a) source categories were compared to total global emissions of the well-mixed greenhouse gases. The total air pollution problem, as already discussed, is the elevated and climbing levels of the six greenhouse gas concentrations in the atmosphere, which are global in nature because these concentrations are globally well mixed (whether they are emitted from CAA section 202(a) source categories or any other source within or outside the United States). In addition, comparisons were also made to U.S. total well-mixed greenhouse gases emissions to appreciate how CAA section 202(a) source categories fit into the larger U.S. contribution to the global problem. It is typical for the Administrator to consider these kinds of comparisons of emissions of a pollutant in evaluating contribution to air pollution, such as the concentrations of that same pollutant in the atmosphere (*e.g.,* the Administrator analyzes $PM_{2.5}$ emissions to determine if a source category contributes to $PM_{2.5}$ air pollution). When viewed in the circumstances discussed above, both of these comparisons provide useful information in determining whether these source categories should be judged as contributing to the total air pollution problem.

a. Section 202(a) of the CAA—Share of Global Aggregate Emissions of the Well-Mixed Greenhouse Gases

Global emissions of well-mixed greenhouse gases have been increasing, and are projected to continue increasing unless the major emitters take action to reduce emissions. Total global emissions of well-mixed greenhouse gases in 2005 (the most recent year for which data for all countries and all greenhouse gases are available) [39] were 38,726 teragrams of CO_2-equivlant ($TgCO_2eq$.) [40] This represents an increase in global greenhouse gas emissions of about 26 percent since 1990 (excluding land use, land use change and forestry). In 2005, total U.S. emissions of well-mixed greenhouse gases were responsible for 18 percent of global emissions, ranking only behind China, which was responsible for 19 percent of global emissions of well-mixed greenhouse gases.

In 2005 emissions of the well-mixed greenhouse gas pollutant from CAA section 202(a) source categories represented 4.3 percent of total global well-mixed greenhouse gas emissions and 28 percent of global transport well-mixed greenhouse gas emissions (Table 1 of these Findings). If CAA section 202(a) source categories' emissions of well-mixed greenhouse gas were ranked against total well-mixed greenhouse gas emissions for entire countries, CAA section 202(a) source category emissions would rank behind only China, the United States as a whole, Russia, and India, and would rank ahead of Japan, Brazil, Germany and every other country in the world. Indeed, countries with lower emissions than the CAA section 202(a) source categories are members of the 17 ''major economies'' ''that meet to advance the exploration of concrete initiatives and joint ventures that increase the supply of clean energy while cutting greenhouse gas emissions.'' *See http://www.state.gov/g/oes/climate/mem/.* It would be anomalous, to say the least, to consider Japan and these other countries as major players in the global climate change community and an integral part of the solution, but not find that CAA section 202(a) source category emissions contribute to the global problem. Thus, the Administrator finds that emission of well-mixed greenhouse gases from CAA section 202(a) source categories contribute to the air pollution of well-mixed greenhouse gases.

TABLE 1—COMPARISON TO GLOBAL GREENHOUSE GAS (GHG) EMISSIONS ($TG\ CO_2E$)

	2005	Sec 202(a) share (percent)
All U.S. GHG emissions	7,109	23.5
Global transport GHG emissions	5,968	28.0
All global GHG emissions	38,726	4.3

b. Section 202(a) of the CAA—Share of U.S. Aggregate Emissions of the Well-Mixed Greenhouse Gases

The Administrator considered compared total emissions of the well-mixed greenhouse gases from CAA section 202(a) source categories to total U.S. emissions of the well-mixed greenhouse gases as an indication of the role these sources play in the total U.S. contribution to the air pollution problem causing climate change.[41]

In 2007, U.S. well-mixed greenhouse gas emissions were 7,150 $TgCO_2eq$. The dominant gas emitted was carbon dioxide, mostly from fossil fuel combustion. Methane was the second largest well-mixed greenhouse gas, followed by N_2O, and the fluorinated gases (HFCs, PFCs, and SF_6). Electricity generation was the largest emitting sector (2,445 $TgCO_2eq$ or 34 percent of

[39] The source of global greenhouse gas emissions data, against which comparisons are made, is the Climate Analysis Indicators Tool of the World Resources Institute (WRI) (2007). Note that for global comparisons, all emissions are from the year 2005, the most recent year for which data for all greenhouse gas emissions and all countries are available. WRI (2007) Climate Analysis Indicators Tool (CAIT). Available at *http://cait.wri.org.* Accessed August 5, 2009.

[40] One teragram (Tg) = 1 million metric tons. 1 metric ton = 1,000 kg = 1.102 short tons = 2,205 lbs. Long-lived greenhouse gases are compared and summed together on a CO_2 equivalent basis by multiplying each gas by its Global Warming Potential (GWPs), as estimated by IPCC. In accordance with UNFCCC reporting procedures, the U.S. quantifies greenhouse gas emissions using the 100-year time frame values for GWPs established in the IPCC Second Assessment Report.

[41] Greenhouse gas emissions data for the United States in this section have been updated since the Proposed Findings to reflect EPA's most up-to-date information, which includes data for the year 2007. The source of the U.S. greenhouse gas emissions data is the *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2007,* published in 2009 (hereinafter ''U.S. Inventory'').

total U.S. greenhouse gas emissions), followed by transportation (1,995 $TgCO_2eq$ or 28 percent) and industry (1,386 $TgCO_2eq$ or 19 percent). Emissions from the CAA section 202(a) source categories constitute the major part of the transportation sector. Land use, land use change, and forestry offset almost 15 percent of total U.S. emissions through net sequestration. Total U.S. well-mixed greenhouse gas emissions have increased by over 17 percent between 1990 and 2007. The electricity generation and transportation sectors have contributed the most to this increase.

In 2007 emissions of well-mixed greenhouse gases from CAA section 202(a) source categories collectively were the second largest emitter of well-mixed greenhouse gases within the United States (behind the electricity generating sector), emitting 1,663 $TgCO_2eq$ and representing 23 percent of total U.S. emissions of well-mixed greenhouse gases (Table 2 of these Findings). The Administrator is keenly aware that the United States is the second largest emitter of well-mixed greenhouse gases. Part of analyzing whether a sector within the United States contributes to the global problem is to see how those emissions fit into the contribution from the United States as a whole. This informs her judgment as to the importance of emissions from this source category in any overall national strategy to address greenhouse gas emissions. Thus, it is relevant that CAA section 202(a) source categories are the second largest emitter of well-mixed greenhouse gases in the country. This is part of the Administrator looking at the totality of the circumstances. Based on this the Administrator finds that emission of well-mixed greenhouse gases from CAA section 202(a) source categories contribute to the air pollution of well-mixed greenhouse gases.

TABLE 2—SECTORAL COMPARISON TO TOTAL U.S. GREENHOUSE GAS (GHG) EMISSIONS ($TG\ CO_2E$)

U.S. emissions	1990	1995	2000	2005	2006	2007
Section 202(a) GHG emissions	1231.9	1364.4	1568.1	1670.5	1665.7	1663.1
Share of U.S. (%)	20.2%	21.1%	22.4%	23.5%	23.6%	23.3%
Electricity Sector emissions	1859.1	1989.0	2329.3	2429.4	2375.5	2445.1
Share of U.S. (%)	30.5%	30.8%	33.2%	34.2%	33.7%	34.2%
Industrial Sector emissions	1496.0	1524.5	1467.5	1364.9	1388.4	1386.3
Share of U.S. (%)	24.5%	23.6%	20.9%	19.2%	19.7%	19.4%
Total U.S. GHG emissions	6098.7	6463.3	7008.2	7108.6	7051.1	7150.1

C. Response to Key Comments on the Administrator's Cause or Contribute Finding

EPA received numerous public comments regarding the Administrator's proposed cause or contribute finding. Below is a brief discussion of some of the key comments. Responses to comments on this issue are also contained in the Response to Comments document, Volume 10.

1. The Administrator Reasonably Defined the ''Air Pollutant'' for the Cause or Contribute Analysis

a. The Supreme Court Held that Greenhouse Gases Fit Within the Definition of ''Air Pollutant'' in the CAA

Several commenters reiterate arguments already rejected by the Supreme Court, arguing that greenhouse gases do not fit into the definition of ''air pollutant'' under the CAA. In particular, at least one commenter contends that EPA must show how greenhouse gases impact or materially change ''ambient air'' when defining air pollutant and making the endangerment finding. This commenter argues that because carbon dioxide is a naturally occurring and necessary element in the atmosphere, it cannot be considered to materially change air.

These and similar arguments were already rejected by the Supreme Court in *Massachusetts* v. *EPA*, 549 U.S. 497 (2007). Briefs before the Supreme Court also argued that carbon dioxide is an essential role for life on earth and therefore cannot be considered an air pollutant, and that the concentrations of greenhouse gases that are a potential problem are not in the ''ambient air'' that people breathe.

The Court rejected all of these and other arguments, noting that the statutory text forecloses these arguments. ''The Clean Air Act's sweeping definition of 'air pollutant' includes '*any* air pollution agent or combination of such agents, including *any* physical, chemical * * * substance or matter which is emitted into or otherwise enters the ambient air . * * *' § 7602(g) (emphasis added). On its face, the definition embraces all airborne compounds of whatever stripe, and underscores that intent through the repeated use of the word 'any.' Carbon dioxide, methane, nitrous oxide, and hydrofluorocarbons are without a doubt 'physical [and] chemical * * * substance[s] which [are] emitted into * * * the ambient air.' The statute is unambiguous.''

547 U.S. at 529–30 (footnotes omitted); see also *id.* at 530, n26 (the distinction regarding ambient air, however, finds no support in the text of the statute, which uses the phrase ''the ambient air'' without distinguishing between atmospheric layer.). Thus, the question of whether greenhouse gases fit within the definition of air pollutant under the CAA has been decided by the Supreme Court and is not being revisited here.

b. The Definition of Air Pollutant May Include Substances Not Emitted by CAA Section 202(a) Sources

Many commenters argue that the definition of ''air pollutant''—here well-mixed greenhouse gases—cannot include PFCs and SF6 because they are not emitted by CAA section 202(a) motor vehicles and hence, cannot be part of any ''air pollutant'' emitted by such sources. They argue that by improperly defining ''air pollutant'' to include substances that are not present in motor vehicle emissions, the Agency has exceeded its statutory authority under CAA section 202(a). Commenters contend that past endangerment findings under CAA section 202(a) demonstrate EPA's consistent approach of defining ''air pollutant(s)'' in accordance with the CAA's clear direction, to include only those pollutants emitted from the relevant source category (citing Notice of Proposed Rulemaking for Heavy-Duty Engine and Vehicle Standards finding that ''emissions of NO_X, VOCs, SO_X, and PM from heavy-duty trucks can reasonably be anticipated to endanger the public health or welfare.'' (65 FR 35436, June 2, 2000). Commenters argue that EPA itself is inconsistent in the Proposed Findings, sometimes referring

to ''air pollutant'' as the group of six greenhouse gases, and other times falling back on the four greenhouse gases emitted by motor vehicles.

EPA acknowledges that the Proposed Findings could have been clearer regarding the proposed definition of air pollutant, and how it was being applied to CAA section 202(a) sources, which emit only four of the six substances that meet the definition of well-mixed greenhouse gases. However, our interpretation does not exceed EPA's authority under CAA section 202(a). It is reasonable to define the air pollutant under CAA section 202(a) to include substances that have similar attributes (as discussed above), even if not all of the substances that meet that definition are emitted by motor vehicles. For example, as commenters note, EPA has heavy duty truck standards applicable to VOCs and PM, but it is highly unlikely that heavy duty trucks emit *every* substance that is included in the group defined as VOC or PM. *See* 40 CFR 51.100(s) (defining volatile organic compound (VOC) as ''any compound of carbon, excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, and ammonium carbonate, which participates in atmospheric photochemical reactions'', a list of exemptions are also included in the definition); 40 CFR 51.100(oo) (defining particulate matter (PM) as ''any airborne finely divided solid or liquid material with an aerodynamic diameter smaller than 100 micrometers'').

In this circumstance the number of substances included in the definition of well-mixed greenhouse gases is much smaller than other ''group'' air pollutants (*e.g.,* six greenhouse gases versus hundreds of VOCs), and CAA section 202(a) sources emit an easily discernible number of these six substances. However, this does not mean that the definition of the well-mixed greenhouse gases as the air pollutant is unreasonable. By defining well-mixed greenhouse gases as a single air pollutant comprised of six substances with common attributes, the Administrator is giving effect to these shared attributes and how they are relevant to the air pollution to which they contribute. The fact that these six substances share these common, relevant attributes is true regardless of the source category being evaluated for contribution. Grouping these six substances as one air pollutant is reasonable regardless of whether a contribution analysis is undertaken for CAA section 202(a) sources that emit one subset of the six substances (*e.g.*, carbon dioxide, CH_4, N_20 and HFCs, but not PFCs and SF_6), or for another category of sources that may emit another subset. For example, electronics manufacturers that may emit N_2O, PFCs, HFCs, SF_6 and other fluorinated compounds, but not carbon dioxide or CH_4 unless there is on-site fuel combustion. In other words, it is not necessarily the source category being evaluated for contribution that determines the reasonableness of defining a group air pollutant based on the shared attributes of the group.

Even if EPA agreed with commenters, and defined the air pollutant as the group of four compounds emitted by CAA section 202(a) sources, it would not change the result. The Administrator would make the same contribution finding as it would have no material effect on the emissions comparisons discussed above.

c. It Was Reasonable for the Administrator To Define the Single Air Pollutant as the Group of Substances With Common Attributes

Several commenters disagree with EPA's proposed definition of a single air pollutant composed of the six well-mixed greenhouse gases as a class. Commenters argue that the analogy to VOCs is misplaced because VOCs are all part of a defined group of chemicals, for which there are established quantification procedures, and for which there were extensive data showing that the group of compounds had demonstrated and quantifiable effects on ambient air and human health and welfare, and for which verifiable dispersion models existed. They contend this is in stark contrast to the entirely diverse set of organic and inorganic compounds EPA has lumped together for purposes of the Proposed Findings, and for which no model can accurately predict or quantify the actual impact or improvement resulting from controlling the compounds. Moreover, they argue that the gases EPA is proposing to list together as one pollutant are all generated by different processes and, if regulated, would require different types of controls; the four gases emitted by mobile sources can generally be limited only by using controls that are specific to each.

At least one commenter argues that EPA cannot combine greenhouse gases into one pollutant because their common attribute is not a ''physical, chemical, biological or radioactive property'' (quoting from CAA section 302(g)), but rather their effect or impacts on the environment. They say this differs from VOCs, which share the common attribute of volatility, or PM which shares the physical property of being particles.

As discussed above, the well-mixed greenhouse gases share physical attributes, as well as attributes based on sound policy considerations. The definition of ''air pollutant'' in CAA section 302(g) does not limit consideration of common attributes to those that are ''physical, chemical, biological or radioactive property'' as one commenter claims. Rather, the definition's use of the adjectives ''physical, chemical, biological or radioactive'' refer to the different types of substance or matter that is emitted. It is not a limitation on what characteristics the Administrator may consider when deciding how to group similar substances when defining a single air pollutant.

The common attributes that the Administrator considered when defining the well-mixed greenhouse gases are reasonable. While these six substances may originate from different processes, and require different control strategies, that does not detract from the fact that they are all long-lived, well-mixed in the atmosphere, directly emitted, of well-known radiative forcing, and generally grouped and considered together in climate change scientific and policy forums. Indeed, other group pollutants also originate from a variety of processes and a result may require different control technologies. For example, both a power plant and a dirt road can result in PM emissions, and the method to control such emissions at each source would be different. But these differences in origin or control do not undermine the reasonableness of considering PM as a single air pollutant. The fact that there are differences, as well as similarities, among the well-mixed greenhouse gases does not render the decision to group them together as one air pollutant unreasonable.

2. The Administrator's Cause or Contribute Analysis Was Reasonable

a. The Administrator Does Not Need To Find Significant Contribution, or Establish a Bright Line

Many commenters essentially argue that EPA must establish a bright line below which it would never find contribution regardless of the air pollutant, air pollution, and other factors before the Agency. For example, some commenters argue that EPA must provide some basis for determining de minimis amounts that fall below the threshold of ''contributing'' to the endangerment of public health and welfare under CAA section 202(a).

Commenters take issue with EPA's statement that it ''need not determine at this time the circumstances in which emissions would be trivial or de minimis and would not warrant a finding of contribution.'' Commenters argue that EPA cannot act arbitrarily by determining that a constituent contributing a certain percent to endangerment in one instance is de minimis and in another is contributing to endangerment of public health and welfare. They request that EPA revise the preamble language to make clear that the regulated community can rely on its past determinations with respect to ''contribution'' determinations to predict future agency action and argue that EPA should promulgate guidance on how it determines whether a contribution exceeds a de minimis level for purposes of CAA section 202(a) before finalizing the proposal.

The commenters that argue that the air pollution EPA must analyze to determine endangerment is limited to the air pollution resulting from new motor vehicles also argue that as a result, the contribution of emissions from new motor vehicles must be significant. They essentially contend that the endangerment and cause or contribute tests are inter-related and the universe of both tests is the same. In support of their argument, commenters argue that because the clause ''cause, or contribute to, air pollution'' is in plural form, it must be referring back to ''any class or classes of new motor vehicles or new motor vehicle engines,'' demonstrating that EPA must consider only the emissions from new motor vehicles which emit the air pollution which endangers.

Since the Administrator issued the Proposed Findings, the DC Circuit issued another opinion discussing the concept of contribution. See *Catawba County* v. *EPA*, 571 F.3d 20 (DC Cir. 2009). This decision, along with others, supports the Administrator's interpretation that the level of contribution under CAA section 202(a) does not need to be significant. The Administrator is not required to establish a bright line below which she would never find contribution under any circumstances. Finally, it is reasonable for the Administrator to apply a ''totality-of-the-circumstances test to implement a statute that confers broad discretionary authority, even if the test lacks a definite 'threshold' or 'clear line of demarcation to define an open-ended term.'' *Id.* at 39 (citations omitted).

In upholding EPA's $PM_{2.5}$ attainment and nonattainment designation decisions, the DC Circuit analyzed CAA section 107(d), which requires EPA to designate an area as nonattainment if it ''contributes to ambient air quality in a nearby area'' not attaining the national ambient air quality standards. *Id.* at 35. The court noted that it had previously held that the term ''contributes'' is ambiguous in the context of CAA language. *See EDF* v. *EPA*, 82 F.3d 451, 459 (DC Cir. 1996). ''[A]mbiguities in statutes within an agency's jurisdiction to administer are delegations of authority to the agency to fill the statutory gap in reasonable fashion.'' 571 F.3d at 35 (citing *Nat's Cable & Telecomms. Ass'c* v. *Brand X Internet Servs,* 545 U.S. 967, 980 (2005)).

The court then proceeded to consider and reject petitioners' argument that the verb ''contributes'' in CAA section 107(d) necessarily connotes a significant causal relationship. Specifically, the DC Circuit again noted that the term is ambiguous, leaving it to EPA to interpret in a reasonable manner. In the context of this discussion, the court noted that ''a contribution may simply exacerbate a problem rather than cause it * * * '' 571 F.3d at 39. This is consistent with the DC Circuit's decision in *Bluewater Network* v. *EPA,* 370 F.3d 1 (DC Cir. 2004), in which the court noted that the term contribute in CAA section 213(a)(3) ''[s]tanding alone, * * * has no inherent connotation as to the magnitude or importance of the relevant 'share' in the effect; certainly it does not incorporate any 'significance' requirement.'' 370 F.3d at 13. The court found that the bare ''contribute'' language invests the Administrator with discretion to exercise judgment regarding what constitutes a sufficient contribution for the purpose of making an endangerment finding. *Id.* at 14.

Finally, in *Catawba County,* the DC Circuit also rejected ''petitioners' argument that EPA violated the statute by failing to articulate a quantified amount of contribution that would trigger'' the regulatory action. 571 F.3d at 39. Although petitioners preferred that EPA establish a bright-line test, the court recognized that the statute did not require that EPA ''quantify a uniform amount of contribution.'' *Id.*

Given this context, it is entirely reasonable for the Administrator to interpret CAA section 202(a) to require some level of contribution that, while more than de minimis or trivial, does not rise to the level of significance. Moreover, the approach suggested by at least one commenter collapses the two prongs of the test by requiring that contribution must be significant because any climate change impacts upon which an endangerment determination is made result solely from the greenhouse gas emissions of motor vehicles. It essentially eliminates the ''contribute'' part of the ''cause or contribute'' portion of the test. This approach was clearly rejected by the en banc court in *Ethyl.* 541 F.2d at 29 (rejecting the argument that the emissions of the fuel additive to be regulated must ''in and of itself, *i.e.* considered in isolation, endanger[ ] public health.''); see also *Catawba County,* 571 F.3d at 39 (noting that even if the test required significant contribution it would be reasonable for EPA to find a county's addition of $PM_{2.5}$ is significant even though the problem would persist in its absence). It is the commenter, not EPA that is ignoring the statutory language. Whether or not the clause ''cause, or contribute to, air pollution'' refers back to ''any class or classes of new motor vehicles or new motor vehicle engines,'' or to ''emission of any air pollutant,'' the language of CAA section 202(a) clearly contemplates that emission of an air pollutant from any class or classes may merely contribute to, versus cause, the air pollution which endangers.

It is also reasonable for EPA to decline to establish a ''bright-line 'objective' test of contribution.'' 571 F.3d at 39. As noted in the Proposed Findings, when exercising her judgment, the Administrator not only considers the cumulative impact, but also looks at the totality of the circumstances (*e.g.,* the air pollutant, the air pollution, the nature of the endangerment, the type of source category, the number of sources in the source category, and the number and type of other source categories that may emit the air pollutant) when determining whether the emissions justify regulation under the CAA. *Id.* (It is reasonable for an agency to adopt a totality-of-the-circumstances test).

Even if EPA agreed that a level of significance was required to find contribution, for the reasons discussed above, EPA would find that the contribution from CAA section 202(a) source categories is significant. Their emissions are larger than the great majority of emitting countries, larger than several major emitting countries, and they constitute one of the largest parts of the U.S. emissions inventory.

b. The Unique Global Aspects of Climate Change Are an Appropriate Consideration in the Contribution Analysis

Some commenters disagree with statements in the Proposed Findings that the ''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 appropriate when considering contribution to a local or regional air pollution problem.'' They argue there is no basis in the CAA or existing EPA policy for this position, and that it reveals an apparent effort to expand EPA's authority to the ''truly trivial or de minimis'' sources that are acknowledged to be outside the scope of regulation, in that it expands EPA's authority to regulate pollutants to address global effects.

Commenters also assert that contrary to EPA's position, lower contribution numbers are appropriate when looking at local pollution, like nonattainment concerns—in other words, in the context of a statutory provision like CAA section 213 specifically aimed at targeting small source categories to help nonattainment areas meet air quality standards. However, they conclude this policy is simply inapplicable in the context of global climate change.

As discussed above, the term ''contribute'' is ambiguous and subject to the Administrator's reasonable interpretation. It is entirely appropriate for the Administrator to look at the totality of the circumstances when making a finding of contribution. In this case, the Administrator believes that the global nature of the problem justifies looking at contribution in a way that takes account of these circumstances. More specifically, because climate change is a global problem that results from global greenhouse gas emissions, there are more sources emitting greenhouse gases (in terms both of absolute numbers of sources and types of sources) than EPA typically encounters when analyzing contribution towards a more localized air pollution problem. From a percentage perspective, there are no dominating sources and fewer sources that would even be considered to be close to dominating. The global problem is much more the result of numerous and varied sources each of which emit what might seem to be smaller percentage amounts when compared to the total. The Administrator's approach recognizes this reality, and focuses on evaluating the relative importance of the CAA section 202(a) source categories compared to other sources when viewed in this context.

This recognition of the unique totality of the circumstances before the Administrator now as compared to previous contribution decisions is entirely appropriate. It is not an attempt by the Administrator to regulate ''truly trivial or de minimis'' sources, or to regulate sources based on their global effects. The Administrator is determining whether greenhouse gas emissions from CAA section 202(a) sources contribute to an air pollution problem is endangering U.S. public health and welfare. As discussed in the Proposed Findings, no single greenhouse gas source category dominates on the global scale, and many (if not all) individual greenhouse gas source categories could appear small in comparison to the total, when, in fact, they could be very important contributors in terms of both absolute emissions or in comparison to other source categories, globally or within the United States. If the United States 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. The commenters' approach, if used globally, would effectively lead to a tragedy of the commons, whereby no country or source category would be accountable for contributing to the global problem of climate change, and nobody would take action as the problem persists and worsens. The Administrator's approach, on the contrary, avoids this kind of approach, and is a reasonable exercise of her discretion to determine contribution in the global context in which this issue arises.

Importantly, as discussed above, the contribution from CAA section 202(a) sources is anything but trivial or de minimis under any interpretation of contribution. See, *Massachusetts v. EPA,* 549 U.S. at 1457–58 (''Judged by any standard, U.S. motor-vehicle emissions make a meaningful contribution to greenhouse gas concentrations and hence, * * * to global warming'').

c. The Administrator Reasonably Relied on Comparisons of Emissions From Existing CAA Section 202(a) Source Categories

i. It Was Reasonable To Use Existing Emissions From Existing CAA Section 202(a) Source Categories Instead of Projecting Future Emissions From New CAA Section 202(a) Source Categories

Many commenters argue that EPA improperly evaluated the emissions from the entire motor vehicle fleet, and it is required to limit its calculation to just emissions from new motor vehicles. Thus the emissions that EPA should consider in the cause or contribute determination is far less than the 4.3 percent of U.S. greenhouse gas emissions attributed to motor vehicles in the Proposed Findings, because this number includes both new and existing motor vehicles. One commenter calculated the emissions from new motor vehicles as being 1.8 percent of global emissions, assuming approximately one year of new motor vehicle production in the United States (11 million vehicles) in a total global count currently of approximately 600 million motor vehicles.

In the Proposed Findings, EPA determined the emissions from the entire fleet of motor vehicles in the United States for a certain calendar year. EPA explained that, consistent with its traditional practice, it used the recent motor vehicle emissions inventory for the entire fleet as a surrogate for estimates of emissions for just new motor vehicles and engines. This was appropriate because future projected emissions are uncertain and current emissions data are a reasonable proxy for near-term emissions.

In effect, EPA is using the inventory for the current fleet of motor vehicles as a reasonable surrogate for a projection of the inventory from new motor vehicles over the upcoming years. New motor vehicles are produced year in and year out, and over time the fleet changes over to a fleet composed of such vehicles. This occurs in a relatively short time frame, compared to the time period at issue for endangerment. Because new motor vehicles are produced each year, and continue to emit over their entire life, over a relatively short period of time the emission from the entire fleet is from vehicles produced after a certain date. In addition, the emissions from new motor vehicles are not limited to the emissions that occur only during the one year when they are new, but are emissions over the entire life of the vehicle.

In such cases, EPA has traditionally used the recent emissions from the entire current fleet of motor vehicles as a reasonable surrogate for such a projection instead of trying to project and model those emissions. While this introduces some limited degree of uncertainty, the difference between recent actual emissions from the fleet and projected future emissions from the fleet is not expected to differ in any way that would substantively change the decision made concerning cause or contribution. There is not a specific numerical bright line that must be achieved, and the numerical percentages are not treated and do not need to be treated as precise values. This approach provides a reasonable and clear indication of the relative magnitudes involved, and EPA does not believe that attempting to make future

projections (for both vehicles and the emissions value they are compared to) would provide any greater degree of accuracy or precision in developing such a relative comparison.

ii. The Administrator Did Not Have To Use a Subset or Reduced Emissions Estimate From Existing CAA Section 202(a) Source Categories

Several commenters note that although EPA looks at emissions from all motor vehicles regulated under CAA section 202(a) in its contribution analysis, the Presidential announcement in May 2009 indicated that EPA was planning to regulate only a subset of 202(a) sources. Thus, they question whether the correct contribution analysis should look only at the emissions from that subset and not all CAA section 202(a) sources. Some commenters also argue that because emission standards will not eliminate all greenhouse gas emissions from motor vehicles, the comparison should compare the amount of greenhouse gas emissions ''reduced'' by those standards to the global greenhouse emissions. They also contend that the cost of the new standards will cause individual consumers, businesses, and other vehicle purchasers to hold on to their existing vehicles to a greater extent, thereby decreasing the amount of emissions reductions attributable to the standard and appropriately considered in the contribution analysis. Some commenters go further and contend that EPA also can only include that incremental reduction that the EPA regulations will achieve beyond any reductions resulting from CAFE standards that NHTSA will set.

Although the May announcement and September proposed rule involved only the light duty motor vehicle sector, the Administrator is making this finding for all classes of new motor vehicles under CAA section 202(a). Thus, although the announcement and proposed rule involve light duty vehicles, EPA is working to develop standards for the rest of the classes of new motor vehicles under CAA section 202(a). As the Supreme Court noted, EPA has ''significant latitude as to the manner, timing, content, and coordination of its regulations with those of other agencies. *Massachusetts* v. *EPA,* 549 U.S. at 533.

The argument that the Administrator can only look at that portion of emissions that will be reduced by any CAA section 202(a) standards, and even then only the reduction beyond those attributable to CAFE rules, finds no basis in the statutory language. The language in CAA section 202(a) requires that the Administrator set ''standards applicable to the emission of any air pollutant from [new motor vehicles], which in [her] judgment cause, or contribute to, air pollution which [endangers].'' It does not say set ''standards applicable to the emission of any air pollutant from [new motor vehicles], if in [her] judgment the emissions of that air pollutant as reduced by that standard cause, or contribute to, air pollution which [endangers].'' As discussed above, the decisions on cause or contribute and endangerment are separate and distinct from the decisions on what emissions standards to set under CAA section 202(a). The commenter's approach would improperly integrate these separate decisions. Indeed, because, as discussed above, the Administrator does not have to propose standards concurrent with the endangerment and cause or contribute findings, she would have to be prescient to know at the time of the contribution finding exactly the amount of the reduction that would be achieved by the standards to be set. As discussed above, for purposes of these findings we look at what would be the emissions from new motor vehicles if no action were taken. Current emissions from the existing CAA section 202(a) vehicle fleet are an appropriate estimate.

d. The Administrator Reasonably Compared CAA Section 202(a) Source Emissions to Both Global and Domestic Emissions of Well-Mixed Greenhouse Gases

EPA received many comments on the appropriate comparison(s) for the contribution analysis. Several commenters argue that in order to get around the ''problem'' of basing an endangerment finding upon a source category that contributes only 1.8 percent annually to global greenhouse gas emissions, EPA inappropriately also made comparisons to total U.S. greenhouse gas emissions. These commenters argue that a comparison of CAA section 202(a) source emissions to U.S. greenhouse gas emissions, versus global emissions, is arbitrary for purposes of the cause or contribute analysis, because it conflicts with the Administrator's definition of ''air pollution,'' as well as the nature of global warming. They note that throughout the Proposed Findings, the Administrator focuses on the global nature of greenhouse gas. Thus, they continue, while the percentage share of motor vehicle emissions at the U.S. level may be relevant for some purposes, it is irrelevant to a finding of whether these emissions contribute to the air pollution, which the Administrator has proposed to define on a global rather than a domestic basis. Commenters also accuse EPA of arbitrarily picking and choosing when it takes a global approach (*e.g.,* endangerment finding) and when it does not (*e.g.,* contribution findings).

The language of CAA section 202(a) is silent regarding how the Administrator is to make her contribution analysis. While it requires that the Administrator assess whether emission of an air pollutant contributes to air pollution which endangers, it does not limit *how* she may undertake that assessment. It surely is reasonable that the Administrator look at how CAA section 202(a) source category emissions compare to global emissions on an absolute basis, by themselves. But the United States as a nation is the second largest emitter of greenhouse gases. It is entirely appropriate for the Administrator to decide that part of understanding how a U.S. source category emitting greenhouse gases fits into the bigger picture of global climate change is to appreciate how that source category fits into the contribution from the United States as a whole, where the United States as a country is a major emitter of greenhouse gases. Knowing that CAA section 202(a) source categories are the second largest emitter of well-mixed greenhouse gases in the country is relevant to understanding what role they play in the global problem and hence whether they ''contribute'' to the global problem. Moreover, the Administrator is not ''picking and choosing'' when she applies a global or domestic approach in these Findings. Rather, she is looking at both of these emissions comparisons as appropriate under the applicable science, facts, and law.

e. The Amount of Well-Mixed Greenhouse Gas Emissions From CAA Section 202(a) Sources Reasonably Supports a Finding of Contribution

Many commenters argue that the ''cause or contribute'' prong of the Proposal's endangerment analysis fails to satisfy the applicable legal standard, which requires more than a minimal contribution to the ''air pollution reasonably anticipated to endanger public health or welfare.'' They contend that emissions representing approximately four percent of total global greenhouse gas emissions are a minimal contribution to global greenhouse gas concentrations.

EPA disagrees. As stated above, CAA section 202(a) source category total emissions of well-mixed greenhouse gases are higher than most countries in the world; countries that the U.S. and others believe play a major role in the

global climate change problem. Moreover, the percent of global well-mixed greenhouse gas emissions that CAA section 202(a) source categories represent is higher than percentages that the EPA has found contribute to air pollution problems. *See Bluewater Network,* 370 F.3d at 15 (''For Fairbanks, this contribution was equivalent to 1.2 percent of the total daily CO inventory for 2001.'') As noted above, there is no bright line for assessing contribution, but as discussed in the Proposed Findings and above, when looking at a global problem like climate change, with many sources of emissions and no dominating sources from a global perspective, it is reasonable to consider that lower percentages contribute than one may consider when looking at a local or regional problem involving fewer sources of emissions. The Administrator agrees that ''[j]udged by any standard, U.S. motor-vehicle emissions make a meaningful contribution to greenhouse gas concentrations and hence, * * * to global warming.'' *Massachusetts v. EPA,* 549 U.S. at 525.

VI. Statutory and Executive Order Reviews

A. Executive Order 12866: Regulatory Planning and Review

Under Executive Order (EO) 12866 (58 FR 51735, October 4, 1993), this action is a ''significant regulatory action'' because it raises novel policy issues. Accordingly, EPA submitted this action to the Office of Management and Budget (OMB) for review under EO 12866 and any changes made in response to Office of Management and Budget (OMB) recommendations have been documented in the docket for this action.

B. Paperwork Reduction Act

This action does not impose an information collection burden under the provisions of the Paperwork Reduction Act, 44 U.S.C. 3501 *et seq.* Burden is defined at 5 CFR 1320.3(b). These Findings do not impose an information collection request on any person.

C. Regulatory Flexibility Act

The Regulatory Flexibility Act (RFA) generally requires an agency to prepare a regulatory flexibility analysis of any rule subject to notice and comment rulemaking requirements under the Administrative Procedure Act or any other statute unless the agency certifies that the rule will not have a significant economic impact on a substantial number of small entities. Small entities include small businesses, small organizations, and small governmental jurisdictions.

For purposes of assessing the impacts of this action on small entities, small entity is defined as: (1) A small business as defined by the Small Business Administration's (SBA) regulations at 13 CFR 121.201; (2) a small governmental jurisdiction that is a government of a city, county, town, school district, or special district with a population of less than 50,000; and (3) a small organization that is any not-for-profit enterprise which is independently owned and operated and is not dominant in its field.

Because these Findings do not impose any requirements, the Administrator certifies that this action will not have a significant economic impact on a substantial number of small entities. This action does not impose any requirements on small entities. The endangerment and cause or contribute findings do not in-and-of-themselves impose any new requirements but rather set forth the Administrator's determination on whether greenhouse gases in the atmosphere may reasonably be anticipated to endanger public health or welfare, and whether emissions of greenhouse gases from new motor vehicles and engines contribute to this air pollution. Accordingly, the action affords no opportunity for EPA to fashion for small entities less burdensome compliance or reporting requirements or timetables or exemptions from all or part of the Findings.

D. Unfunded Mandates Reform Act

This action contains no Federal mandates under the provisions of Title II of the Unfunded Mandates Reform Act of 1995 (UMRA), 2 U.S.C. 1531–1538 for State, local, or tribal governments or the private sector. The action imposes no enforceable duty on any State, local or tribal governments or the private sector. Therefore, this action is not subject to the requirements of sections 202 or 205 of the UMRA.

This action is also not subject to the requirements of section 203 of UMRA because it contains no regulatory requirements that might significantly or uniquely affect small governments. This finding does not impose any requirements on industry or other entities.

E. Executive Order 13132: Federalism

This action does not have federalism implications. Because this action does not impose requirements on any entities, it will not have substantial direct effects on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government, as specified in Executive Order 13132. Thus, Executive Order 13132 does not apply to this action.

F. Executive Order 13175: Consultation and Coordination With Indian Tribal Governments

This action does not have tribal implications, as specified in Executive Order 13175 (65 FR 67249, November 9, 2000). This action does not have substantial direct effects on one or more Indian tribes, on the relationship between the Federal Government and Indian tribes, or on the distribution of power and responsibilities between the Federal Government and Indian tribes, nor does it impose any enforceable duties on any Indian tribes. Thus, Executive Order 13175 does not apply to this action.

G. Executive Order 13045: Protection of Children From Environmental Health Risks and Safety Risks

EPA interprets EO 13045 (62 FR 19885, April 23, 1997) as applying only to those regulatory actions that concern health or safety risks, such that the analysis required under section 5–501 of the EO has the potential to influence the regulation. This action is not subject to EO 13045 because it does not establish an environmental standard intended to mitigate health or safety risks. Although the Administrator considered health and safety risks as part of these Findings, the Findings themselves do not impose a standard intended to mitigate those risks.

H. Executive Order 13211: Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution, or Use

This action is not a ''significant energy action'' as defined in Executive Order 13211 (66 FR 28355 (May 22, 2001)), because it is not likely to have a significant adverse effect on the supply, distribution, or use of energy because it does not impose any requirements.

I. National Technology Transfer and Advancement Act

Section 12(d) of the National Technology Transfer and Advancement Act of 1995 (''NTTAA''), Public Law 104–113, 12(d) (15 U.S.C. at 272 note) directs EPA to use voluntary consensus standards in its regulatory activities unless to do so would be inconsistent with applicable law or otherwise impractical. Voluntary consensus

standards are technical standards (*e.g.,* materials specifications, test methods, sampling procedures, and business practices) that are developed or adopted by voluntary consensus standards bodies. NTTAA directs EPA to provide Congress, through OMB, explanations when the Agency decides not to use available and applicable voluntary consensus standards.

This action does not involve technical standards. Therefore, EPA did not consider the use of any voluntary consensus standards.

J. Executive Order 12898: Federal Actions To Address Environmental Justice in Minority Populations and Low-Income Populations

Executive Order (EO) 12898 (59 FR 7629, Feb. 16, 1994) establishes federal executive policy on environmental justice. Its main provision directs federal agencies, to the greatest extent practicable and permitted by law, to make environmental justice part of their mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority populations and low-income populations in the United States.

EPA has determined that these Findings will not have disproportionately high and adverse human health or environmental effects on minority or low-income populations because it does not affect the level of protection provided to human health or the environment. Although the Administrator considered climate change risks to minority or low-income populations as part of these Findings, this action does not impose a standard intended to mitigate those risks and does not impose requirements on any entities.

K. Congressional Review Act

The Congressional Review Act, 5 U.S.C. 801 *et seq.,* as added by the Small Business Regulatory Enforcement Fairness Act of 1996, generally provides that before a rule may take effect, the agency promulgating the rule must submit a rule report, which includes a copy of the rule, to each House of the Congress and to the Comptroller General of the United States. EPA will submit a report containing this rule and other required information to the U.S. Senate, the U.S. House of Representatives, and the Comptroller General of the United States. This action is not a ''major rule'' as defined by 5 U.S.C. 804(2). This rule will be effective January 14, 2010.

Dated: December 7, 2009.

Lisa P. Jackson,

Administrator.

[FR Doc. E9–29537 Filed 12–14–09; 8:45 am]

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Reconsideration of 2009 Endangerment Finding and Greenhouse Gas Vehicle Standards

Draft Regulatory Impact Analysis

United States Environmental Protection Agency

Reconsideration of 2009 Endangerment Finding and Greenhouse Gas Vehicle Standards

Draft Regulatory Impact Analysis

Office of Transportation and Air Quality
U.S. Environmental Protection Agency

NOTICE

This technical report does not necessarily represent final EPA decisions or positions. It is intended to present technical analysis of issues using data that are currently available. The purpose in the release of such reports is to facilitate the exchange of technical information and to inform the public of technical developments.

EPA United States Environmental Protection Agency

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Table of Contents

1 Introduction

This Draft Regulatory Impact Analysis (DRIA) contains an analysis of projected impacts for the proposed removal of all U.S. Environmental Protection Agency (EPA) greenhouse gas (GHG) standards for light-duty (LD), medium-duty (MD) and heavy-duty vehicles (HD) and HD engines as outlined in the preamble to the *Federal Register* notice associated with this document in accordance with Executive Orders (E.O.) 12866 and 13563. As stated in the preamble for this rule, the EPA recognizes that there have been a number of significant changes since we issued the spring 2024 rulemakings for the Light- & Medium-Duty Vehicle Multipollutant final rule (LMDV)[1] and the Heavy-Duty Vehicle GHG Phase 3 final rule (HD GHG Phase 3)[2] which impact the technical assessment in those two actions, including, but not limited to, the EPA's 2024 assessment of program costs and benefits. Some of the assumptions we no longer believe are appropriate and would significantly impact the costs and benefits of this proposed rule include, but are not limited to:

- The impact and existence of electric vehicle (EV) related tax credits and other subsidies from the 2022 Inflation Reduction Act (IRA) which have been changed by the 2025 One Big Beautiful Bill (OBBB);
- The impact of the EPA's waiver rule of California's Advanced Clean Truck (ACT) regulation that has been disapproved under the Congressional Review Act (CRA) and is no longer in force;
- Changes in consumers' interest in purchasing EVs;
- Recent projections of future gasoline and diesel prices from the U.S. Energy Information Administration (EIA) as well as changes in Administration and policies; and
- Changes in the power generation sector as a result of recent projections for data center demands and changes in the OBBB, and the impacts of increased use of EVs.

This document contains discussions of some of the key assumptions that supported the technical analysis contained in the LMDV and HD GHG Phase 3 rulemakings (2024 vehicle rulemakings), and how those assumptions may be different today. Specifically:

- Chapter 2 summarizes information which has become available since the spring of 2024 regarding changes in consumers' and commercial purchasers' interest in batteryEVs (BEVs), as well as recent third-party studies' assessments of how changes in policies may impact the U.S. EV market;
- Chapter 3 discusses recent projections in gasoline and diesel fuel prices and compares those projections to the data the EPA used in the 2024 vehicle rulemakings;
- Chapter 4 discusses the projections the EPA made regarding the power generation sector changes needed to support the increased electrification of the vehicle fleet estimated in the 2024 vehicle rulemakings, and how those projections may change in light of more recent information; and

[1] 89 FR 27842 (Apr. 18, 2024) "Multi-Pollutant Emissions Standards for Model Years 2027 and Later Light-Duty and Medium-Duty Vehicles."
[2] 89 FR 29440 (Apr. 22, 2024) "Greenhouse Gas Emissions Standards for Heavy-Duty Vehicles-Phase 3."

- Chapter 5 discusses existing literature on how LD consumers value savings due to fuel saving technology and the EPA's treatment of fuel savings in previous rulemakings.

In recognition of these and other changes since the 2024 vehicle rulemakings, in Chapter 6 the EPA presents the estimated impacts of removing the GHG standards from LD, MD, and HD vehicles and HD engines. These results are estimated using two different methodologies and a total of seven different modeled scenarios. One method uses the same models and tools used to estimate the impacts of the 2024 vehicle rulemakings. We present five scenarios using these models and tools: 1) impacts using the same assumptions as the 2024 vehicle rulemakings; 2) impacts assuming the removal of IRA tax credits and the ACT rule; 3) impacts assuming the removal of those policies as well as reduced fuel prices; 4) impacts of scenario 2 accounting only for the first two and half years of fuel savings; and 5) impacts of scenario 3 accounting only for the first two and half years of fuel savings. More information on these scenarios is contained in Appendix A. The second method describes and presents two scenarios that attempt to capture some of the multiple opportunity costs created by the LD, MD, and HD GHG standards using a revealed preference approach to estimate the costs and benefits of this proposed action. Appendix B contains more information on this method, as well as on the aggregate reduced form representations of consumer behavioral responses and shifts in related markets. More information on this method is contained Appendix B.

Chapter 7 contains our analysis of small business entities that are subject to the LD, MD, and HD GHG emission standards and related regulations we propose to remove.

2 Changes in assumptions related to customers' interest in purchasing electric vehicles

There is indication that consumer/purchaser demand for LD, MD, and HD EVs has decreased below the levels projected in the 2024 vehicle rulemakings. Recent uncertainty related to the continued existence of tax credits established by the IRA have also led to reduced projections of demand for these EVs.

For LD vehicles, a recent survey from the American Automobile Association (AAA) representing the U.S. population indicates that fewer adults in 2024 reported they were "likely" to purchase a BEV compared to the previous year.[3] The reasons cited include many of the same issues consumers have historically been concerned with: high purchase price, high battery maintenance costs, and range concerns. Other concerns cited include lower gas prices, an increasingly uncertain future of EV incentives, and politics. A survey from JD Power representing U.S. consumers planning to buy or lease a vehicle in the next year indicates that the percent of vehicle shoppers who are at least somewhat interested in buying an EV in early 2025 is the same as a year ago, and that EV sales have increased compared to last year – potentially due to concerns about the EV tax credit being

[3] Moye, B. (2025). AAA: Americans Slow to Adopt Electric Vehicles. *American Automobile Association*: https://newsroom.aaa.com/2025/06/aaa-ev-survey/.

eliminated.[4] The survey also indicates that there is continued concern with charging. A Gallup poll from March 2025 indicates that the percentage of Americans who either own or express interest in (seriously considering or might consider) owning an EV declined in 2024 compared to the previous year, and remains steady at the 2024 levels today, though the portion of those who say they are seriously considering purchasing an EV has declined since 2024.[5]

A study from Princeton University's Zero-carbon Energy systems Research and Optimization Laboratory (ZERO Lab) looked at the impact of removing EPA tailpipe emission regulations and the IRA's federal clean vehicle tax credits.[6] They estimate that removing the emission regulations and the tax credits together will reduce the sales of BEVs by about 30 percent in 2027 and 40 percent in 2030, compared to retaining the emission regulations and tax credits. This corresponds to a slower increase in the BEV share of new LD vehicle sales, reducing the BEV share by approximately five percentage points in 2026 (to about 13 percent), and by approximately 14 percentage points in 2030 (to about 24 percent). The study also estimates that planned construction and expansion of EV assembly and battery cell manufacturing as well as existing assembly and manufacturing could be at risk of cancellation or closure.[7]

A recent study by the Salata Institute for Climate and Sustainability at Harvard University estimated the effect of a set of EV policy change scenarios on LD vehicles, including removing the IRA tax credits, terminating the waiver that allows California to set tighter emissions standards, and withholding the remaining unspent funds in the National Electric Vehicle Infrastructure (NEVI) Formula Program, as well as a series of combining different policies. [8] They find that all three scenarios, as well as the combination of different scenarios, lead to a reduction in the EV share of new vehicles sold. They also find that eliminating the EV tax credits for consumers buying new and used vehicles has the biggest effect on EV sales in the single scenarios they analyzed, reducing the EV share of new vehicle sales in 2030 by 6 percentage points.

For MD and HD vehicles, California's ACT and Advanced Clean Fleet (ACF) rules were expected to provide regulatory drivers for the production of HD zero EVs (ZEVs) and the purchase of HD ZEVs. Congress' decision under the CRA to disapprove the EPA's waiver for ACT, and California's January 2025 decision to withdraw the waiver request for ACF, ended both of those programs.

In recent discussions between the EPA and HD industry stakeholders, the HD original equipment manufacturers (OEMs) indicated that, while they still believe that HD ZEVs will continue to grow and they continue to invest in HD ZEVs, they expect the pace of growth to be significantly slower than

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[4] Thomhave, K. (2025). Consumers sustain interest in EVs but range anxiety still a concern. *Automotive Dive*: https://www.automotivedive.com/news/jd-power-ev-sales-consumer-interest-strong/748924/;J.D. Power. (2025). EV Purchase Consideration Holds Steady amid Market Uncertainty, J.D. Power Finds: https://www.jdpower.com/business/press-releases/2025-us-electric-vehicle-consideration-evc-study.

[5] Saad, L. (2025). U.S. Electric Vehicle Interest Steady at Lower 2024 Level. *Gallup*: https://news.gallup.com/poll/658964/electric-vehicle-interest-steady-lower-2024-level.aspx.

[6] Jenkins, J. (2025). Potential Impacts of Electric Vehicle Tax Credit Repeal on US Vehicle Market and Manufacturing. *Princeton University ZERO* Lab: https://doi.org/10.5281/zenodo.15001498.

[7]Domonoske, C. (2025). The fate of the EV tax credits depends on the GOP's megabill. *National Public* Radio: https://www.npr.org/2025/06/03/nx-s1-5414604/ev-tax-credits-republican-bill.

[8] The Salata Institute for Climate and Sustainability at Harvard University. (2025). Quantifying Trump's impacts on EV adoption: https://salatainstitute.harvard.edu/quantifying-trumps-impacts-on-ev-adoption/

they projected just a few years ago, and OEMs continue to lower projected EV sales volumes for model years (MYs) 2025 and later. OEMs suggest there is a range of reasons for lower EV demand, including higher purchase prices leading to unfavorable total cost of ownership, charging infrastructure limitations, current performance limitations of EV technology for many HD truck applications, supply chain uncertainty, potential changes in IRA incentives, and the lack of California's ACT and ACF programs.

A recent market update report from CALSTART supported the expectation of slower ZEV growth for much of the HD market.[9] CALSTART notes that zero emission truck (ZET) deployments have grown steadily since 2022, but there was a relative slowdown in the first six months of 2024. CALSTART states that the lack of growth can be attributed to many of the same reasons stated above, including high upfront costs and financing costs, underdeveloped private and public infrastructure, and policy uncertainty. They also note that though more MD and HD ZEVs were deployed in 2024 compared to 2023, these deployments were concentrated in a handful of states, and the ZEV share of new MD and HD registrations decreased from 2023. Furthermore, CALSTART showed that much of the ZEV deployments were concentrated in California or other states that adopted the ACT program. It is unclear if ZEV deployment will continue at the same level in those states without the regulatory driver of the ACT and ACF rules.

3 Estimates of future gasoline and diesel prices due to the change in Administration and related policies

Predicting future gasoline and diesel prices, specifically 10 – 15 years or more in the future, is difficult due to high uncertainty. Historically, the EPA has used the EIA's Annual Energy Outlook (AEO) to determine future gasoline and diesel prices for rulemaking. Due to unforeseen changes, including, but not limited to: (1) changes in U. S.' policies; (2) international incidents (e.g., wars); (3) changes in policies by international organizations (e.g., OPEC); and (4) changes in supply and demand of gasoline and diesel.

The 2024 vehicle rulemakings relied on the AEO assessment from the EIA for fuel prices. Specifically, we used the most recent version available at the time, AEO 2023, to project future fuel prices in those rules.[10] The AEO 2023 "Reference case" included considerations of the IRA as well as the EPA GHG and National Highway Traffic Safety Administration's (NHTSA) Corporate Average Fuel Economy (CAFE) standards that were in place at the time. EIA recently released the AEO 2025, which includes significant updates to the Reference case, as well as an alternative analysis for the transportation sector.

[9] Richard, J. (2025). Zeroing in on Zero-Emission Trucks: June 2025 Market Update. *CALSTART*: https://calstart.org/wp-content/uploads/2025/05/ZIO-ZET-June.pdf.
[10] U.S. Energy Information Administration. (2023). Annual Energy Outlook 2023: https://www.eia.gov/outlooks/archive/aeo23/.

The Reference case for AEO 2025 continues to include the IRA, as well as California's ACT program and the 2024 EPA vehicle rulemakings.[11] AEO 2025 also includes an alternative case, called the "Alternative Transportation case", in which California's ACT, the EPA's 2024 vehicle rulemakings, and NHTSA's 2024 final rule for CAFE standards for model years 2027-2032 are not in place. In addition, the AEO 2025 Alternative Transportation case also models a slower growth for IRA credit eligibility than the AEO 2025 Reference case.

In Figure 1, we compare the gasoline and diesel fuel prices for the three AEO scenarios:

- **AEO 2023 Reference case** used in the 2024 EPA vehicle rulemakings, which did not include California's ACT program or the rulemakings finalized by the EPA in 2024
- **AEO 2025 Reference case** that includes California's ACT program and the EPA's 2024 rulemakings
- **AEO 2025 Alt Transportation case** that removes the impacts of California's ACT program, the EPA's 2024 vehicle rulemakings, and NHTSA's 2024 CAFE rule, and lessens the growth of eligibility for IRA credits compared to the AEO 2025 Reference case

AEO 2023 prices are presented in 2022 dollars (2022$), and AEO 2025 prices are in 2024 dollars (2024$). The AEO 2025 prices shown in the chart below were converted to 2022$ by applying a multiplier of 0.942.[12]

[11] U.S. Energy Information Administration. (2025). Annual Energy Outlook 2025: https://www.eia.gov/outlooks/aeo/.

[12] U.S. Department of Congress, Bureau of Economic Analysis. (Last modified July 7, 2025). National GDP & Personal Income: https://www.bea.gov/itable/national-gdp-and-personal-income. See National Income and Product Accounts, Section 1 – Domestic Product and Income, Table 1.1.9. Implicit Price Deflators for Gross Domestic Product.

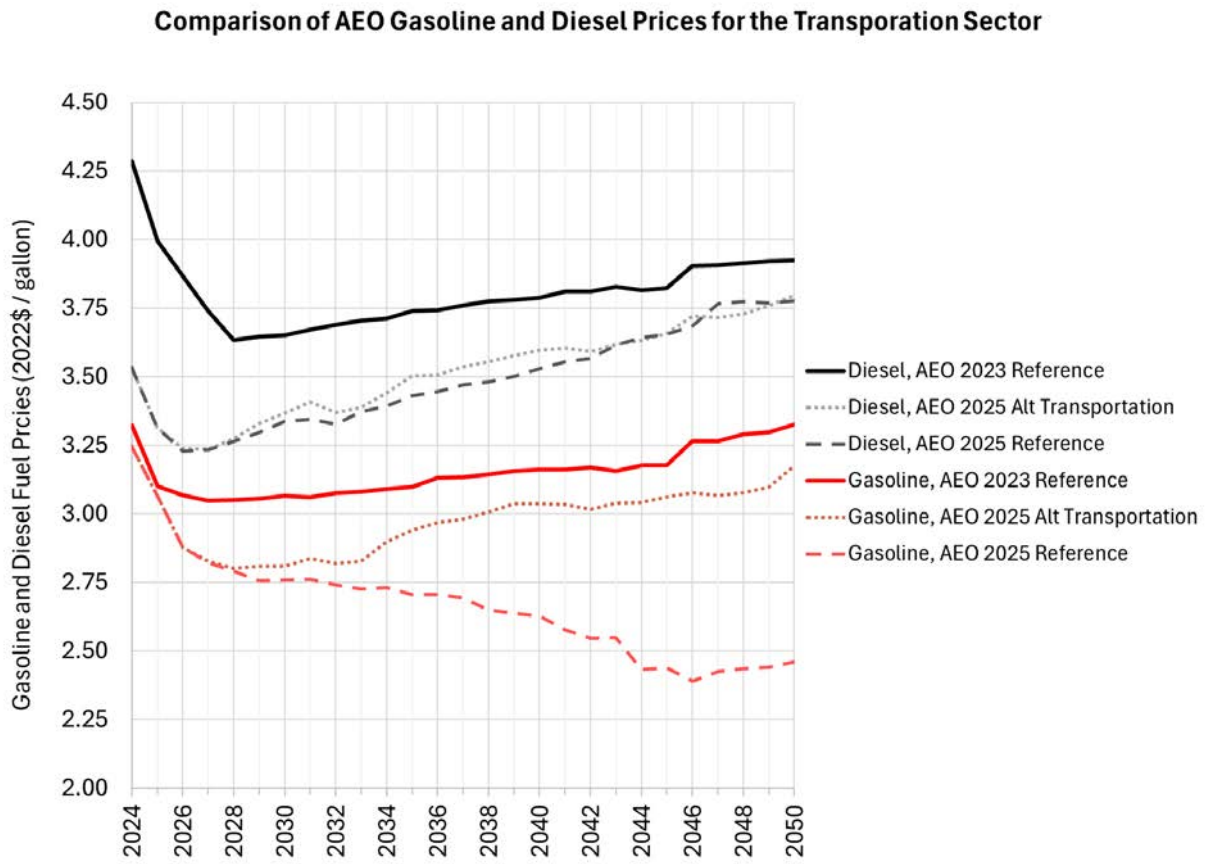

Figure 1: Comparison of AEO 2023 and AEO 2025 Fuel Prices (2022$).

Summary of Gasoline Price Projections

As shown in Figure 1, the AEO 2025 Reference price for gasoline fuel is significantly lower than AEO 2023, and the difference grows over time. In 2027, AEO 2025 Reference price is approximately $0.23/gallon lower than AEO 2023, and that difference grows to $0.49/gallon in 2038, and $0.87 in 2050. However, it does not appear that AEO 2025 took into account the policies being implemented by President Trump that are intended to drive down the price of gasoline and diesel.

For the AEO 2025 Alternative Transportation case, the difference compared to AEO 2023 is smaller, yet still lower than the prices in the AEO 2023, and the difference remains relatively stable over time. In 2027, the AEO 2025 Alternative Transportation price is $0.22/gallon lower than AEO 2023, and that difference shrinks to $0.14/gallon in 2038, and $0.15/gallon in 2050.

In general, the updated AEO 2025 projected gasoline fuel prices are lower than AEO 2023, which means for an individual vehicle owner, we would expect lower fuel savings from the purchase of a BEV compared to the savings projected by the EPA in its analysis for the 2024 vehicle rulemakings, all other things held equal.

Summary of Diesel Price Projections

As can be seen in Figure 1, the AEO 2025 Reference price for diesel fuel is lower than AEO 2023, and the difference shrinks over time. In 2027, AEO 2025 Reference diesel price is $0.51/gallon lower than AEO 2023, and that difference shrinks to $0.29/gallon in 2038, and $0.15/gallon in 2050.

The AEO 2025 Alternative Transportation case price projections for diesel fuel are similar to the AEO 2025 Reference case, though a little higher for most years. Therefore, the AEO 2025 Alternative Transportation case diesel price projections compared to AEO 2023 are also lower in each calendar year, though the difference is slightly smaller than the AEO 2025 Reference case. In 2027, the AEO 2025 Alternative Transportation case price is $0.50/gallon lower than AEO 2023, and that difference shrinks to $0.22/gallon in 2038, and $0.13 in 2050.

In general, the updated AEO 2025 projected diesel fuel prices are lower than AEO 2023. The lower AEO 2025 projected diesel fuel prices means that for an individual vehicle owner or operator, we would expect lower fuel savings from the purchase of a BEV compared to the EPA analysis performed for the 2024 vehicle rulemakings, all other things held equal. The lower projected diesel fuel prices in AEO 2025 for calendar years 2027 through 2055 would lengthen the payback periods for HD BEVs compared to the analysis done to support the HD GHG Phase 3 rule. A longer payback period could reduce the purchaser demand for EVs from the commercial vehicle sector.

For these reasons and others, we included a fuel price sensitivity assessment which examines the impact lower fuel prices have on some program costs and benefits. Specifically, we examine a $1.00/gallon lower gasoline cost and a $0.25/gallon lower diesel cost as compared to the AEO 2023 gasoline reference fuel cost. This assessment is summarized in chapter 6 of this document, with more details presented in Appendix A.3 and A.4.

4 Impact of EVs on the power generation sector and major changes since the 2024 vehicle rulemakings

Since the EPA issued the 2024 vehicle rulemakings, there have been two significant changes as they relate to the power generation sector. There has been a significant increase in the projected growth of electricity demand for artificial intelligence (AI) data centers, and the 2022 IRA solar and wind tax incentives have been repealed in OBBB.

The analysis used for the 2024 vehicle rulemakings included projections for all necessary increases in capacity and associated costs. These costs were included in the projected retail price of electricity, which included the costs of electricity generating unit (EGU) builds, EGU retrofits, EGU retirements, increased transmission capacity, and necessary upgrades to the distribution system to accommodate direct current (DC) fast charging for LD, MD, and HD plug-in EV (PEV) applications.[13] This was modeled utilizing the "EPA's Power Sector Modeling Platform Post-IRA 2022 Reference case using the Integrated Planing Model (IPM)."[14] IPM provides projections of least-cost capacity expansion, electricity dispatch, and emission control strategies for meeting energy demand and

[13] LMDV Regulatory Impact Analysis (RIA), Chapter 5: https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P1019VPM.pdf

[14] U.S. Environmental Protection Agency. (Last updated Mar. 19, 2025). Power Sector Post-IRA 2022 Reference Case: https://www.epa.gov/power-sector-modeling/post-ira-2022-reference-case.

environmental, transmission, dispatch, and reliability constraints represented within 67 regions of the 48 contiguous U.S. However, IPM does not account for difficulties in permitting for either EGUs or transmission lines.

The final LD and MD were anticipated to increase electricity generation by less than one percent in 2030, and by approximately 7.6 percent by 2050. When combined with anticipated demand from HD applications, electricity generation was anticipated to increase by 11.6 percent by 2050.[15]

The IPM analysis within the RIA for 2024 vehicle rulemakings estimated that higher levels of PEV adoption would result in an incremental increase in demand for electricity, which in turn resulted in improving economics for existing thermal resources such as coal-fired EGUs. This, in turn, resulted in fewer projected retirements at those facilities over the analysis period.[16] This analysis was predicated on demand data from AEO 2023, which in turn was calibrated to conditions as of 2022, and included full implementation of the IRA.

Electricity rates for the 2024 vehicle rulemakings were estimated from IPM results using the Retail Price Model.[17,18] The Retail Price Model showed a trend of reduced electricity rates through 2050 despite an increase in electricity demand through 2050. Increased costs due to increased generation and transmission capacity were more than offset by a shift towards renewables and increased grid battery storage from power sector tax incentives within the RIAs. The Retail Price Model projected higher national average electricity rates in 2050 due to the 2024 vehicle rulemakings of approximately 2.5% (approximately $0.0025 per kilowatt-hour (kWh)).

Since the 2024 vehicle rulemakings were finalized in the spring of 2024, there has been a significant change in the forecasts of electricity demand. According to the 2024 North American Electric Reliability Corporation (NERC) Long Term Reliability Assessment,[19] in 2022 the projected compound annual growth rate for summer peak demand over the ten-year period 2022-2031 was estimated to be 0.65%. In the latest available assessment, the ten-year compound annual growth rate for summer peak demand over the 2025-34 period is estimated to be 1.67%. This more than 2.5-fold increase in projected growth rates is driven primarily by increasing amounts of large commercial and industrial loads, particularly those related to data center demand for AI applications. These higher levels of demand significantly improve the market fundamentals of existing firm dispatchable capacity and reduce the likelihood of thermal resource retirement. Moreover, this demand growth significantly outweighs the level of incremental electricity demand from LD, MD, and HD PEV charging projected by the adoption of LMDV and HD GHG Phase 3 standards.

Furthermore, the passage of OBBB will also have important impacts on the power sector – notably, the phase-out of tax subsidies to wind and solar resources will likely reduce incremental builds of

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[15] LMDV RIA, https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P1019VPM.pdf.
[16] LMDV RIA, Chapter 5, https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P1019VPM.pdf.
[17] ICF. 2019. "Documentation of the Retail Price Model." ICF Contract Report to the U.S. EPA.
[18] LMDV RIA, Chapter 5, https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P1019VPM.pdf.
[19] North American Electric Reliability Corporation. (2024, updated July 15, 2025). December 2024 Long-Term Reliability Assessment:
https://www.nerc.com/pa/RAPA/ra/Reliability%20Assessments%20DL/NERC_Long%20Term%20Reliability%20Assessment_2024.pdf.

these technologies particularly after 2028. This, in turn, will further strengthen the relative economics of existing thermal resources, resulting in fewer retirements and therefore dampening the impact of LMDV and HD GHG Phase 3 on the power sector. Finally, higher levels of demand, particularly for around-the-clock power required for data centers, will likely further improve the outlook for thermal resources and reduce incentives for retirement. Collectively, these changes – including rescinding LD, MD, and HD GHG standards – would reflect a net improvement to energy and capacity markets for thermal resources. These changes may also be anticipated to impact the year-over-year reductions in the retail price of electricity forecast within the 2024 RIAs; however, the EPA did not perform the additional analysis that would be needed to determine the impacts on the retail price of electricity for this assessment for this proposal. The EPA expects to consider this further at the final rule stage.

Considering the need to meet this higher level of demand mainly driven by data centers, managing ongoing thermal retirements, and the need for additional transmission and resource development, NERC concludes that critical reliability challenges are facing the sector. No longer requiring compliance with LD, MD, and HD GHG standards would reduce the overall demand for electricity, which in turn may incrementally improve the reliability outlook for the sector. However, the impact of reducing demand from PEV charging is likely to be small in comparison to the impact from increased data center demand. For example, in 2030, PEV charging demand from all vehicle categories will be reduced by approximately 64 terawatt-hour (TWh)[20] compared to new demand from data centers of approximately 600 TWh.[21,22]

5 How do car and light truck buyers value improved fuel economy?

How potential buyers value improvements in the fuel economy of new cars and light trucks is an important issue in assessing the benefits and costs of government regulation. As noted in the Office of Management and Budget (OMB) Circular A-4 (2003),[23] "individual preferences of the affected population should be a guiding principle in the regulatory analysis." If buyers fully value the savings in fuel costs that result from higher fuel economy, manufacturers will presumably supply any improvements that buyers demand, and vehicle prices will fully reflect future fuel cost savings consumers would realize from owning—and potentially reselling—more fuel-efficient models.

If consumers internalize fuel savings in this case, more stringent fuel economy standards will impose net costs on vehicle owners and can only result in social benefits through correcting externalities, because consumers would already fully incorporate private savings into their

[20] Sherwood, T. (2025). Vehicle Rule LD/MD/HD Physical Effects.
[21] U.S. Department of Energy (2025). Resource Adequacy Report Evaluating the Reliability and Security of the United States Electric Grid: https://www.energy.gov/sites/default/files/2025-07/DOE%20Final%20EO%20Report%20%28FINAL%20JULY%207%29.pdf.
[22] North American Electric Reliability Corporation. (Last updated July 2025). 2023 and 2024 NERC Electricity Supply & Demand database: https://www.nerc.com/pa/RAPA/ESD/pages/default.aspx.
[23] Office of Management and Budget. (2003). Circular A-4: Regulatory Analysis: https://obamawhitehouse.archives.gov/omb/circulars_a004_a-4.

purchase decisions, as discussed further below. If instead consumers systematically undervalue the cost savings generated by improvements in fuel economy when choosing among competing models due to some market failure such as an information asymmetry that leads to an underinvestment in fuel-saving technology, then more stringent fuel economy standards will lead manufacturers to adopt improvements in fuel economy that buyers might not choose despite the cost savings they offer and thus improve consumer welfare.

The potential for car buyers to voluntarily forego improvements in fuel economy that offer savings exceeding their initial costs is one example of what is often termed the “energy efficiency gap.” The topic of the "energy efficiency gap" or “energy efficiency paradox” has been extensively discussed in previous analyses of vehicle GHG standards, including the 2024 LMDV final rule RIA. The appearance of such a gap, between the level of energy efficiency that would minimize consumers’ overall expenses and what they actually purchase, is typically based on engineering calculations that compare the initial cost for providing higher energy efficiency to the discounted present value of the resulting savings in future energy costs.

There has long been an active debate about why such a gap might arise and whether it actually exists (Klemick and Wolverton, 2025).[24] Economic theory predicts that individuals will purchase more energy-efficient products only if the savings in future energy costs they offer promise to offset their higher initial costs. However, the additional up-front cost of a more energy-efficient product includes more than just the cost of the technology necessary to improve its efficiency; because consumers have a scarcity of resources, it also includes the opportunity cost of any other desirable features that consumers give up when they choose the more efficient alternative. In the context of vehicles, whether the expected fuel savings outweigh the opportunity cost of purchasing a vehicle offering higher fuel economy will depend, among other things, on how much its buyer expects to drive, their expectations about future fuel prices, the discount rate they use to value future expenses, the expected effect on resale value, and whether more efficient models offer equivalent attributes such as performance, carrying capacity, reliability, quality, or other characteristics.

Historically, the published literature has offered little consensus about consumers’ willingness to pay for greater fuel economy, and whether it implies over-, under- or full-valuation of the expected discounted fuel savings from purchasing a model with higher fuel economy. Most studies have relied on car buyers’ purchasing behavior to estimate their willingness to pay for future fuel savings. Traditionally the approach was to use “discrete choice” models that relate cross-sectional data on individual buyers’ choices among competing vehicles to their purchase prices, fuel economy, and other attributes (such as performance, carrying capacity, and reliability), and to infer buyers’ valuation of higher fuel economy from the relative importance of purchase prices and fuel economy.[25] Empirical estimates using this approach span a wide range, extending from substantial undervaluation of fuel savings to significant overvaluation, thus making it difficult to draw solid conclusions about the influence of fuel economy on vehicle buyers’ choices (e.g., Helfand and

[24] Klemick, H., and Wolverton, A. (2025). The Energy-Efficiency Gap in Encyclopedia of Energy, Natural Resource, and Environmental Economics. 2nd Edition. *Elsevier Academic Press*: https://doi.org/10.1016/B978-0-323-91013-2.00033-2

[25] In a typical vehicle choice model, the ratio of estimated coefficients on fuel economy—or more commonly, fuel cost per mile driven—and purchase price is used to infer the dollar value buyers attach to slightly higher fuel economy.

Wolverton, 2011 and Greene, 2010).[26,27] Because a vehicle's price is often correlated with its other attributes (both measured and unobserved), analysts have often used instrumental variables or other approaches to address endogeneity and other resulting concerns (e.g., Berry et al., 1995).[28]

More recent research has criticized these cross-sectional studies; some have questioned the effectiveness of the instruments they use (Allcott and Greenstone, 2012)[29], while others have observed that coefficients estimated using non-linear statistical methods can be sensitive to the optimization algorithm and starting values (Knittel and Metaxoglou, 2014)[30]. Collinearity (i.e., high correlations) among vehicle attributes—most notably among fuel economy, performance or power, and vehicle size—and between vehicles' measured and unobserved features also raises questions about the reliability and interpretation of coefficients that may conflate the value of fuel economy with other attributes (Leard et al., 2023; [31] Sallee et al., [32] 2016; Busse et al., 2013;[33] Allcott and Wozny, 2014;[34] Allcott and Greenstone, 2012; Helfand and Wolverton, 2011).

In an effort to overcome shortcomings of past analyses, more recent studies have relied on panel data from sales of individual vehicle models to improve their reliability in identifying the association between vehicles' prices and their fuel economy (Leard et al., 2023; Sallee et al., 2016; Allcott and Wozny, 2014; Busse et al., 2013). Although they differ in certain details, each of these analyses relates changes over time in individual models' selling prices to fluctuations in fuel prices, differences in their fuel economy, and increases in their age and accumulated use, which affects their expected remaining life and thus their market value. Because a vehicle's future fuel costs are a function of both its fuel economy and expected gasoline prices, changes in fuel prices have different effects on the market values of vehicles with different fuel economy; comparing these effects over time and among vehicle models reveals the fraction of changes in fuel costs that is reflected in changes in their selling prices (Allcott and Wozny, 2014). Using very large samples of sales enables these studies to define vehicle models at an extremely disaggregated level, which enables their authors to isolate differences in their fuel economy from the many other attributes, including those that are difficult to observe or measure, that affect their sale prices.[35] These studies

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[26] Helfand, G., and Wolverton, A. (2011). Evaluating the Consumer Response to Fuel economy: A Review of the Literature. *International Review of Environmental and Resource Economics,* 5: 103-146.
[27] Greene, D. (2010). How Consumers Value Fuel Economy: A Literature Review. EPA-420-R-10-008.
[28] Berry, S. et al.. (1995). Automobile Prices in Market Equilibrium. *Econometrica,* 63(4): 841-890.
[29] Allcott, H., and Greenstone, M. (2012). Is There an Energy Efficiency Gap*? Journal of Economic Perspectives,* 26(1): 3-28.
[30] Knittel, C., and Metaxoglou, K. (2014). Estimation of Random-Coefficient Demand Models: two Empiricists' Perspectives. *Review of Economics and Statistics,* 96(1): 34-59.
[31] Leard, B. et al.. (2023). How Much Do Consumers Value Fuel Economy and Performance? Evidence from Technology Adoption. *Review of Economics and Statistics,* 105(1): 158–174.
[32] Sallee, J. et al..(2016). Do Consumers Recognize the Value of Fuel Economy? Evidence from Used Car Prices and Gasoline Price Fluctuations. *Journal of Public Economics,* 135: 61-73.
[33] Busse, M. R. et al.. (2013). Are Consumers Myopic? Evidence from New and Used Car Purchases. *American Economic Review*, 103(1): 220– 256.
[34] Allcott, H., and Wozny, N. (2014). Gasoline Prices, Fuel Economy, and the Energy Paradox. *Review of Economics and Statistics,* 96(5): 779– 795.
[35] These studies rely on individual vehicle transaction data from dealer sales and wholesale auctions, which include actual sale prices and allow their authors to define vehicle models at a highly disaggregated level. For

point to a somewhat narrower range of estimates than suggested by previous cross-sectional studies; more importantly, ***they consistently suggest that buyers value a large proportion—and perhaps even all—of the future savings that models with higher fuel economy offer***.[36]

Because they rely on estimates of fuel costs over vehicles' expected remaining lifetimes, these studies' estimates of how buyers value fuel economy are sensitive to the strategies they use to isolate differences among individual models' fuel economy, as well as to their assumptions about buyers' discount rates and gasoline price expectations, among others. Since Anderson et al. (2013)[37] found evidence that consumers expect future gasoline prices to resemble current prices, the EPA uses this assumption to compare the findings of the three studies and examine how their findings vary with the discount rates buyers apply to future fuel savings.[38]

As Table 1 indicates, for discount rates of five to six percent, the Busse et al. (2013) results imply that vehicle prices reflect 60 to 100 percent of future fuel costs. Allcott and Wozny (2014) found that consumers incorporate 55 percent of future fuel costs into vehicle purchase decisions at a six percent discount rate, when their expectations for future gasoline prices are assumed to reflect prevailing prices at the time of their purchases. With the same expectation about future fuel prices, the authors report that consumers would fully value fuel costs only if they apply discount rates of 24 percent or higher. However, these authors' estimates are closer to full valuation when using

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instance, Allcott and Wozny (2014) differentiate vehicles by manufacturer, model or nameplate, trim level, body type, fuel economy, engine displacement, number of cylinders, and "generation" (a group of successive model years during which a model's design remains largely unchanged). All three studies include transactions only through mid-2008 to limit the effect of the recession on vehicle prices. To ensure that the vehicle choice set consists of true substitutes, Allcott and Wozny (2014) define the choice set as all gasoline-fueled light-duty cars, trucks, SUVs, and minivans that are less than 25 years old (i.e., they exclude vehicles where the substitution elasticity is expected to be small). Sallee et al. (2016) exclude diesels, hybrids, and used vehicles with less than 10,000 or more than 100,000 miles.

[36] Killian and Sims (2006) and Sawhill (2008) rely on similar longitudinal approaches to examine consumer valuation of fuel economy except that they use average values or list prices instead of actual transaction prices. Since these studies remain unpublished, their empirical results are subject to change, and they are excluded from this discussion.

[37] Anderson, S.T. et al.. (2013). What do consumers believe about future gasoline prices? *Journal of Environmental Economics and Management,* 66(3): 383-403.

[38] Each of the studies makes slightly different assumptions about appropriate discount rates. Sallee et al. (2016) use five percent in their base specification, while Allcott and Wozny (2014) rely on six percent. As some authors note, a five to six percent discount rate is generally consistent with observed interest rates on car loans, but they also acknowledge that borrowing rates could be higher in some cases, which could be used to justify higher discount rates. Rather than assuming a specific discount rate, Busse et al. (2013) and Leard et al. (2023) directly estimate implicit discount rates at which future fuel costs would be fully internalized; Busse et al. (2013) find discount rates of six to 21 percent for used cars and one to 13 percent for new cars at assumed demand elasticities ranging from -2 to -3. Leard et al. (2023) finds implied discount rates of 10 and 12 percent using an assumed demand elasticity of -2 and -3, respectively. Their estimates can be translated into the percent of fuel costs internalized by consumers, assuming a particular discount rate. To make the Busse et al. (2013) results more directly comparable to the other studies, we assume a range of discount rates and uses the authors' spreadsheet tool to translate their results into the percent of fuel costs internalized into the purchase price at each rate. Because Busse et al. (2013) estimate the effects of future fuel costs on vehicle prices separately by fuel economy quartile, these results depend on which quartiles of the fuel economy distribution are compared; our summary shows results using the full range of quartile comparisons.

gasoline price forecasts that mirror oil futures markets, because the petroleum market expected prices to fall during this period (this outlook reduces the discounted value of a vehicle's expected remaining lifetime fuel costs). With this expectation, Allcott and Wozny (2014) found that buyers value 76 percent of future cost savings (discounted at six percent) from choosing a model that offers higher fuel economy, and that a discount rate of 15 percent would imply that they fully value future cost savings. Sallee et al. (2016) begins with the perspective that buyers fully internalize future fuel costs into vehicles' purchase prices and cannot reliably reject that hypothesis; their base specification suggests that changes in vehicle prices incorporate slightly more than 100 percent of changes in future fuel costs. Leard et al.'s (2023) preferred estimate implies that consumers only internalize 55 percent of changes in future fuel costs when assuming a real discount rate of 1.3 percent and that fuel prices will follow a random walk (i.e., current prices are a prediction of future prices). When they adopt similar assumptions to Busse et al. (2013) for vehicle miles traveled (VMT) and scrappage rates, they find that consumers valued 73 percent of future fuel costs. As Table 1 suggests, higher private discount rates move all the estimates closer to full valuation or to over-valuation, while lower discount rates imply less complete valuation in all four studies.

Table 1: Percent of Future Fuels Costs Internalized in Car and Light-Truck Purchase Prices

Authors (Pub. Date)	**Future fuel price assumption**	**Vehicles Type**	**Discount rate assumption**			
			1 - 3%	**5%**	**6% -7%**	**10%**
Busse et al. (2013)	Gasoline price at time of sale	New and used cars & light trucks	54-87%	60-96%	62-100%	73-117%
	24-month gasoline price futures		71-103%	78-114%	81-119%	96-139%
Allcott & Wozny (2014)	Gasoline price at time of sale	Used cars & light trucks	48%		55%	65%
	Oil futures-based forecast		67%		76%	87%
Sallee et al. (2016)	Gasoline price at time of sale	Used cars & light trucks		101%		142%
Leard et al (2023)	Gasoline price at time of sale	New cars & light trucks	54-73%	69%	77%	
	AEO projected gasoline price		57%			

*Note: The ranges in the Busse et al. (2013) estimates depend on which quartiles of the fuel economy distribution are compared. With no prior on which quartile comparison to use, this analysis presents the full quartile comparison range.

The studies also explore the sensitivity of the results to other parameters that could influence their results. Busse et al. (2013) and Allcott and Wozny (2014) find that relying on data that suggest lower annual vehicle use or survival probabilities, which imply that vehicles will not last as long, moves their estimates closer to full valuation, an unsurprising result because both reduce the changes in

expected future fuel costs caused by fuel price fluctuations. Allcott and Wozny's (2014) base results rely on an instrumental variables estimator that groups miles per gallon (MPG) into two quantiles to mitigate potential attenuation bias due to measurement error in fuel economy, but they find that greater disaggregation of the MPG groups implies greater undervaluation (for example, it reduces the 55 percent estimated reported in Table 1 to 49 percent). Busse et al. (2013) allow gasoline prices to vary across local markets in their main specification; using national average gasoline prices, an approach more directly comparable to the other studies, results in estimates that are closer to or above full valuation. Sallee et al. (2016) find modest undervaluation by vehicle fleet operators or manufacturers making large-scale purchases, compared to retail dealer sales (i.e., 70 to 86 percent).

Only Busse et al. (2013) and Leard et al. (2023) examine new vehicle sales; Busse et al (2013) find that consumers value between 75 to 129 percent of future fuel costs for new vehicles, while Leard et al. (2023) find they value between 54 and 77 percent, depending on the discount rate assumed. Allcott and Wozny (2014) examine how their estimates vary by vehicle age and find that fluctuations in purchase prices of younger vehicles imply that buyers whose fuel price expectations mirror the petroleum futures market value a higher fraction of future fuel costs: 93 percent for one- to three-year-old vehicles, compared to 76 percent for all used vehicles assuming the same price expectation.[39] Allcott and Wozny (2014) and Sallee et al. (2016) also find that future fuel costs for older vehicles are substantially undervalued (26-30 percent).

The empirical literature finds evidence that manufacturers invest in performance instead of improved fuel economy when standards remain unchanged (Leard et al., 2023; Klier and Linn, 2016;[40] Knittel, 2011[41]). Thus, in addition to understanding how consumers value changes in fuel economy, it is important to account for the value they place on changes in performance at the margin. Explicitly accounting for the tradeoff between fuel economy and performance, Leard et al. (2023) find that consumers are willing to pay about three times as much for improved performance than a comparable fuel economy increase. Taken together, they calculate that a one percent

[39] The pattern of results in Allcott and Wozny (2014) for different vehicle ages is similar when they use retail transaction prices (adjusted for customer cash rebates and trade-in values) instead of wholesale auction prices, although the degree of valuation falls substantially in all age cohorts with the smaller, retail price based sample.

[40] Klier, T., and Linn, J. (2016). Technological Change, Vehicle Characteristics and the Opportunity Costs of Fuel Economy Standards. *Journal of Public Economics,* 133: 41–63.

[41] Knittel, C. (2011). Automobiles on Steroids: Product Attribute Tradeoffs and Technological Progress in the Automobile Sector. *American Economic Review*, 101: 368–3399.

improvement in fuel economy slightly reduces consumer welfare, holding all other vehicle attributes constant, despite undervaluation of fuel economy.[42,43,44,45]

Some commenters on previous rules have taken issue with the EPA's characterization of the literature on the value of fuel economy, citing the Agency's previous determination that the estimates in the literature represented too large a range, and the degree of uncertainty made including a value of fuel economy challenging, while other commenters have agreed with the EPA's characterization. But what analysts assume about consumers' vehicle purchasing behavior, particularly about potential buyers' perspectives on the value of increased fuel economy, clearly matters in the context of benefit-cost analysis for any regulation that affects fuel economy. Considering the recent evidence on this question, a more nuanced approach than merely assuming that buyers drastically undervalue benefits from higher fuel economy, (and that, as a consequence, these benefits are unlikely to be realized without stringent fuel economy standards) seems warranted.

Empirical results that find consumers internalize 100 percent of changes in future fuel costs means that consumers are already fully incorporating private fuel savings into their purchase decisions. Under this case, a finding based on engineering calculations that the initial cost of requiring higher energy efficiency is less than the discounted present value of future energy cost savings is suggestive of missing or misspecified costs or consumer preferences in the analysis. Use of that framework to project purchase decisions would then be likely to provide results inconsistent with expectations about real world outcomes.

One approach to addressing such gaps is to incorporate additional or refined aspects of the tradeoffs being considered by consumers and/or improved reflections of their preferences into the calculations. However, many of these aspects are not directly observable and can be challenging to robustly represent and parameterize in a model. An alternative approach is to adjust the value consumers place on the private fuel savings in the modeling such that projected purchase decisions match available evidence and expectations. Under this approach, the value of private fuel savings considered by consumers in the modeling reflects their willingness to pay for the increase in energy efficiency adjusted for potentially missing costs or consumer preferences.

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[42] Allcott, H. and Knittel, C. (2019). Are Consumers Poorly Informed about Fuel Economy? Evidence from Two Experiments. *American Economic Journal: Economic Policy,* 11(1): 1 – 37.

[43] This finding is consistent with other recent work by Allcott and Knittel (2019). They find that experiments designed to overcome possible consumer inattention and imperfect information in new car buyers result in little additional uptake of fuel economy. They conclude that one must either point to some other market or behavioral failure to justify increasingly stringent fuel economy standards or that the large net private benefits projected by recent regulatory analyses do not exist. "The latter possibility would arise if the [regulatory analyses] engineering models did not account for the full fixed costs, production costs, or performance reductions from fuel economy-improving technologies."

[44] Watten, A., and Anderson, S. (2025). Attribute Production and Biased Technical Change in Automobiles. *National Bureau of Economic Research* Working Paper, #33979: https://www.nber.org/system/files/working_papers/w33979/w33979.pdf .

[45] Recent, still unpublished work by Watten and Anderson (2025) finds that the tradeoff between fuel economy and performance may have fallen over time.

Manufacturers have consistently told the Agency that new vehicle buyers will pay for about two or three years' worth of fuel savings before the price increase associated with providing those improvements begins to affect sales. In public comments on the Safer Affordable Fuel-Efficient Vehicle Rule proposed by NHTSA and the EPA in 2018 (SAFE rule),[46] the National Automobile Dealers Association (NADA), the Alliance of Automobile Manufacturers (Alliance), and American Fuel and Petrochemical Manufacturers (AFPM) argued that CAFE/carbon dioxide (CO_2) standards have already reached the point where the price increases necessary to recoup manufacturers' increased costs for providing further increases in fuel economy outweigh the value of fuel savings, and requiring further increases in fuel economy will reduce new vehicle sales.[47] The modeling conducted for the scenarios in Appendix A assumes that the value consumers are willing to pay for fuel economy improvements is equal to the savings from the first 2.5 years of reduced fuel costs in all components of the analysis that reflect consumer decisions regarding LD and MD vehicle purchases and retirements.[48] More specifically, this analysis explicitly assumes that: 1) consumers are willing to pay for fuel economy improvements that pay back within the first 2.5 years of vehicle ownership (at average usage rates); 2) manufacturers know this and will provide these improvements even in the absence of regulatory pressure; 3) consumers weigh these savings against increases in new vehicle prices when deciding whether to purchase a vehicle; 4) vehicle performance is held constant (i.e., the potential to enhance performance even further in lieu of investing in fuel economy is not accounted for);[49] and 5) the amount of technology for which buyers will pay fluctuates with fluctuating fuel prices.

One interpretation of these specifications, and in particular the assumption that consumers only value 2.5 years of fuel savings, is that consumers significantly undervalue the private fuel savings in their purchase decisions. In which case, some of the additional fuel savings beyond the 2.5 years should be incorporated into the benefit cost analysis. However, based on evidence from recent studies that use a rich panel of individual transaction data, several of these assumptions, or that interpretation, seem implausible. Another interpretation is that consumers fully internalize changes in future fuel costs and the value of 2.5 years of fuel savings approximates consumers' willingness to pay for the increase in fuel economy adjusted for potentially missing costs or consumer preferences. In which case, the benefit cost analysis should focus on that estimate of willingness to pay for changes in fuel savings.

6 Summary of results

As discussed in the introduction, there have been many changes to the underlying assumptions used for the 2024 rulemakings. These changes impact all aspects of the 2024 RIAs and thus the EPA cannot rely upon those previous assessments to confidently and appropriately quantify or

[46] 83 FR 42986; Aug. 24, 2018.
[47] *See* NADA, NHTSA-2018-0067-12064 at 11; Auto Alliance, Full Comment Set, NHTSA-2018-0067-12073 at 163-64; AMFP, Comments, NHTSA-2018-0067-12078-29 at 3.
[48] When accounting for social benefits and costs associated with an alternative, the full lifetime value of fuel savings is included.
[49] Recent, still unpublished work by Watten and Anderson (2025) notes that holding vehicle attributes fixed may overstate technology costs since they find evidence that downsizing is a much cheaper alternative to a technology-only response to meeting abatement requirements.

monetize many of the impacts from this proposed action. Reflecting these uncertainties, the EPA has estimated the impacts of removing the GHG standards from LD, MD, and HD vehicles and HD engines using two different modeling methodologies, resulting in seven different modeled scenarios. The details for the first method (and scenarios one through five) are presented in Appendix A. The details for the second method (and scenarios six and seven) are presented in Appendix B.

The first method uses the same models and tools used to estimate the regulatory impacts presented in the 2024 RIAs. For this proposal, we estimate impacts under five different scenarios using these tools. The first scenario contains all the same assumptions and inputs as presented in the 2024 RIAs. The second scenario estimates the impacts of removing the IRA and the ACT rule. Recognizing the significant uncertainties related to future gasoline and diesel prices, the third scenario considers lower fuel prices, in addition to the removal of IRA and the ACT rule. All other assumptions and inputs are the same as those used in the 2024 RIAs. The fourth and fifth scenarios build on the second and third scenarios, respectively, accounting for only the first 2.5years of fuel savings in estimating the net monetized impact of this proposed rule.

The first scenario shows the impacts of rescinding the GHG standards for LD, MD, and HD vehicles result in an estimated net cost of about $260 billion over 2027 through 2055 discounted at a 3 percent discount rate, or $26 billion discounted at a 7 percent discount rate. This is associated with an annualized value of about $13 billion per year or $2.1 billion dollars per year, respectively.

Removing IRA tax credits and the ACT rule result in higher estimated net societal costs associated with rescinding GHG standards for LD, MD, and HD vehicles compared to when the policies are in place. The estimated net costs under this second scenario are about $350 billion over 2027 through 2055 at a three percent discount rate, or $52 billion discounted at a 7 percent rate. These are associated with annualized values of about $18 billion per year and $4.1 billion per year, respectively. This change is largely driven by higher fuel consumption and associated fuel costs, which is greater than the reduction in vehicle technology costs. Both increased fuel consumption and technology costs are consistent with the expected impact of the removal of IRA credits and the ACT program. Removing both of these impacts led to reduced penetration of BEVs in the action case (i.e., without any GHG standards), while having relatively little impact on BEV penetration in the no action case (i.e., where BEV adoption is driven by Federal GHG standards). However, it is important to note that these results should be considered with some question, given the potential change in future product offerings, including the potential restriction or elimination of sales of higher GHG emitting gasoline and diesel vehicles, which firms may need to do to ensure compliance with the vehicle GHG standards in the absence of the significant incentives included in the 2022 IRA – effects which we have not captured in our modeling assessment. Specifically, as discussed in more detail in Appendix A, the EPA's modeling of the LD vehicle market showed the industry was not able to comply with the MY 2032 CO_2 standard in the absence of IRA credits. In addition, as discussed in more detail in Appendix A, for the HD vehicle sector, the EPA's model would not project compliance with the MY 2027 and later CO_2 standards in the absence of IRA credits.

As discussed in Chapter 3, it is likely that diesel and gasoline prices will be lower throughout the analysis period compared to the fuel prices used in the 2024 RIAs. The third scenario builds on the

assumptions in the second scenario and estimates the effects of reducing the AEO 2023 fuel price projections by $0.25 per gallon for diesel and $1.00 per gallon for gasoline. With these lower fuel prices, we estimate a reduction in the net societal costs (i.e., a net benefit) associated with rescinding GHG standards of about $160 billion over 2027 through 2055 at a three percent discount rate, or $18 billion at a seven percent discount rate. These are associated with a decrease in net societal costs of about $9 billion per year or $18 billion per year, respectively. In contrast to the second scenario, results of this scenario are driven primarily by the reduction in vehicle technology costs, which are now only partially offset by the lower increase in fuel costs associated with greater fuel consumption.

As discussed in Chapter 5, there is uncertainty regarding how vehicle purchasers value the fuel savings that result from increased fuel efficiency. To reflect some of this uncertainty, the fourth and fifth scenarios discussed in Appendix A.4 assume consumers' willingness to pay for the changes in fuel economy are consistent with the value of the first 2.5 years of fuel savings in estimating the net monetized impacts of this proposed rule. Both the fourth and the fifth scenarios are estimated assuming no IRA tax credits or ACT rule. The fourth scenario assumes the 2023 AEO prices, as in the second scenario, while the fifth scenario assumes the reduced fuel prices used in the third scenario. The estimates for the fourth scenario result in a reduction in the net societal costs (i.e., a net benefit) associated with rescinding GHG standards of about $380 billion over 2027 through 2055 at a three percent discount rate, or $320 billion at a seven percent discount rate. These are associated with a decrease in net societal costs of about $20 billion per year or $26 billion per year, respectively. The estimates for the fifth scenario result in a reduction in net societal costs of about $490 billion over 2027 through 2055 at a 3 percent discount rate, or $380 billion at a 7 percent discount rate. These are associated with a decrease in net societal costs of about $26 billion per year or $31 billion per year, respectively.

Table 2 and Table 3 show the net present value of the monetized savings, costs, and net savings of the five scenarios discussed above presented at seven and three percent discount rates, respectively.

*Table 2: Monetized Savings, Costs, and Net Savings at 7 Percent Net Present Value (billions of 2022 dollars)**

	2024 LMDV and HDP3 Rule Analysis	2024 LMDV and HDP3 Rule Analysis, no IRA and ACT	2024 LMDV and HDP3 Rule, no IRA and ACT; low liquid fuel prices	2024 LMDV and HDP3 Rule Analysis, no IRA and ACT, 2.5 years of fuel savings	2024 LMDV and HDP3 Rule; no IRA and ACT, low liquid fuel prices, 2.5 years of fuel savings
Savings	$570	$640	$640	$640	$640
Costs	$590	$690	$420	$320	$260
Net Savings	($30)	($50)	$220	$320	$380

*Results may not sum due to rounding.

*Table 3: Monetized Savings, Costs, and Net Savings at 3 Percent Net Present Value (billions of 2022 dollars)**

	2024 LMDV and HDP3 Rule Analysis	2024 LMDV and HDP3 Rule Analysis, no IRA and ACT	2024 LMDV and HDP3 Rule, no IRA and ACT; low liquid fuel prices	2024 LMDV and HDP3 Rule Analysis; no IRA and ACT, 2.5 years of fuel savings	2024 LMDV and HDP3 Rule; no IRA and ACT, low liquid fuel prices, 2.5 years of fuel savings
Savings	$950	$1,030	$1,030	$1,030	$1,030
Costs	$1,210	$1,390	$870	$660	$550
Net Savings	($260)	($350)	$160	$380	$490

*Results may not sum due to rounding.

The second method uses a revealed preference approach to project program savings, costs, and net savings under two additional scenarios. The results under both three and seven percent discount rates are presented in Table 4.

The sixth scenario utilizes vehicle compliance cost values extrapolated from earlier EPA actions. This scenario results in an estimated reduction in the net societal costs (i.e., a net benefit) associated with rescinding GHG standards of about $3,050 billion over 2027 through 2055 at a three percent discount rate, or $1,720 billion at a seven percent discount rate. These are associated with a decrease in net societal costs of about $160 billion per year or $150 billion per year, respectively.

The seventh scenario utilizes market information to project vehicle compliance costs. This scenario results in an estimated reduction in the net societal costs *(i.e.*, a net benefit) associated with rescinding GHG standards of about $8,180 billion over 2027 through 2055 at a three percent discount rate, or $4,660 billion at a seven percent discount rate. These are associated with a decrease in net societal costs of about $440 billion per year or $400 billion per year, respectively. Details on the revealed preference approach and scenarios six and seven are provided in Appendix B.

*Table 4: Revealed Preference Method: Monetized Savings, Costs, and Net Savings (billions of dollars)**

	EPA cost extrapolation, 3% DR	Market Data, 3% DR	EPA cost extrapolation, 7% DR	Market Data, 7% DR
Savings, annualized	$170	$440	$160	$410
Costs, annualized	$8	$5	$7	$5
Net Savings, annualized	$160	$440	$150	$400
Net Savings, NPV	$3,050	$8,180	$1,720	$4,660

*Results may not sum due to rounding.

7 Small Business Analysis

The Regulatory Flexibility Act (RFA), as amended by the Small Business Regulatory Enforcement Fairness Act of 1996 (SBREFA), generally requires an agency to prepare a regulatory flexibility analysis for any rule subject to notice-and-comment rulemaking requirements under the Administrative Procedure Act or any other statute. This requirement does not apply if the agency certifies that the rule will not have a significant economic impact on a substantial number of small entities. This chapter contains an overview of small entities in the LD, MD, and HD vehicle and HD engine markets, and our assessment that the proposed rule would not have a significant impact on a substantial number of small entities.

Under the Regulatory Flexibility Act (5 USC 601 et seq.), a small entity is defined as: (1) a business that meets the definition for small business based on the Small Business Administration's (SBA) size standards; (2) a small governmental jurisdiction that is a government of a city, county, town, school district, or special district with a population of less than 50,000; or (3) a small organization that is any not-for-profit enterprise which is independently owned and operated and is not dominant in its field.

This analysis considers small business entities that are subject to the LD, MD, and HD GHG emission standards and related regulations we propose to remove. Small governmental jurisdictions and small not-for-profit organizations would not be subject to the proposed rule as they have no certification or compliance requirements.

The regulated entities that are subject to the regulations we are proposing to remove in this proposed rule are engine and vehicle manufacturers, alternative fuel converters, and independent commercial importers subject to GHG emissions standards for vehicles. These entities are expected to have registered under NAICS codes shown in Table 5. The small business size standards that qualify the regulated entities as "small entities" are also outlined in Table 5.

Table 5: Primary small business NAICS categories affected by this proposed rule[a]

NAICS Code[b]	NAICS Title	Defined by SBA (3/17/2023) as a small business if less than or equal to:[c]
336110	Automobile and Light-duty Motor Vehicle Manufacturing	1,500 employees
336120	Heavy Duty Truck Manufacturing	1,500 employees
336211	Motor Vehicle Body Manufacturing	1,000 employees
336213	Motor Home Manufacturing	1,250 employees
336310	Motor Vehicle Gasoline Engine and Engine Parts Manufacturing	1,050 employees
336390	Other Motor Vehicle Parts Manufacturing	1,000 employees
333618	Other Engine Equipment Manufacturing	1,500 employees
423110	Automobile and Other Motor Vehicle Merchant Wholesalers	250 employees
811198	All Other Automotive Repair and Maintenance	$10.0 million annual receipts

[a] According to SBA's regulations (13 CFR Part 121), businesses with no more than the listed number of employees or dollars in annual receipts are considered "small entities" for RFA purposes.
[b] NAICS Association. NAICS & SIC Identification Tools: *https://www.naics.com/search*.
[c] U.S. Small Business Administration. (2023). Table of Small Business Size Standards Matched to North American Industry Classification System Codes: https://www.sba.gov/document/support-table-size-standards; pdf version at https://www.sba.gov/sites/default/files/2023-06/Table%20of%20Size%20Standards_Effective%20March%2017%2C%202023%20%282%29.pdf.

All entities, including all small entities, in the three industries (engine and vehicle manufacturers, alternative fuel converters, and commercial importers) are expected to see a decrease in regulatory burden as a result of the proposed action. This action proposes to remove portions of the regulations of the standard-setting parts directly related to GHG emission standards and compliance provisions for implementing the EPA's GHG engine and vehicle programs. We do not anticipate that there would be any significant adverse economic impact on directly regulated small entities as a result of these revisions. Because the proposed action would relieve regulatory burden, creating a benefit for the small entities subject to the current rules, an initial regulatory flexibility analysis of this rule is not required.

An additional benefit of the proposed rule would be to give vehicle buyers, including vehicle buyers that are small entities, more choices and relieve them from unnecessary and sometimes prohibitive regulatory costs that would be built into vehicle prices without this action. This action proposes to achieve this end by removing portions of the regulations of the standard-setting parts directly related to GHG emission standards and compliance provisions that apply to engine and vehicle manufacturers, alternative fuel converters, and independent commercial importers implementing the EPA's GHG engine and vehicle programs. The EPA notes that about 14 million Schedule C businesses own at least one vehicle, with most of those owning two or more. With 285 million vehicles registered nationwide, about 10 percent of those vehicles, if not more, are owned by small businesses. Additional vehicles are owned by non-profits and small for-profit businesses

that do not file Schedule C. If finalized, the savings to these businesses would be substantial, as discussed in Section 6 of this DRIA.

Appendix A: Results using LMDV and HDP3 methodologies

The analyses in this Appendix rely on the same models and tools used to analyze the impacts of the LMDV and HD GHG Phase 3 rules as discussed in the final RIAs for those rules. The assumptions and methodologies can be found in those previously docketed RIAs. We recognize that by using the impact estimates from the prior rules, this analysis does not account for the fact that standards for non-GHGs finalized in the LMDV rule (such as particulate matter ($PM_{2.5}$) and non-methane organic gases plus nitrogen oxides ($NMOG+NO_X$) standards) will remain in place.

Appendix A.1: Results using 2024 LMDV and HDP3 methods and assumptions

The results presented in Table A- 1 are estimated using the same assumptions, methods and tools as used in the analyses for the LMDV and HDP GHG Phase 3 rules, including projections of vehicles, technologies, emission estimates, and fuel prices. These results also include the continued existence IRA tax credits and the California ACT rule as assumed in the rules finalized in 2024.

*Table A- 1: Net monetized impacts of the proposal based on 2024 RIA analyses, including IRA tax credits and the CA ACT rule (billions of 2022 dollars)**

	2055	Present Value at 3%	Present Value at 7%	Annualized Value at 3%	Annualized Value at 7%
Vehicle Technology	$38	$750	$450	$39	$37
Electric Vehicle Supply Equipment & Replacements	$11	$200	$120	$11	$9.5
Fuel, Repair, Maintenance, Insurance, etc.	($140)	($1,100)	($560)	($60)	($45)
Energy Security, Refueling Time, & Drive Value	($7.8)	($70)	($35)	($3.7)	($2.8)
Net Monetized Impacts	($100)	($260)	($26)	($13)	($2.1)

* Positive values reflect savings due to the proposal (i.e., decreases in social costs) while negative values reflect increases in social costs.

For additional information on the development of these values, please see the RIAs developed for the 2024 LMDV and HDP3 final rules.[50]

Appendix A.2: Results from removing IRA tax credits and CA ACT rule

The results in Table A- 2 illustrate the estimated impact of rescinding GHG standards when the IRA tax credits and California ACT program are removed. All other assumptions and inputs remain the

[50] See "Multi-Pollutant Emissions Standards for Model Years 2027 and Later Light-Duty and Medium-Duty Vehicles: Regulatory Impact Analysis", EPA-420-R-24-004, March 2024; and "Greenhouse Gas Emissions Standards for Heavy-Duty Vehicles: Phase 3: Regulatory Impact Analysis, EPA-420-R-24-06, March 2024.

same as those used in the final LMDV and HD GHG Phase 3 rules and in the estimates presented in Table A- 1. The analysis presented below discusses results in comparison to the results the EPA projected in the 2024 LMDV and HDP3 final rules, which included the IRA tax credits and the ACT rule.

For the analysis presented here, we removed the following IRA tax credits after 2025: the credits for purchasing (30D) and leasing (45W) LD and MD battery BEVs, battery production tax credits (45X) for LD, MD, and HD BEVs and HD fuel cell EVs (FCEVs), vehicle purchase tax credits (45W) for HD BEVs and HD FCEVs, and the tax credit for EV supply equipment (EVSE) installation (30C) for HD BEVs. This analysis has some overlap with actions recently signed into law in the OBBB. For example, while the OBBB eliminates the IRA tax credits in 30D, 45W, and 30C, the OBBB modified but did not eliminate the battery production tax credits in 45X.

For purchasers of LD, MD, and HD ZEVs,[51] the removal of the purchasing and leasing credits would lead to higher purchasing costs. For LD, MD, and HD vehicle manufacturers, the removal of the battery tax credits would result in higher manufacturer costs per ZEV. These costs are likely passed on to consumers/purchasers, decreasing the demand for ZEVs compared to a scenario in which the tax credits are in place. HD purchasers also face further increased costs resulting from the removal of the Electric Vehicle Supply Equipment (EVSE) tax credits. Consequently, without the IRA tax credits, LD, MD, and HD purchasers would be less likely to purchase a ZEV due to the higher price.

In this updated analysis, we also removed the impacts of the California ACT rule. We modeled reduced adoption of HD BEVs and FCEVs in California and other states that had adopted ACT, consistent with how we modeled ZEV adoption in non-ACT states in the final HD GHG Phase 3 analysis. In addition, we reduced the long-term adoption of HD BEVs and FCEVs across all states to account for expected lower investment resulting from the repeal of IRA incentives for ZEVs and supporting infrastructure. Altogether, removing the IRA tax credits and the ACT rule leads to reduced estimates of HD ZEV populations in the action case (removing the GHG standards) for this 2025 NPRM alternative analysis.

[51] For the purposes of this discussion, ZEVs refer to LD, MD, and HD BEVs and HD FCEVs.

*Table A- 2: Net monetized impacts of the proposal after removing IRA tax credits and the CA ACT rule (billions of 2022 dollars)**

	2055	Present Value at 3%	Present Value at 7%	Annualized Value at 3%	Annualized Value at 7%
Vehicle Technology	$35	$800	$500	$42	$41
Electric Vehicle Supply Equipment & Replacements	$15	$230	$130	$12	$11
Fuel, Repair, Maintenance, Insurance, etc.	($160)	($1,300)	($650)	($70)	($53)
Energy Security, Refueling Time, & Drive Value	($6.5)	($69)	($36)	($3.6)	($2.9)
Net Monetized Impacts	($110)	($350)	($52)	($18)	($4.1)

* Positive values reflect savings due to the proposal (i.e., decreases in social costs) while negative values reflect increases in social costs.

As shown in Table A- 2, the updated analysis without IRA tax credits and the ACT rule shows an increase in the estimated net societal costs associated with rescinding GHG standards for LD, MD, and HD vehicles of about $350 billion over calendar years 2027 through 2055 at a three percent discount rate. This reflects an increase in net societal costs of about $90 billion compared to the analysis that includes the tax credits and ACT rule, as seen in Table 3 ($260 billion). This change is largely driven by higher fuel consumption and associated fuel costs in the updated analysis ($1,300 billion vs $1,100 billion), which is greater than the reduction in vehicle technology costs (-$800 billion vs $750 billion). Both increased fuel consumption and technology costs are consistent with the expected impact of the removal of IRA credits and the ACT program. Removing both impacts lead to reduced penetration of BEVs in the action case (i.e., without any GHG standards), while having relatively little impact on BEV penetration in the no action case (i.e., where BEV adoption is driven by Federal GHG standards).

In evaluating these results, it is also important to note that in the updated analysis, ***in the absence of IRA credits, the LD industry is not compliant in model year 2032*** where the BEV adoption rate is not sufficient to keep pace with the year-over-year increases in stringency of the GHG standards set in the LMDV rule. As a result, the MY 2032 GHG industry-wide compliance value is approximately 11 percent higher than the GHG target for that year. These results are different from the analysis that includes IRA tax credits in which the LD industry is compliant with the GHG standards in every year. Our modeling projects that the industry does comply with the MY 2033 and later GHG standards as more lead time and continued technology cost reductions allow additional technologies to be considered and purchased by consumers at lower cost, and manufacturers continue to take advantage of GHG averaging, banking, and trading flexibilities.

It is important to note that our modeling does not account for all possible manufacturer compliance strategies which firms may adopt to ensure compliance with the vehicle GHG standards in the absence of the significant incentives included in the 2022 IRA. In reality, non-compliance in 2032 would likely not play out as the model projects. Instead, the LD manufacturers would likely use a variety of strategies that were not included in our modeling. For example, manufacturers might adjust the product mix by limiting vehicle offerings of the highest emitting

vehicles and/or lowering prices of the lowest emitting vehicles. Manufacturers might also generate additional credits in the earlier years to be carried forward to 2032 when the GHG standards are most stringent. We have not modeled the impacts of these alternative compliance approaches, including how limiting or eliminating the sales of the highest emitting vehicles to ensure compliance would impact the automobile companies, automobile workers, dealerships, and consumers; nor have we assessed the program's costs, benefits, and other impacts. Additionally, the model does not account for finance costs or issues with affordability to account for the increased need for sales in earlier years.

Similar to the LD and MD modeling, the HD truck model only evaluates a single compliance strategy in the HD GHG Phase 3 analysis. The HD model uses a technology acceptance model based on payback periods of ZEV technologies.[52] Without IRA tax credits and the California ACT Rule, HD ZEV purchasers would experience longer payback periods for adopting ZEV technologies than modeled in the HD GHG Phase 3 analysis, impacting the acceptance of the technologies in the market. The estimates of average payback period without the IRA tax credits and as estimated in the HD GHG Phase 3 final rule, which includes IRA tax credits are shown in Table A- 3.

Table A- 3: Average payback period (years) of MY 2032 HD ZEVs before and after removal of the IRA tax credits (45X, 45W, and 30C)

	2024 Analysis with IRA Tax Credits	**2025 Analysis without IRA Tax Credits**
Light Heavy-Duty Vocational Vehicles	2	3
Medium Heavy-Duty Vocational Vehicles	3	4
Heavy Heavy-Duty Vocational Vehicles	4	6
Day Cab Tractors	2	5
Sleeper Cab Tractors	5	11

In the analysis that removes the IRA tax credits and California's ACT rule, the longer payback periods of ZEV technologies ***lead the model to project that the HD industry would not be in compliance with the existing MY 2027 through MY 2032 and later standards.*** For this scenario, we did not revise the technology assessment for the no-action case (with standards) and instead assume that HD vehicle purchasers would continue to purchase HD ZEVs under much longer payback periods. It is plausible that what would more likely happen under these circumstances is that manufacturers may restrict sales of higher emitting vehicles or substitute other technologies, such as hybrid vehicles, to comply with the standards. We have not modeled the impacts of how limiting or eliminating the sales of the highest emitting vehicles (in general, gasoline and diesel-fueled vehicles) in order to ensure compliance would impact the HD vehicle manufacturers, HD vehicle workers, dealerships, fleets, and other purchasers; nor have we assessed the impacts on the program's costs, benefits, and other impacts.

[52] Payback period is the amount of time it takes for the lower annual operational costs of a ZEV to offset the higher upfront cost of the ZEV technologies.

Appendix A.3: Impact of reducing fuel prices

In DRIA Chapter 3, we present a range of projected future gasoline and diesel fuel prices comparing AEO 2023 and two scenarios estimated in AEO 2025, as well as a discussion of how these prices relate to the fuel prices used in the 2024 vehicle rulemaking analyses. The results presented in Table A- 4 contain the same assumptions as those in Table A- 2 (namely, they do not include the IRA tax credits or the ACT rule), with the exception of fuel prices. For this scenario, we reduced the AEO 2023 fuel price projections by $0.25 per gallon for diesel and $1.00 per gallon for gasoline. With these lower fuel costs, we estimate a decrease in the estimated net societal costs associated with rescinding GHG standards for LD, MD, and HD vehicles of about $160 billion over calendar years 2027 through 2055 at a three percent discount rate. Unlike the results using AEO 2023 fuel prices shown in Table A- 2, the combined reduction in vehicle technology costs – $800 billion – and EVSE costs – $230 billion – now exceeds the increase in fuel costs – $820 billion. We note that we did not model potential impacts that lower fuel prices would have on manufacturer decisions for vehicle technologies, nor did we model how lower fuel prices would affect consumer demand and manufacturer decisions which might lead to a different mix of vehicle models, technology adoption, and BEV penetration. The results shown in Table A- 4 were developed using the same fleet of new vehicles that were estimated for Table A- 2. In other words, the differences from Table A- 2 are solely the result of differences in owning and operating vehicles over their lifetimes, and not the result of differences in new vehicle production.

*Table A- 4: Net monetized impacts of the proposal after removing IRA tax credits and the CA ACT rule and using lower projected fuel prices (billions of 2022 dollars)**

	2055	Present Value at 3%	Present Value at 7%	Annualized Value at 3%	Annualized Value at 7%
Vehicle Technology	$35	$800	$500	$42	$41
Electric Vehicle Supply Equipment & Replacements	$15	$230	$130	$12	$11
Fuel, Repair, Maintenance, Insurance, etc.	($110)	($820)	($390)	($43)	($32)
Energy Security, Refueling Time, & Drive Value	($5.1)	($55)	($28)	($2.8)	($2.3)
Net Monetized Impacts	($66)	$160	$220	$9	$18

* Positive values reflect savings due to the proposal (i.e., decreases in social costs) while negative values reflect increases in social costs.

Appendix A.4: Impact of accounting for 2.5 years of fuel savings

DRIA Chapter 5 presents a summary of literature on how consumers value future fuel costs at the time of vehicle purchase. As discussed, some of these studies suggest that that buyers may fully value the future fuel cost savings from a vehicle with improved fuel economy, in which case the entire benefit from private fuel savings is incorporated in the buyers' purchase decisions. Other studies suggested buyers do not fully value the future fuel cost savings from improved fuel

economy, and only part of the private future fuel savings would be incorporated into the purchase decision. In this section, we present the monetized net impacts of this proposed action under the assumption that consumers' willingness to pay for the change in fuel economy is consistent with the fuel cost impacts during the first 2.5 years after new vehicle purchase. To estimate the results accounting for only the first 2.5 years of fuel savings, we scale the fuel cost impacts from scenarios 2 and 3 using an estimate of the portion ofVMT in the first 2.5 years of the full vehicle life. For this analysis, we use the vehicle mileage accumulation assumptions used in our effects modeling. For the average LD and MD vehicle, about 21 percent of driving occurs during the first 2.5 years of vehicle life, whereas for HD vehicles, this value is about 20 percent. For the results presented in this section, we represent 2.5 years of fuel costs by scaling the combined lifetime fuel costs of LD, MD, and HD vehicles estimated in scenarios 2 and 3 by 21 percent.

Appendix A.4.1 Accounting for 2.5 years of fuel savings using AEO 2023 fuel prices

The results presented in Table A- 5 are based on the same modeling as Table A- 2 (no IRA tax credits or ACT rule), with the exception that for this estimate, fuel cost impacts are scaled to 21 percent of the full lifetime values. We estimate a decrease of about $380 billion in net societal costs over calendar years 2027 through 2055 at a three percent discount rate. This societal cost savings is greater than the $160 billion estimate shown in Table A- 2 due to the smaller costs related to lost fuel savings due to this proposal compared to scenario 2.

*Table A- 5: Net monetized impacts of the proposal after removing IRA tax credits and the CA ACT rule, with 2.5 years of lifetime fuel costs (billions of 2022 dollars)**

	2055	**Present Value at 3%**	**Present Value at 7%**	**Annualized Value at 3%**	**Annualized Value at 7%**
Vehicle Technology	$35	$800	$500	$42	$41
Electric Vehicle Supply Equipment & Replacements	$15	$230	$130	$12	$11
Fuel, Repair, Maintenance, Insurance, etc.	-$78	-$590	-$280	-$31	-$23
Energy Security, Refueling Time, & Drive Value	-$6.5	-$69	-$36	-$3.6	-$2.9
Net Monetized Impacts	-$34	$380	$320	$20	$26

* Positive values reflect savings due to the proposal (i.e., decreases in social costs) while negative values reflect increases in social costs.

Appendix A.4.2 Accounting for 2.5 years of fuel savings using reduced fuel prices

Table A- 6 is based on the same modeling as Table A- 5, with the additional assumption that future fuel prices will be lower than the projections in AEO 2023. As with scenario 3 (Table A- 4), this scenario reduces the AEO 2023 fuel price projections by $0.25 per gallon for diesel and $1.00 per

gallon for gasoline. In this scenario, we estimate that the removal of GHG standards will result in a decrease of about $490 billion in net societal cost over calendar years 2027 through 2055 at a three percent discount rate.

*Table A- 6: Net monetized impacts of the proposal after removing IRA tax credits and the CA ACT rule and using lower projected fuel prices, with 2.5 years of lifetime fuel costs (billions of 2022 dollars)**

	2055	**Present Value at 3%**	**Present Value at 7%**	**Annualized Value at 3%**	**Annualized Value at 7%**
Vehicle Technology	$35	$800	$500	$42	$41
Electric Vehicle Supply Equipment & Replacements	$15	$230	$130	$12	$11
Fuel, Repair, Maintenance, Insurance, etc.	($69)	($490)	($230)	($26)	($19)
Energy Security, Refueling Time, & Drive Value	($5.1)	($55)	($28)	($2.8)	($2.3)
Net Monetized Impacts	($25)	$490	$380	$26	$31

* Positive values reflect savings due to the proposal (i.e., decreases in social costs) while negative values reflect increases in social costs.

Appendix B: Results using a revealed preference approach

A. Key facts pointing toward enormous costs of compliance with the 2024 rules

Key facts point to enormous compliance costs and the need for a more market-oriented approach to assessing costs and benefits. Overall, these analyses further support the reasonableness of the proposed rule and the unreasonableness of the existing rule.

The approaches in this Appendix emphasize revealed preference, particularly when assessing the per-vehicle costs of tighter emissions standards. They all share the same framework – a "derived demand" representation of the markets for vehicles. They differ in terms of which of two data sources are used to quantify the willingness of consumers to accept EVs instead of vehicles powered with internal combustion engines (ICE vehicles). One source is an earlier EPA rulemaking. The alternative source is an investigation of inter-manufacturer regulatory credit trades by the White House Council of Economic Advisers (CEA) in connection to the SAFE rule.

The estimates here differ markedly from those in the 2021 rule (86 FR 74434) and, especially, the 2024 vehicle rulemakings. Except where specifically indicated in what follows, all of the deviations between this DRIA's estimates and the 2024 vehicle rulemaking RIAs are due to the EPA's assumptions related to supply, demand, incentives, and market equilibrium. The accuracy of previous assumptions about links between worldwide emissions and future climate bears little relationship to the fact that these are proper ingredients of benefit-cost analysis.

1. Market size and importance

A key economic fact about the U.S. market for LD vehicles is its sheer size. Sixteen million new vehicles are sold annually, with consumers spending almost $800 billion on them. The consumer value created significantly exceeds expenditures, reflecting substantial consumer surplus. That is, cars and light trucks offer more than transportation—they deliver freedom, mobility, and reliability. For many Americans, obtaining a driver's license remains one of life's most memorable milestones.

Beyond fuel efficiency, vehicle buyers value affordability, safety, reliability, driving performance, and much more. All this points to the fact that a government-driven radical transformation of the market would be enormously costly. The price tag—likely in the hundreds of billions annually and thereby several trillion in net present value—cannot be justified without demonstrating even greater benefits. Conversely, any benefit-cost analysis that acknowledges costs of only a few percent of revenue is detached from the realities of the American vehicle market and the reasons consumers choose to own cars and light trucks.

Although less personal, MD and HD vehicle markets nonetheless deliver consumer surplus by enabling businesses to provide a range of goods and services at prices and locations that better appeal to consumers.

2. The indirect and incidental relationship between "emissions standards" and market wide emissions

A key economic fact about the 2021 and 2024 vehicle rulemakings is they rewarded the sale of EVs while penalizing the sale of ICE vehicles, rather than penalizing vehicle owners in proportion to the fossil fuels that they burn. That is, the link between the rules' economic incentives and total emissions from regulated-vehicle markets is indirect and incidental.

Under the 2021 and 2024 LD vehicle rules, the market wide sales-weighted average of regulatory coefficients must be less than the EPA's target. The regulatory coefficients, expressed in grams per mile, are assigned by the rules according to laboratory test-cycle measurements for various vehicle designs. The average for a particular manufacturer in a particular segment (by footprint, car versus truck) may exceed the target, but the manufacturer must ultimately compensate by falling short of the target in other segments or purchasing credits from another manufacturer with an average below the target.[53]

The regulatory coefficient applicable to a particular vehicle's sale is not connected to the fossil fuels used by that vehicle after it leaves the showroom. Two vehicles with the same regulatory coefficient can result in vastly different fossil-fuel usage. One may be driven intensely for decades, while the other is put on display in a museum never to be driven again. One may primarily carry light payloads on highway trips, while the other primarily carries heavy payloads between intra-city destinations. Among a pair of EVs, one may primarily be charged from a grid particularly reliant on coal-fired power plants while the other is charged in a nuclear-intensive grid.

In addition, the regulatory coefficients only count tailpipe emissions, whereas, from the perspective of climate change, there is little difference between a ton of emissions from a tailpipe and a ton emitted upstream at electric power plants.[54] ICE vehicles and EVs are completely different in terms of the distribution of their emissions between tailpipe and power plant. Indeed, the regulatory coefficient for EVs was set to zero by the 2021 and 2024 vehicle rulemakings. These are all reasons why, from an economic perspective, the 2021 and 2024 vehicle rulemakings should be understood as incentivizing EV sales and only indirectly and incidentally incentivizing reduced GHG emissions.

A reliable economic analysis must also recognize that fossil fuels are traded in a world-wide market. The majority of fossil fuel use, even within the U. S., occurs outside the jurisdiction of the EPA vehicle-emissions rules. Through market forces, discouraging fossil fuel use by U.S. vehicles will encourage additional fossil fuel use elsewhere in the U.S. and world economies. Transportation might shift from cars to short-haul air travel with higher emissions per passenger mile. It may shift from trucks to railroad or ships that partially offset the reduce emissions from trucks.[55] Through international trade, the U.S. economy might substitute toward more urban-intensive industries that

[53] This occurs through the EPA's Averaging, Banking, and Trading program, which also allows for deviations from the target in a particular year to be offset by opposite deviations in adjacent years. Less stringent compliance pathways are available for small volume manufacturers.
[54] The location of emissions is relevant for the health consequences of particulate-matter emissions.
[55] The offset may be more than 100 percent depending on the type of emission and mode of transport used instead of trucks.

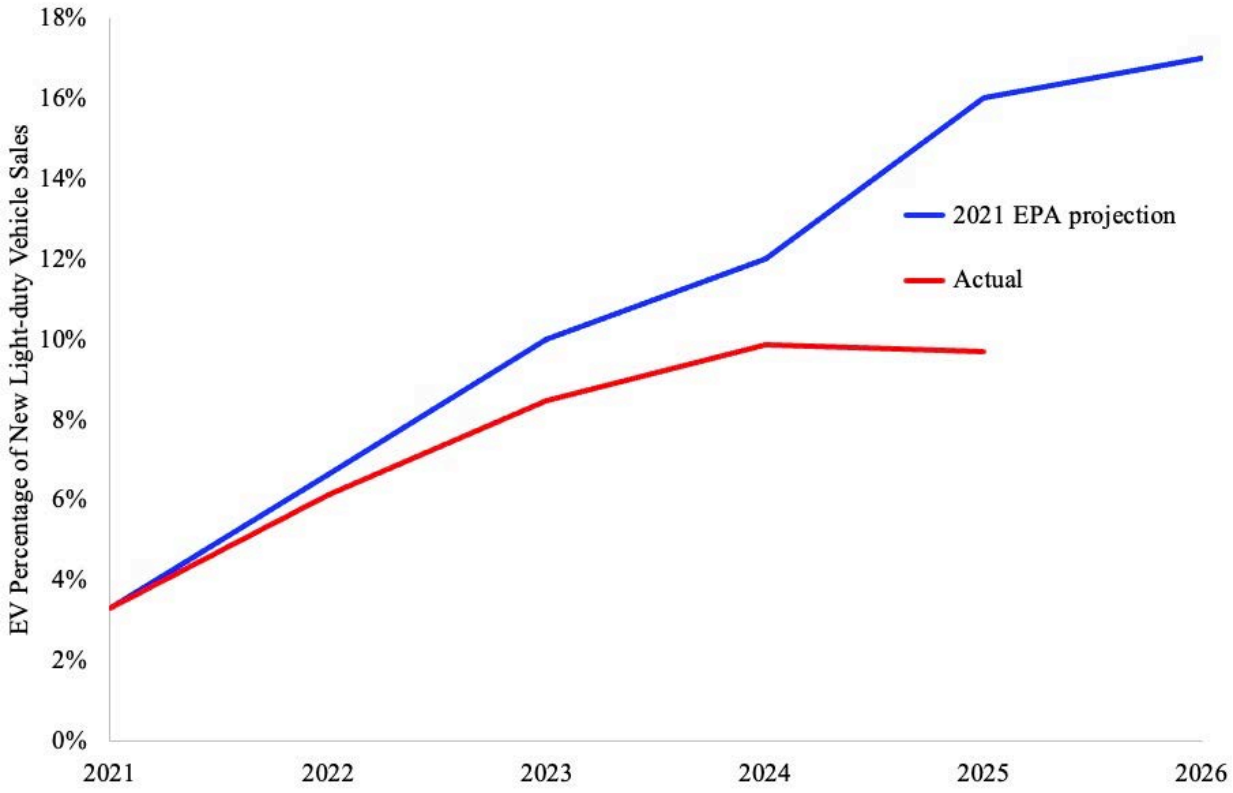
involve less LD vehicles in exchange for foreign economies shifting in the other direction. "Leakage" of this sort would at least partially offset emissions reduction among U.S. vehicles. It is possible that the offset would be more than 100 percent. The 2021 and 2024 vehicle rulemakings failed to account for either of these possibilities.

3. EPA 2021 and 2024 systematically over-estimated consumer acceptance of EVs

The resource and opportunity costs of the 2021 and 2024 vehicle rulemakings especially depend on the ease with which consumers accept EVs. If enough consumers viewed EVs and ICE vehicles as essentially equivalent, regulation might increase EV market shares with little increase in the price of ICE vehicles or little decrease in the price of EVs. But that is not the reality of U.S. vehicle markets.

Figure RIA-1 shows two time series for EV market shares for model years. The upper series is the projection from the EPA's 2021 rule. The share would increase every year, reaching 16 percent in model year 2025 from only three percent only four years prior. In fact, the lower series shows that the EV share has yet to exceed 10 percent. So far, the 2025 MY share looks to be slightly below the share from 2024.

Figure RIA-1: 2021 EPA Overestimates Consumer Acceptance of EVs
(Battery electric + Plug-in Hybrids)



Despite emerging evidence to the contrary, in early 2024 the EPA doubled down on its assumed ease of substitution toward EVs, predicting that "that electrification of the light-duty vehicle market

will [] accelerate dramatically."[56] Meanwhile, another part of the Federal government offered less optimistic predictions about the costs of EV adoption. CEA used market prices to quantify the costs of emissions standards of the kind that would ultimately be imposed by the 2021 and 2024 LD rules.[57] Especially, CEA concluded that, because most consumers do not see EVs and ICE vehicles as close substitutes, the standards would sharply increase the inter-manufacturer-market price of regulatory credits from $86 per ton of CO_2 to well over $100 per ton. This appears to have occurred.[58]

Under the Regulatory Flexibility Act and E.O. 13563, the EPA has a duty to consider the "actual results of regulatory requirements" and adjust its rulemaking accordingly. The EPA now acknowledges that the benefit-cost analysis supporting its 2021 and 2024 vehicle rulemakings has been contradicted by reality. We take this opportunity to utilize CEA's market-based approach to assessing costs and benefits.

4. Vehicle utilization rates are not necessarily the same for ICE vehicles and EVs, and may be affected by regulations that change consumer access to the vehicles that they prefer

Given consumers' limited willingness to accept an EV instead of an ICE vehicle, they may adjust their utilization rates. In other words, they would react to a scarcity of ICE vehicles by driving the remaining ones more frequently and for more years. That would allow the market to comply with more stringent standards while still providing consumers almost as many miles with ICE vehicles. Indeed, the EPA's 2024 LMDV RIA acknowledges that several studies find that EVs are already driven fewer miles per year than ICE vehicles are, without incorporating that into the benefit-cost analysis.[59]

Current ICE vehicle usage patterns leave plenty of room for increased utilization in response to regulatory incentives. Especially, vehicles are parked more than 90 percent of the time.[60] Consumers can also spend resources extending the life of their ICE vehicles, including the ICE vehicles they purchase in MY 2027 and beyond.

In acknowledgment of the gap between regulatory instruments and the regulatory intent of the 2021 and 2024 vehicle rulemakings, this Appendix allows for the possibility that the EPA's 2021 and 2024 "emissions" standards result in an increase in fossil fuels burned per ICE vehicle and reduction in

[56] LMDV RIA, p. 4-2, https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P1019VPM.pdf.
[57] The Council of Economic Advisers. (2020). Estimating the Value of Deregulating Automobile Manufacturing Using Market Prices for Emissions Credits: https://trumpwhitehouse.archives.gov/wp-content/uploads/2020/12/CEA_SAFE_Report.pdf.
[58] Also in 2020, three economists from the same CEA predicted negative economic-growth effects of Federal regulation, especially vehicle standards. These predictions also proved correct (https://www.wsj.com/opinion/nobelists-for-harris-are-unburdened-by-proof-9b33ac0f).
[59] LMDV RIA, p. 4-23, https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P1019VPM.pdf.
[60] State of Charge. (2022). Latest EV Charging Station Reviews: https://evchargingstations.com/chargingnews/on-average-vehicles-are-parked-for-95-percent-of-the-day/ citing U.S. Department of Energy data for 2022.

miles driven per EV. Conversely, one effect of ending those standards might be to reduce fossil fuels burned per ICE vehicle even while increasing the number of ICE vehicles sold.

B. Summary of Costs and Benefits

This Appendix estimates that the total benefits of this proposed action far exceed the total costs with the annualized value of monetized benefits to the U.S. estimated at $157 billion to $444 billion, as shown in Table RIA-1. The annualized costs associated with emissions are estimated to be less than $5 billion, relative to the baseline of retaining the 2009 Endangerment Finding and the GHG vehicle standards that followed. This puts the net benefits of the proposed action in the hundreds of billions annually and more than $1 trillion in net present value.

Table RIA-1. Summary of Benefits and Costs
billions of 2022 dollars, annualized over years 2027-2055

Benefit Category	Range	Cost Category	Range
Opportunity and resource cost savings			
Vehicle composition	114-365	Congestion	1.2
Vehicle quantity	17-44	Fossil-fuel risk	1.4-2.3
Strained electric grid	10-21	PM emissions	2.2-4.2
Savings on Insurance	1.8-2.1		
Savings on EVSE Ports	14		
Total Benefits	**157-444**	**Total Costs**	**5-8**

1. Resource and opportunity costs: vehicle markets

Most of the benefits of the proposed rule come from having a composition of LD vehicles that is closer to consumer needs and preferences (recall Figure RIA-1).[61] Still, the benefits to MD and HD markets are significant too, especially due to the additional challenges of electrifying them.

Resource costs include, but are not limited to, the "Vehicle technology costs" referenced in the 2021 and 2024 vehicle rulemakings. They include the additional costs of manufacturing EVs that share some of the characteristics that consumers value in their ICE vehicles. Resource costs also include capital equipment, additional maintenance, human time, and effort required to manage a fleet of vehicles whose composition would, under the 2024 vehicle rulemakings, become increasingly divorced from what consumers want to drive.

Table RIA-1's opportunity-cost savings include consumers' value of ICE vehicles that would not have been produced under the 2024 vehicle rulemakings.[62] Although not necessarily related to

[61] Resource and opportunity costs are not reported separately because they are a combined category in the CEA model of the regulatory costs of vehicle-emission standards.

[62] Foregone consumer surplus is an instance of opportunity cost. Traditionally, the EPA has featured foregone consumer surplus in the RIAs of its vehicle-emissions rules. See, for example, 77 FR 62716, 85 24200, and 86 FR 74509. This important cost category, also emphasized in RIA guidance from OMB, was improperly omitted from the 2024 vehicle rulemakings.

vehicles, the concept and importance of opportunity costs became more salient during the COVID-19 pandemic when social distancing meant giving up valuable activities. In-person schooling was among the missed opportunities for millions of children during the pandemic, which is now recognized as a substantial cost. A similar logic applies to vehicle regulation. The 2024 vehicle rulemakings would have eliminated the opportunity to purchase inexpensive ICE vehicles, which is a significant cost to consumers looking for vehicle features that EVs do not have.

We take two approaches to quantifying resource and opportunity costs of the 2024 vehicle rulemakings. One builds on estimates from the earlier EPA emissions rules, such as the 2021 LD rule (86 FR 74434) and the 2011 MD and HD rule (76 FR 57106).[63] The second approach is the examination of inter-manufacturer credit markets undertaken by CEA (2020) for the purpose of assessing the costs associated with vehicle-emission regulations.[64] If enough consumers view ICE vehicles and EVs as functionally interchangeable, then manufacturers will find it relatively easy to comply with a more stringent standard by marketing the EVs, without dropping the EV purchase price or elevating ICE prices, rather than seeking credits from other manufacturers. In this case, tightening the standard results in only a slight increase in the credit prices. If instead credit prices increase markedly as the standard tightens, that is evidence that consumers are unsatisfied with the EPA-prescribed vehicle composition unless they are charged a significant premium for the ICE vehicles.

The analytical details of all approaches are provided in section C of this Appendix. An inescapable fact about the 2024 vehicle rulemakings is that they prescribed changes far beyond U.S. experience. They would have put the stock of LD vehicles on a path toward majority electric from a mere 1.5 percent electric at the time of writing. The MD and HD markets were also expected to become half electric in order to comply with the 2024 vehicle rulemakings. Each of these is at least an order of magnitude change requiring a great deal of extrapolation beyond the historical data, whether it be with the engineering approach taken in the 2024 vehicle rulemakings or the more market-based approach taken here.[65]

For this Appendix, the relationship between credit prices and emissions standards observed by CEA must be extrapolated to levels well beyond what has yet been experienced in the United States. This Appendix also allows for technological progress in vehicle manufacturing that steadily increases the miles per gallon (reduces CO_2 grams per mile) for each subsequent MY at the annual rate observed in the EPA's automotive trends data for the model years 1978 through 2011.

This Appendix's estimates of combined savings resource and opportunity cost savings ("benefits") relating to the composition of vehicle fleets range from $114 billion to $365 billion annually. Reducing quality-adjusted vehicle prices also increases consumer surplus by resulting in a greater

[63] 86 FR 74434 (Dec. 30, 2021) "Revised 2023 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions Standards"; 76 FR 57106 (Sept. 15, 2011) "Greenhouse Gas Emissions Standards and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles."

[64] The Council of Economic Advisers. (2020). Estimating the Value of Deregulating Automobile Manufacturing Using Market Prices for Emissions Credits: https://trumpwhitehouse.archives.gov/wp-content/uploads/2020/12/CEA_SAFE_Report.pdf

[65] A separate and more speculative feature of the 2024 vehicle rulemakings, that is much less relevant here, was putting significant weight on climate benefits centuries in the future. The citizens of, say, the year 2200 U. S. have yet to be born and will have access to technologies that we cannot even imagine.

quantity of vehicles. This addition to consumer surplus is an instance of opportunity cost savings. Its amount can be approximated as one half the decline in quality-adjusted price times the increase in quantity.[66] This Appendix's annualized estimate of this addition to consumer surplus ranges from $17 billion to $44 billion.

2. Resource and opportunity costs: electricity and labor markets

EV charging can soak up spare generation and transmission capacity that would otherwise power everything from factories to data-center servers to air-conditioning on the hottest days. At a time when only about five percent of California's registered vehicles were electric, state officials urged residents to "avoid … charging electric vehicles" because "California and the West are expecting extreme heat that is likely to strain the grid."[67] The 2024 LMDV rule aimed for 50 percent of LD vehicles nationwide to be EVs, or about ten times the California grid burden. Additional grid burden would come from electrifying MD and HD vehicles.

If the grid runs tight, system operators must either build costly new plants and lines, fire up expensive fossil "peaker" units, or curtail other demand—choices that divert capital and fuel away from alternative uses such as industrial expansion, data-center growth, or deeper decarbonization of existing loads. Consumers may face higher electricity rates or reliability risks, while public dollars earmarked for schools, or get pulled into emergency subsidies and grid upgrades. In short, every extra megawatt-hour (MWh) needed for EVs carries an opportunity cost.

The 2021 and 2024 vehicle rulemakings quantified such opportunity costs by assuming that the rules would have little effect on electricity prices or average costs. In contrast, Fitzgerald and Mulligan (2023) modeled EV charging in the face of renewable energy standards and EPA emission standards for LD vehicles.[68] They assumed that essentially all LD vehicles would become electric, which is more ambitious than the EPA's 2024 target. However, they did not consider any additional electricity demand from the more energy intensive MD and HD vehicles that would also be about half electric under the 2024 vehicle rulemakings.

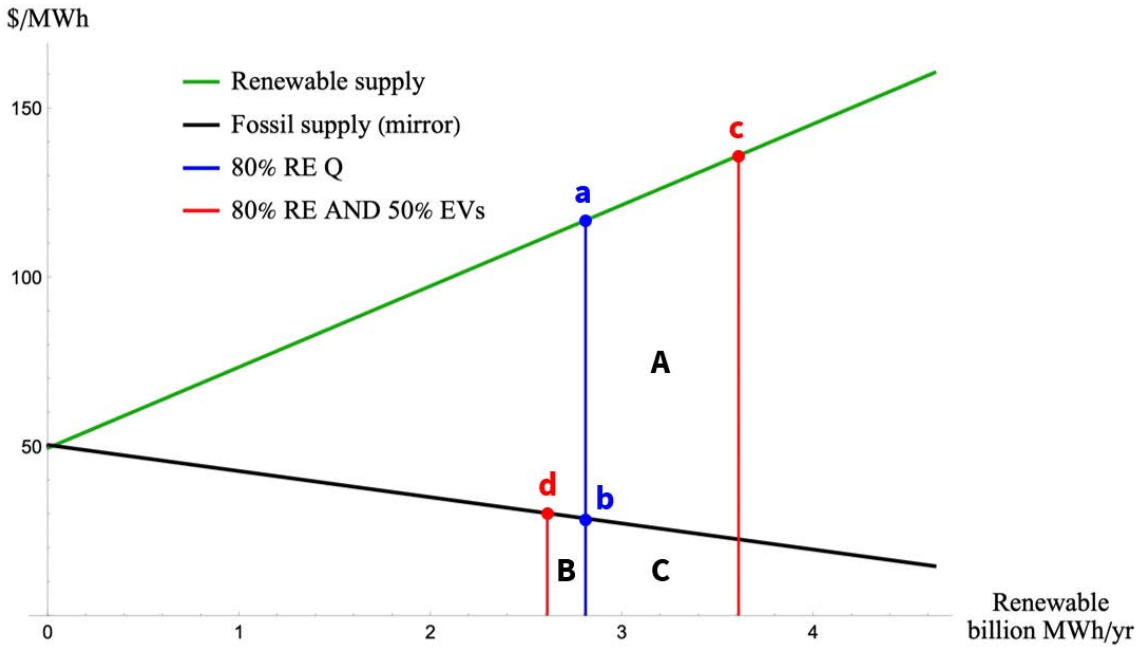
The Fitzgerald and Mulligan approach assumes that supply meets demand and is allocated to the highest-value uses. The cost of electrifying vehicles would be even greater if it led to blackouts or misallocation of the available supply. With these caveats, this Appendix uses the Fitzgerald and Mulligan estimates. The EPA invites comment on monetizing effects of regulation on the reliability of the electric grid.

Figure RIA-2 is reproduced from Fitzgerald and Mulligan. The green curve represents the supply of electricity generated from renewables. The black curve is the supply of fossil-fuel generated electricity, shown as a mirror so that movements to the right in Figure RIA-2 represent a substitution on the supply side from fossil-fuel generation to renewable energy. The point *a* indicates the quantity and wholesale price of electricity produced from renewable sources under the proposed

[66] See also 77 FR 62716.
[67] California ISO. (August 30, 2022). "Excessive heat starting tomorrow will stress energy grid" https://www.caiso.com/Documents/excessive-heat-starting-tomorrow-will-stress-energy-grid.pdf.
[68] Fitzgerald, T. and Mulligan, C.B. (2023).The Economic Opportunity Cost of Green Recovery Plans: https://www.nber.org/papers/w30956.

rule, assuming that the Biden administration's 80 percent renewable goal is realized.[69] The point *b* corresponds to fossil-fuel produced electricity under the proposed rule. The points *c* and *d* are their analogues under the baseline of the 2024 vehicle rulemakings. Together, they involve 1 TWh more electricity usage than under the proposed rule.

Figure RIA-2. The Composition of Non-nuclear Electricity Generation



The combined areas *A*, *B*, and *C* measure the proposed rule's annual savings of resources for generating electricity. Part of this savings is already counted in consumer surplus, which reflects the choices of consumers who considered vehicles options at a time when the wholesale price of electricity was about $50 per MWh. The additional cost of $57 per MWh would either require government subsidies, or be passed onto consumers. In aggregate, the additional cost shown in Figure RIA-2 would amount to $57 billion annually.

To the extent that the quantity of EVs increases even without regulatory incentives, or the EV share of the stock has yet to catch up to the EV share of new sales, only part of the $57 billion applies. As explained further in Section C.5, the annualized cost savings reported in Table RIA-1 ranges from $10 billion to $21 billion, depending on the scenario.

Vehicles are an important part of travel between home and the workplace. For many workers, vehicles are part of the tasks they perform at work. Interference with vehicle markets therefore has the potential to reduce employment, in some of the same ways that a tax on employment would.

[69] Because stationary sources are not part of this rulemaking, the renewable energy goals are treated as constant. Nevertheless, Figure RIA-2 begins to show how the costs of vehicle rules accumulate on top of the costs of electricity rules. Under the Regulatory Flexibility Act, E. O. 12866, and E. O. 13563, Federal agencies have a duty to "give consideration to the cumulative effects of their own regulations, including cumulative burdens."

Especially, the already-taxed labor market is further burdened by the additional costs of acquiring desirable vehicles. The EPA seeks comment on quantifying those potentially important effects, which would add to the benefits of the proposed rule that are already quantified.

3. Tailpipe emissions: physical quantities

U.S. vehicles are not, and will not be, the only source of GHG and PM emissions. It is therefore essential to anticipate the effect of vehicle regulations on other emission sources. The 2024 vehicle rulemaking recognized vehicle-market emissions substitution in the form of shifts toward EVs that increase the demand for fossil fuels by the electricity-generation sector. This Appendix assumes that eliminating GHG standards for vehicles would reduce fossil-fuel use for electricity generation, and the accompanying CO_2 and PM emissions, by the same amount that the 2024 vehicle rulemaking assumed that it increased. The reduction could be even greater to the extent that the proposed rule would reduce EV utilization rates below even the 2024 vehicle rulemaking's baseline, or that the fossil-fuel intensity of electricity supply is now expected to be above the EPA's 2024 projections. [70]

Another source of substitution in the vehicle market is changes in the intensity of use. As the 2024 vehicle rulemakings would, by design, create a shortage of ICE vehicles and a surplus of EVs, per-vehicle utilization of ICE vehicles would increase while utilization of EVs would fall. Eliminating GHG standards for vehicles would have the opposite effect.

ICE vehicle usage patterns leave plenty of room for increased utilization rates in response to regulatory incentives. Especially, vehicles are parked more than 90 percent of the time.[71] Consumers can also spend resources extending the life of their ICE vehicles, including the ICE vehicles they purchase in MY 2027 and beyond. Cuba is world-famous for its extension of vehicle lives; after it lost access to American-made automobiles and parts in 1962,it became incredibly resourceful in maintaining and modifying the vehicles to keep then running.[72] Analogous, albeit less extreme, behavior should be expected in the U.S. if its regulations were to mandate vehicle production that departs sharply from consumer preferences.

This Appendix assumes that the elasticity of the ICE-vehicle utilization rate, as a ratio to the EV utilization rate, has an elasticity of 0.3 with respect to the number of registered EVs per registered ICE vehicle. In other words, the utilization-rate changes occur, but not enough to fully offset the reduction in ICE quantities that result from GHG standards. Indeed, 0.3 is closer to no change than a full offset.

Substitution will also occur in fossil-fuel markets. Vehicle regulation shifts one component of fossil-fuel demand, which unmistakably spills over onto supply and other elements of fossil-fuel demand.

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[70] LMDV RIA, Figure 5-6, https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P1019VPM.pdf. The figure indicates a 70 percent reduction in CO_2 emissions in its baseline power sector that would be generating at least 40 percent more electricity by the year 2050.

[71] Vehicles are real capital goods. In recognition that capital utilization rates vary, one of the most closely watched statistics regarding real capital goods are "capacity utilization rates."

[72] Enoch, M. P.et al. (2004). The Effect of Economic Restrictions on Transport Practices in Cuba: Transport Policy 11, no. 1, 67–76: https://oro.open.ac.uk/2531/4/Enoch_Warren_TP_11.pdf.

The other elements of demand include heating, cooking, industrial processes, agriculture, other forms of U.S. transportation such as air travel, and vehicle use outside the U. S.. This Appendix translates U.S.-vehicle emissions impacts into worldwide emissions using fossil-fuel supply and demand, described more fully in section C.5 of this Appendix. The ultimate conclusion is that half of the reduction of fossil-fuel use by U.S. vehicles–whether it be from powering ICE vehicles or generating electricity for EVs–is offset by increased fossil-fuel use elsewhere in the world economy.

For the purposes of projecting U.S. PM emissions, it matters whether where the offset occurs. That is, part of the GHG emissions offset is not an offset for U.S. PM emissions because some of the change in fossil-fuel use is outside the U. S.. The EPA seeks comment on quantifying this part. For the purposes of this DRIA, this Appendix assumes that all of the offset is outside the U.S., or in a part of the U.S. that does not affect U.S. health. This assumption serves to exaggerate the U.S. increase in PM emissions that would result from this proposed action.

4. Monetization of particulate emissions

The discount rate for comparing near- and long-term costs and benefits should reflect the intertemporal prices that households and businesses trade at, rather than a government bond yield. It is the households and businesses that pay the costs of GHG policies and experience the benefits of reduced emissions in the future. That is why OMB guidance recommends agencies to use three and seven percent annual discount rates.

This Appendix estimates that, by increasing PM emissions, the proposed action would lead to health costs of $2 billion to $4 billion annually, on average. These estimates are of less magnitude than the $10 billion $PM_{2.5}$ cost-reduction reported in the 2024 LMDV rule for two reasons. One is the aforementioned emissions offsets in vehicle markets. The second is that much of the $10 billion reported in the 2024 LDMD rule was due to criteria pollutant standards that are unchanged by this proposed action.

The EPA does not attempt to monetize the value, if any, of changes in GHG emissions that result from the proposed action. However, the EPA notes that any reliable estimate of that value would be orders of magnitude less than the benefits of the proposed action, for the reasons already cited.

5. Additional costs of the proposed actions

This Appendix maintains its modeling of fossil-fuel risks, but recognizes that the proposed action will increase U.S. fossil-fuel demand less than the 2024 vehicle rulemaking projected to decreased it due to changes in vehicle utilization rates. This annualized cost is estimated at about $1 billion to $2 billion.

Fossil-fuel risk was labeled “energy security costs” in previous rules. However, our results suggest that a strained electricity grid is also a significant risk from no action, and therefore relabel the item to avoid ambiguity.

The proposed action is expected to increase vehicle congestion due to increased vehicle sales that result from reduce quality-adjusted vehicle prices. The EPA seeks comment on whether, and how much, the proposed action might affect vehicle congestion by encouraging supply and quality of

roads and related infrastructure as the vehicles used for infrastructure investment become cheaper and better quality (relative to no action). This Appendix's estimate of congestion costs is about $1 billion annually.

6. Additional benefits of the proposed actions

Insurance costs are a cost of vehicle ownership beyond what is spent at new-vehicle dealers. This Appendix maintains the assumption that insurance costs over the lifetime of a new vehicle are proportional to expenditures on purchasing new vehicles. With the proposed action reducing vehicle prices by a greater percentage than it increases vehicle quantities, the result is an insurance saving of almost $2 billion annually.

The proposed action would reduce the number of EVs relative to the baseline. This Appendix maintains the modeling of LD and MD EV charging ports (cited as "EVSE ports" in Table RIA-1), but scales up the total to include HD vehicles as well. We find an annualized savings of $14 billion. The EPA seeks comments on whether and how that modeling should be updated given the low EVSE installation rate in response to Federal programs subsidizing EV infrastructure.[73]

7. Fuel expenditure and "drive value" in a revealed-preference model

In order to avoid double counting, Table RIA-1 does not have an additional cost or benefit for fuel expenditures. A consumer fully cognizant of the fueling requirements of an ICE vehicle may nonetheless prefer the ICE vehicle because it offers other features with value more than offsetting the required fuel expenses. A rule that increased ICE prices enough for the consumer to switch to EV is a consumer harm, not a "benefit" equal to the consumer's reduced spending on fuel. The savings on fuel is more than offset by the loss of access to the ICE's vehicles features. With the net of these two categories already captured by consumer surplus, adding to the benefit-cost analysis an estimate of one without an estimate of the other would substantially distort the results.[74]

Another approach would be to assume that consumers are unaware of the fuel expenses associated with ICE vehicle purchases. Such an assumption may be at odds with empirical evidence.[75] Even if it weren't, the solution would be to improve consumer information.[76] This approach would also overlook the immense heterogeneity among consumers, whose diverse

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[73] International Energy Agency. (2025). Electric vehicle charging: https://www.iea.org/reports/global-ev-outlook-2025/electric-vehicle-charging.

[74] The net of these two is essentially an increase in the quality-adjusted price, as shown by the microeconomics result known as "Shephard's Lemma."

[75] See the literature cited in Section 5 of this DRIA. As noted by the 2011 HDV RIA, p. 9-2, it is even more suspect when the buyers are businesses, for which "we generally expect firms to attempt to minimize their costs in an effort to survive in a competitive marketplace, and therefore to make decisions that are in the best interest of the company and its owners and/or shareholders."

[76] OMB Circular A-4 (https://obamawhitehouse.archives.gov/omb/circulars_a004_a-4) encourages "informational measures rather than regulation." It concludes that "a particularly demanding burden of proof is required to demonstrate the need for …mandatory uniform quality standards for goods or services if the potential problem can be adequately dealt with through voluntary standards or by disclosing information of the hazard to buyers or users." To be clear, Circular A-4 does not assert that information alone is necessarily adequate to address market failures associated with externalities, which is why this proposed action includes environmental costs in its regulatory-impact calculus.

circumstances—such as varying commuting distances, access to charging infrastructure, household budgets, climate conditions, and even preferences for vehicle features like towing capacity or off-road capability—profoundly shape their choices. As a Federal environmental agency, the EPA lacks the granular, real-time knowledge of the individual contexts that consumers themselves navigate daily through their decisions.

Under the consumer-surplus approach, results are somewhat less sensitive to forecasts for fuel and electricity prices. On the other hand, the forecasts matter for quantifying opportunity costs of the proposed action whether and to what degree market forces beyond the rule will contribute to the adoption of EVs. We allow for technological progress in vehicle manufacturing that steadily increases the MPG (reduces CO_2 grams per mile) for each subsequent MY at the annual rate observed in the EPA's automotive trends data for the model years 1978 through 2011.

The 2024 vehicle rulemaking refers to "drive benefits," which can be interpreted as one element of consumer surplus. The RIA for this action includes consumer surplus more broadly. The benefit item "vehicle quantity" shown in Table RIA-1 is particularly close to the concept of "drive benefits."

C. Economic models of regulatory impact

Fundamentally, the economic models used in this Appendix to analyze this action are supply and demand models. The supply of vehicles reflects processes of innovation, manufacturing, and retailing, subject to regulatory constraints. Demand for vehicles derives from demand for transportation, freedom, mobility, reliability, and other characteristics valued by household- and commercial-owners of vehicles. The vehicle-market piece of the analysis is sufficient by itself to estimate a significant portion of the resource and opportunity costs of vehicle-emission standards.

Emissions impacts cannot be reliably quantified without considering the worldwide market for fossil fuels. Vehicle regulation shifts one component of fossil-fuel demand, which unmistakably spills over onto supply and other elements of fossil-fuel demand. This Appendix translates fleet emissions impacts into worldwide emissions using fossil-fuel supply and demand.

1. Vehicle supply and demand: the EV share

Vehicle-emissions regulations are imposed on new vehicles. Resource and opportunity costs are calculated once for each cohort of new vehicles. The calculation begins by letting *B* ("battery") and *X* denote the market-level quantities of new EVs and ICE vehicles, respectively. Because effects of new vehicle production on the entire stock of registered vehicles only appear later when accounting for emissions, we omit MY subscripts.

Although this Appendix derives cost formulas in this two-type setting, the two-type cost formulas also describe models with an arbitrarily large number of vehicle types.[77] For benefit-cost estimation

[77] The many-vehicle case would be analyzed with vectors, which we demonstrate in this footnote and elsewhere confine our analysis to the two-type case. The vector analysis lets *q* denote a (potentially long) vector of market quantities of vehicle models, which differ in many characteristics including emissions. The GHG standards affect these quantities, including setting some of them to zero as vehicles leave the market and moving others off of zero as vehicles enter. Let *p*, *c*, and *g* denote the corresponding vectors of retail

purposes, we therefore summarize the regulatory coefficients for ICE vehicles as a single constant g. As already noted, the coefficient for EVs is zero. Therefore, with a market-level emissions target of $G < g$, the market-level regulatory constraint is:

$$gX \leq (B + X)G \tag{1}$$

G is a policy parameter while B and X are market outcomes. Stricter standards correspond to values of G closer to zero. The regulatory constraint (1) has an equivalent representation as a constraint on the quantity share $B/(B+X)$:

$$\frac{B}{B + X} \geq 1 - \frac{G}{g} \tag{2}$$

Henceforth, the regulatory constraint (2) is assumed to hold with equality. It is an arithmetic demonstration of the earlier conclusion that emissions regulation directly encourages sales of EVs and discourages sales of ICE vehicles. How the vehicles are driven after they leave the showroom, or where EV owners source their electricity, matters a great deal for real-world emissions. Nevertheless, those factors are absent from the regulatory constraint.

The policy parameters corresponding to the quantitative results for the revealed-preference approaches are shown in Table RIA-2.[78] Note that the units are different for HD standards than for the other two classes.

prices, marginal production costs, and GHG emissions (i.e., the regulatory coefficients), respectively. With one-for-one pass through of costs to retail prices, we have $p = \mu + c + (g - G)\lambda$, where G and λ are scalars denoting the emissions standard and the equilibrium price of a GHG credit. μ is a vector of vehicle-specific markups that, by the pass-through assumption, are independent of the GHG standard. If the GHG standard is binding and dot indicates vector dot product, then $g \cdot q = Gq$, which means that specific vehicles can deviate from the standard but the market sales-weighted average emissions does not. It follows that the standard G has a retail price effect that varies across vehicles. The sales-weighted retail price impact is simply the scalar $-\lambda$. In words, the average price effect of a stricter standard (lower G) is exactly the GHG credit price λ, regardless of whether there are just two vehicle types or many.

[78] No-action standards are sourced from 89 FR 27854 (LD), 86 FR 28081 (MD), and 89 FR 29451 (HD).

Table RIA-2. No-action Fleet GHG Targets
by model year and vehicle class,
as used in the economic modeling

	Vehicle class		
Model year	Light-duty	Medium	Heavy
2027	170	461	103.4
2028	153	453	95.1
2029	136	408	91.0
2030	119	353	86.9
2031	102	314	74.4
2032-	85	274	62
Units:	g/mi	g/mi	g/ton-mile
Proposed action projection, MY 2032	250	614	117

Under the proposed action–that is, without the 2009 Endangerment Finding – the NHTSA will still regulate fuel economy, but recent legislation zeroed out the civil monetary penalty for noncompliance. The EPA invites comment on what to expect for vehicle fuel economy and GHG emissions in the coming years absent the 2009 Endangerment Finding. The proposed action projection row of Table RIA-2 shows a scenario where the LD GHG-equivalent of the fuel economy standards return to the standards set in 2010 for MY 2016.[79] For MD and HD vehicles, the Appendix uses a scenario using the baseline of the 2011 rule (76 FR 57106), adjusted for technological progress.

2. Resource and opportunity costs of increasing the EV share

$F(B,X)$ denotes a constant-returns quantity index for the industry, of the same type as the Bureau of Economic Analysis uses in its industry and national accounting. Especially, F reflects consumer preferences. In this way, purchases of EVs B and ICE vehicles X reflect derived demands by ultimate consumers seeking transportation, freedom, mobility, reliability, and other characteristics.[80] Depending on the GHG standard being considered, "the industry" refers to either new LD, MD, or HD vehicles.

[79] 75 FR 25324 (May 7, 2010) "Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards; Final Rule" https://www.govinfo.gov/content/pkg/FR-2010-05-07/pdf/2010-8159.pdf.

[80] The economics of derived demand was developed by Alfred Marshall in *Principles of Economics*, MacMillan and Co., 1895 (https://eet.pixel-online.org/files/etranslation/original/Marshall,%20Principles%20of%20Economics.pdf) and Sir John Hicks' *The Theory of Wages*, MacMillan and Co., 1932 (https://archive.org/details/in.ernet.dli.2015.264357). Its real-world applications have proliferated since then, as with Gary S. Becker's, "A theory of the allocation of time", *Economic Journal*, 1965, and the Council of Economic Adviser's *Economic Report of the President*, 2019 (https://www.govinfo.gov/content/pkg/ERP-2019/pdf/ERP-2019-chapter7.pdf).

The elasticity of substitution quantifies how easy it is to induce the industry's consumers to switch between *B* and *X*. If the market views *B* and *X* as poor substitutes, then the elasticity of substitution in *F* is low, regardless of whether regulators think that EVs are just as good or better for owners than ICE vehicles. In that case, EVs will need to sell for a steep discount, and ICE vehicles for a substantial premium, in order for consumers to make purchases that align with the GHG standards at a market level. The close substitution case is represented with a high elasticity of substitution, in which case consumers readily switch from ICE vehicles to EVs with little relative price change.

Although this Appendix does not treat the elasticity of substitution as a constant, the elasticity can be understood as a parameter that allows consideration of scenarios corresponding to various assumptions about the ease of consumer substitution. Using market signals to assess which scenario is more realistic is known as revealed preference. As emphasized in OMB guidance for RIAs, revealed preference is an important component of reliable benefit-cost analysis. Figure RIA-1 is in the spirit of revealed preference analysis, as is what follows.

The "supply" of *F* reflects the marginal costs of producing the two vehicle types. Regulatory distortions increase this marginal cost, which this Appendix assumes is passed through one-for-one to the purchasers of vehicles.[81] Because *F* is a quantity index representing consumer preferences, regulatory-induced shifts reflect both added manufacturing costs and added opportunity costs of a fleet composition *B*/*X* that differs from what consumers desire. The costs increase, and are convex (i.e., increase at an increasing rate), as *B*/*X* increases above the desired level. The rate of increase is greater (less) when *B* and *X* are poor (close) substitutes, which is why CEA and Figure RIA-1 consult actual results of emission standards to gauge the ease of substitution. The level curves of *F* and the role of its substitution rates are illustrated in Figure 3 of the CEA report.

Because there are one million grams in a metric ton, the fleet miles-per-ton (*MPT*) equivalent of the fleet standard *G* is *MPT* = 1,000,000/*G*. From the equality version of the regulatory constraint (2), the ratio *B*/*X* is linear in fleet miles per ton of CO_2:

$$\frac{B}{X} = \frac{g}{G} - 1 = \frac{g}{1000000} MPT - 1 \tag{3}$$

The average cost per quality-adjusted vehicle is the cost of producing one unit of *F*(*B*,*X*). There is exactly one EV share, and therefore one ratio *B*/*X* and one fleet *MPT*, that minimizes this average cost.[82] The average cost of producing a unit of *F*(*B*,*X*) represents a quality-adjusted price increase in the sense that *F*(*B*,*X*) is more expensive to produce when consumers are not free to choose the mix of vehicles that they want.

We let MPT_0 denote the average-cost-minimizing fleet *MPT*. On a per-vehicle basis, the resource and opportunity costs associated with fleet compositions that differ from what consumers want is

[81] Earlier EPA analyses of effects of vehicle regulation on retail prices (e.g., 2016 and 2020) also assumes a one-for-one pass through.

[82] CEA refers to miles per gallon (*MPG*) rather *MPT*. The two are strictly proportional with the factor 1,000,000/8,887. Council of Economic Advisers. (2020). Estimating the Value of Deregulating Automobile Manufacturing Using Market Prices for Emissions Credits:https://trumpwhitehouse.archives.gov/wp-content/uploads/2020/12/CEA_SAFE_Report.pdf.

the difference between the average cost under regulation and the average cost that would be achieved at MPT_0.[83] F itself is a quality-adjusted quantity in that, when $MPT > MPT_0$, replacing X sales with B sales reduces F even though it has no effect on the raw number of vehicles.

At fleet standards exceed MPT_0, average cost increases with MPT at an increasing rate.[84] This essential result already points to two reasons why the 2024 vehicle rulemakings have enormous resource and opportunity costs. The first reason is that earlier LD rules moved fleet MPT only 1,100 or so (that is, adding about 10 MPG), whereas the 2024 vehicle rulemaking would add another 5,600 (that is, another 50 MPG) to reach 11,765 miles per ton of CO_2.[85] The second reason is that the move from 10,765 MPT to 11,765 MPT costs more than moving from 9,765 to 10,765 MPT, which costs more than moving from 8,765 to 9,765 MPT (each of these is an increment of 1000 MPT), etc.

This economics of costs points toward three approaches to quantifying the resource and opportunity costs of GHG standards. One approach, taken in Section 2.1 for LD vehicles, estimates a lower bound by taking an estimate of the cost of earlier GHG standards and extrapolating it to the cost of the 2024 LMDV standards by the principle that costs increase at an increasing rate. The second approach, taken in Section 2.2 for LD vehicles, uses market information to assess how quickly the effect of MPT on average cost increases with MPT. That section ties the rate of increase with the elasticity of substitution. A third approach, applied in Section 2.4 to MD and HD vehicles, is a special case of the first one that has sharper predictions when an estimate of the value of MPT_0 is available. All three approaches allow for the possibility that consumers may not see EVs and ICE vehicles as close substitutes.

2.1. EPA's 2021 light-duty rule already pointed toward enormous costs of a 50 percent EV fleet

The purpose here is to obtain a lower bound on the resource and opportunity costs of GHG emissions for LD vehicles without relying on CEA's measurement of inter-manufacturer credits or relying on linear extrapolation. It is alternative to what follows in Section 2.2 and is the source of the bottom end ($114 billion annually) scenario for opportunity and resource costs of vehicle composition shown in Table RIA-1.

Table RIA-3 displays the LD emissions targets for the 2012 rule, the SAFE rule, the 2021 rule, and the 2024 LMDV rule for model year 2032. Each is expressed in terms of miles per ton of CO_2. The final column of the table's top panel compares each to the SAFE rule.

[83] The impact of one regulation relative to a baseline of another regulation is the difference between the corresponding two average costs.

[84] This result is known as convex deadweight costs, which is a widely recognized principle in economics. Strictly speaking, the deadweight costs need not be convex at miles per ton far away from MPT_0. This possibility is discussed further in Section 2.2.

[85] The 2021 rule's target for fleet grams of CO_2 per mile was 161 (86 FR 74440), which corresponds to 55.2 MPG and 6,211 MPT. The 2024 vehicle rulemaking's target was 85 grams per mile (89 FR 27854), which corresponds to 104.6 MPG and 11,765 MPT.

Table RIA-3. Light-duty emissions standards under four EPA rules

EPA rule	miles per CO_2 ton	Compared to SAFE
2012	5,952	977
SAFE	4,975	0
2021	6,211	1,236
2024	11,765	6,790
2024 as multiple of:		
2012		6.9
2021		5.5

Because per-vehicle costs are convex in tons per mile, an estimate of the per-vehicle costs of any one of the actions bounds the costs of each of the other three. The bottom half of the table begins to show how, using the SAFE rule as a baseline, the costs of the 2024 LMDV rule are bounded by the costs of the 2012 and 2021 rules.

Relative to the SAFE rule, the 2021 rule would have required a LD vehicle at the standard to drive an additional 1,236 miles on the amount of fuel that emits a ton of CO_2 upon combustion in the vehicle. The 2024 LMDV rule would require 6,790 miles beyond a vehicle at the SAFE-rule standard. In this dimension, the 2024 LMDV rule tightened standards 5.5 times more than the 2021 rule. If the compliance costs were convex in the amount that standards are tightened, then compliance with the 2024 LMDV rule would cost more than 5.5 times what 2021 rule did, which the EPA estimated to be $1,154 per vehicle in constant 2022 dollars.[86] In other words, relative to the SAFE rule, the 2024 LMDV rule would cost at least $6,338 per vehicle (up to rounding, 6338 = 1154*6970/1236). Because this is (a) a lower bound and (b) the lowest cost estimate for the 2024 LMDV rule among the methods considered in this Appendix, the $6,338 is the basis for this Appendix's "low-cost" scenario.

The $6,338 is interpolated for the transition years 2027-2031 according to the proportion of full MPT change (6,970) that had been phased in as of that year. In MY 2027, for example, Table RIA-2 indicates a standard of 170 grams per mile, which corresponds to 5,882 MPT, or an increase of 907 from the SAFE rule alternative of 4,975. Because that 907 is only 13 percent of the way to the MY 2032 MPT, the per-vehicle cost is assumed to be only 13 percent of the $6,338, which is $847 per vehicle. Each MY's per-vehicle costs are translated into vehicle quantities and opportunity-cost amounts using the same formulae as for the other approaches; see Section 3.

2.2 Evidence from the market for compliance credits

The second approach to LD vehicles seeks a point estimate for per-vehicle resource and opportunity costs, rather than a lower bound. Specifically, it uses market information to assess how quickly the effect of *MPT* on average cost increases with *MPT*.

[86] The EPA reported $1,000 in 2018 dollars (86 FR 74492), which is equivalent to $1,154 in 2022 dollars.

The costs of increasing miles per ton (equivalently, the EV share) beyond MPT_0 can be quantified algebraically as the quadratic formula (4):[87]

$$\text{impact of } MPT \text{ on per-vehicle cost} \equiv \Delta(MPT) = \frac{k_0}{2\sigma_0}(MPT - MPT_0)^2 \quad (4)$$

where k_0 is a constant that depends only on the unregulated outcome and σ_0 is the elasticity of substitution between vehicle types in the quantity index *F* at the unregulated EV share.

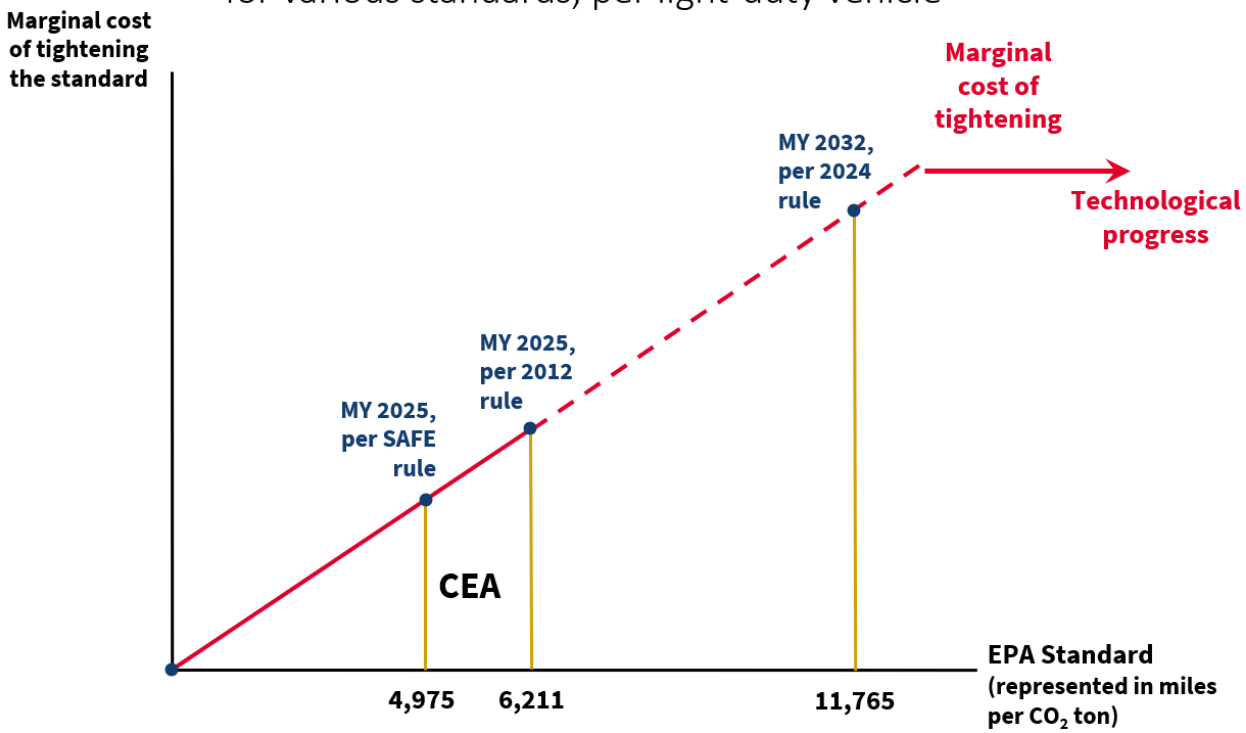
Because formula (4) is inversely proportional to the elasticity of substitution, it formalizes this Appendix's qualitative conclusion about the ease of substitution between vehicles. If the market views *B* and *X* as poor substitutes, then σ_0 is low, and the standard *MPT* has a large effect on per-vehicle cost, especially to the extent it departs from what consumers want (represented as MPT_0). A fundamental omission from the EPA's 2021 and 2024 vehicle rulemakings was any attempt to assess the degree of substitution.

Equation (4) readily allows for technological progress in vehicle manufacturing by letting MPT_0 increase with time at the same rate under the proposed rule and with no action. This progress may represent changing consumer preferences within the ICE category such as the increased adoption of (non-plug-in) hybrid vehicles. It may represent engineering advances, changes in consumer attitudes or circumstances related to EVs, or trends in the structure of energy prices. All of the benefit-cost scenarios from the revealed-preference approach assume technological progress in this way, with details explained further in section 2.6.

The *MPT* derivative of equation (4) is illustrated by Figure RIA-3 red line, adapted from CEA. The cost impact shown in equation (4) therefore corresponds to areas in the figure. The red arrow indicates the assumed technological progress that shifts the red line horizontally over time. Three standards are shown as points on the red line.

[87] This is a second-order Taylor approximation to the impact on average cost per quality-adjusted vehicle in the neighborhood of no standard (MPT_0). CEA (2020, footnote 16, https://trumpwhitehouse.archives.gov/wp-content/uploads/2020/12/CEA_SAFE_Report.pdf) found that a quantity index *F* with a constant elasticity of substitution would be closely approximated by the quadratic equation (4), except when the standard is especially tight, in which case quadratic underestimates compliance costs. Especially tight standards are also analyzed in this DRIA, particularly for trucks. Note that an assumption like equation (4) is required to extrapolate a point estimate, but not for estimating a lower bound as in Section 2.1.

Figure RIA-3. Opportunity and Resource Costs
for various standards, per light-duty vehicle



The 2020 study by CEA estimated the slope and intercept of the red line by measuring the price at which automakers buy and sell credits. For a manufacturer whose sales is relatively intensive in ICE vehicles, the credit price is its cost of meeting the standards. The same credit price reflects the opportunity cost of selling an ICE vehicle for a manufacturer that sells credits because the ICE sale would reduce its credit revenue. CEA relied on data public records of nearly $700 million in credit transactions, which they used to measure how much the credit price increased as the EPA cut the emissions target over time.[88]

In effect, CEA measured the ease of market substitution between EVs and ICE vehicles. If consumers would readily switch from ICE vehicles to EVs, then the regulatory credit prices would hardly increase with the standard because manufacturers would be increasing the EV intensity of their sales with little consumer resistance. CEA found the opposite: tighter standards were associated with substantially greater regulatory-credit prices.

Part of the red line is dashed because it is beyond the range of standards that CEA considered. It was particularly focused on the range between 4,975 (SAFE rule) and 6,135 miles per ton of CO_2 (the 2012 rule that SAFE would replace), as well as historical standards that were less stringent

[88] CEA (2020) also considered the possibility that inter-manufacturer credit markets are not competitive in the sense that manufacturers might withhold some of their trading to favorably affect the credit market price, driving a wedge between their marginal cost of compliance and the credit price. CEA notes that the average automaker is neither a net buyer nor seller over time, so the market credit price generally reflects the sales-weighted average marginal cost of compliance even if the two are not equal at a manufacturer level. The credit price may be a conservative estimate of the marginal cost of compliance if larger manufacturers tend to be net buyers. https://trumpwhitehouse.archives.gov/wp-content/uploads/2020/12/CEA_SAFE_Report.pdf

than the SAFE rule. As already noted, any benefit-cost method must engage in extrapolation because the 2024 LMDV rule set standards so far outside the U.S. experience.

What follows draws more precisely from the CEA cost model, including allowing for standards to vary by MY. It also allows for technological progress in vehicle manufacturing and other modeling approaches. Nevertheless, the few arithmetic steps illustrated in Table RIA-3 indicate why the costs to vehicle consumers of the 2024 LMDV rule must exceed $100 billion annually and likely near $300 billion.

Table RIA-3 shows that the 2024 LMDV rule tightened standards 6.9 times more than the 2012 rule would have. If the compliance costs were convex in the amount that standards are tightened, then compliance with the 2024 LMDV rule would cost more than 6.9 times what 2012 rule did, which CEA estimated to be $2,538 per vehicle (converted to 2022 dollars). If a standard adding less than 1,000 extra miles cost $2,538, then presumably a standard adding 6,790 would cost at least 6.9 times as much, and potentially much more if costs were convex in miles per ton. This points to a cost of at least $18,000 per vehicle. If that were applied to 15 million new vehicles annually, that is at least $270 billion annually relative to the SAFE rule.

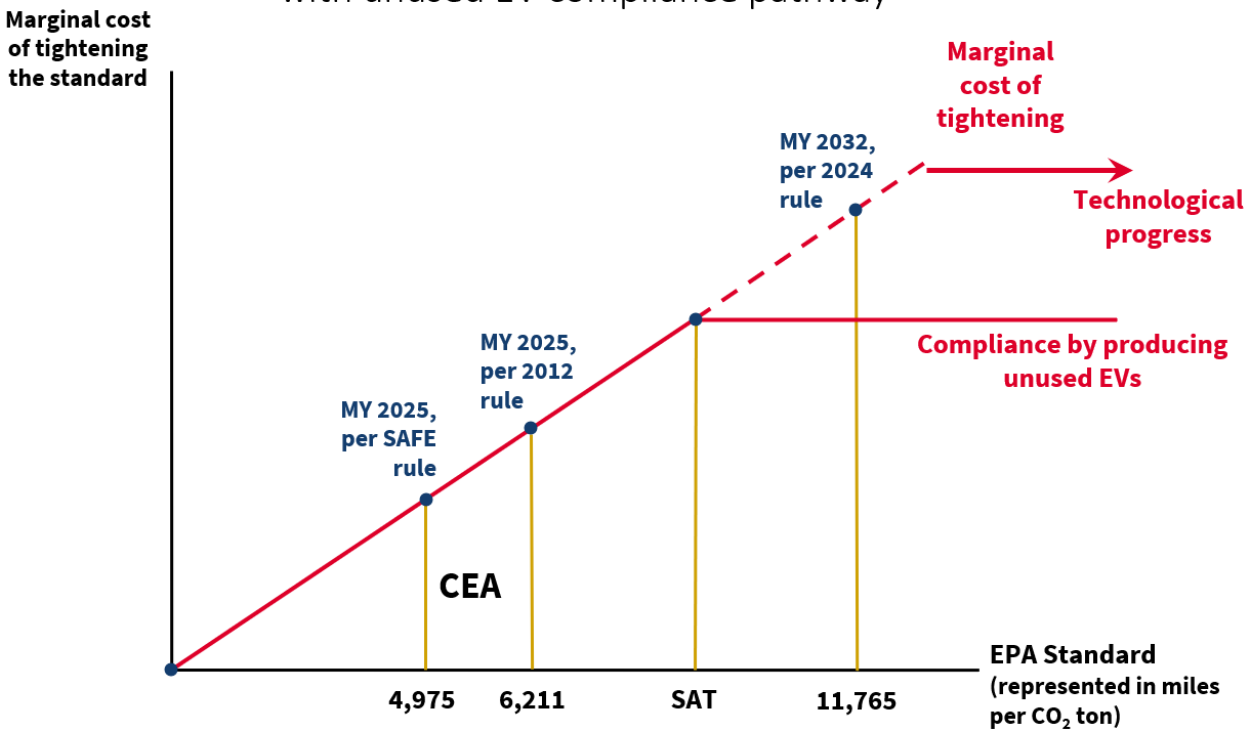
2.3 EV Consumer Satiation

CEA assumed that compliance with the standard is a combination of ICE-manufacturing changes, changes in consumer choices among ICE vehicles, and price-induced decisions of vehicle buyers to select EVs rather than ICE vehicles. In doing so, it warned that the marginal-cost schedule shown in Figure RIA-3 would turn sharply upward near standards that were "especially tight." At that point, none of the three pathways considered by CEA would be economical.

However, a fourth pathway is possible: to manufacture EVs that do not replace ICE vehicles but are sold very cheaply to buyers who hardly intend to use them. At the extreme, EVs may be given away or even sold at a negative price to compensate for storage, in order to give the manufacturer room to sell the ICE vehicles that consumers really want. Or maybe manufacturers develop a compliance vehicle that they expect consumers to rarely use, but instead obtain it for parts or repurpose the batteries. The cost of producing the "free," "compliance," or "scrap," EVs would be built into the price of ICE vehicles. This pathway is itself expensive, but makes any standard achievable because its marginal cost does not rise with *MPT*. As discussed in Section 2.4 and 2.5, it may be the only pathway that 50-percent-EV targets would be reach in truck markets in the near future.

Figure RIA-4 adds the fourth compliance pathway to Figure RIA-3. It adds a horizontal (constant) marginal cost at a high level. The amount of that constant marginal cost has nothing to do with consumer preferences; it is just a function of the cost of producing EVs. It dominates the other three compliance pathways when the standard exceeds SAT ("satiation"). Figure RIA-4 is only for illustration and is not used to produce quantitative estimates for the LD market. The EPA seeks comment on how regulated-manufacturer strategies might have evolved if the 2024 vehicle rulemakings had continued.

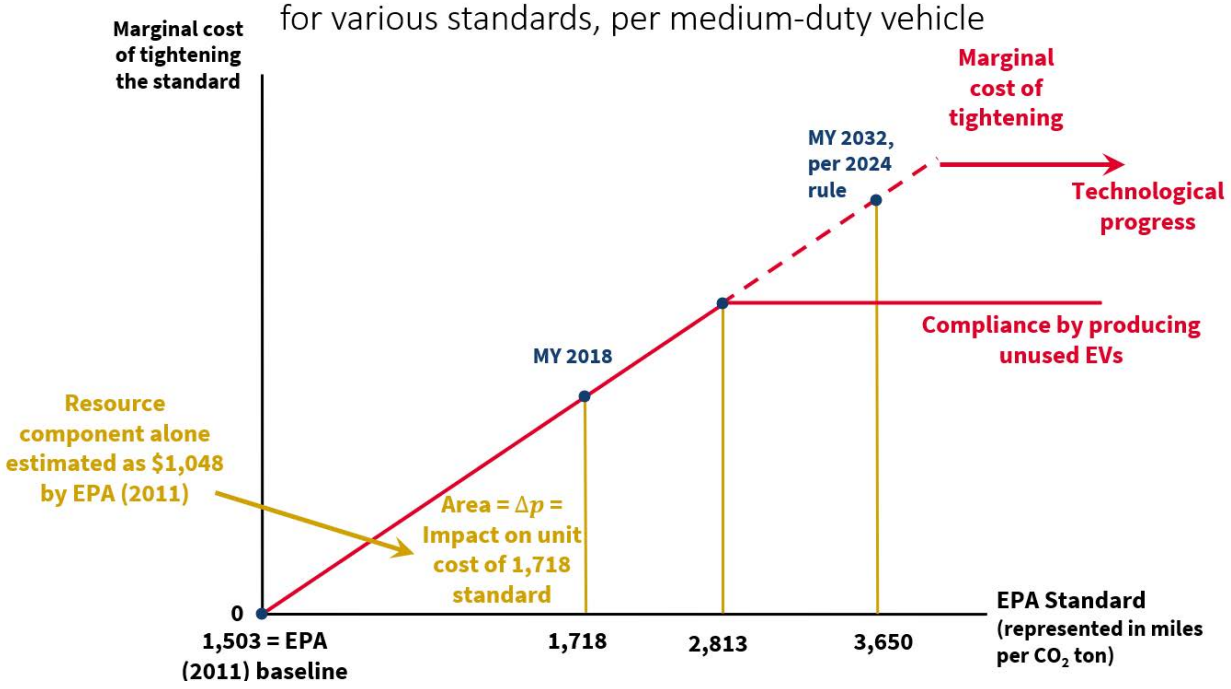
Figure RIA-4. Opportunity and Resource Costs
with unused EV compliance pathway



2.4 Costs of Medium-duty standards

Equations (3) and (4) can describe MD and HD standards too, albeit with different parameters. Unlike LD vehicles, these vehicles were not subject to long-standing fuel-economy standards prior to the 2009 Endangerment Finding. Furthermore, those fuel economy standards are from a different statute with different provisions for relaxing fuel economy requirements. In terms of the notation from equation (4), MPT_0 for MD vehicles can be taken as the fleet average miles per ton of CO_2 in the baseline of the 2011 rule (76 FR 57106), adjusted for technological progress since then. This pins down the *MPT* intercept in Figure RIA-5.

Figure RIA-5. Opportunity and Resource Costs
for various standards, per medium-duty vehicle



Although CEA did not examine credit trades between manufacturers of MD and HD, Figure RIA-5 shows how the marginal-cost slope can be estimated from the EPA's 2011 findings. From a baseline of no-GHG or fuel-economy standards for MD vehicles, the EPA projected (in 2011) that its 2011 rule would add $1,048 to the average cost of a MY 2018 vehicle through vehicle technology costs along (a resource cost). That corresponds to the triangular area in Figure RIA-5. The base of the triangle is between the two emissions levels: 1,503 (baseline) and 1,718 miles per ton of CO_2. That is enough information to pin down the entire marginal cost line (red) in the figure.

For legibility purposes, Figure RIA-5 is not drawn to scale. If it were, the *MPT* values of 2,813 and 3,650 would be far out to the right and the height of the line well above what it would cost to comply with the year 2032 standard by purchasing MD vehicles and parking them, just to have room to sell the ICE vehicles that consumers would want.[89] We estimate that this pathway dominates for standards above 2,813 *MPT*, such as the standard set by the 2024 vehicle rulemaking.

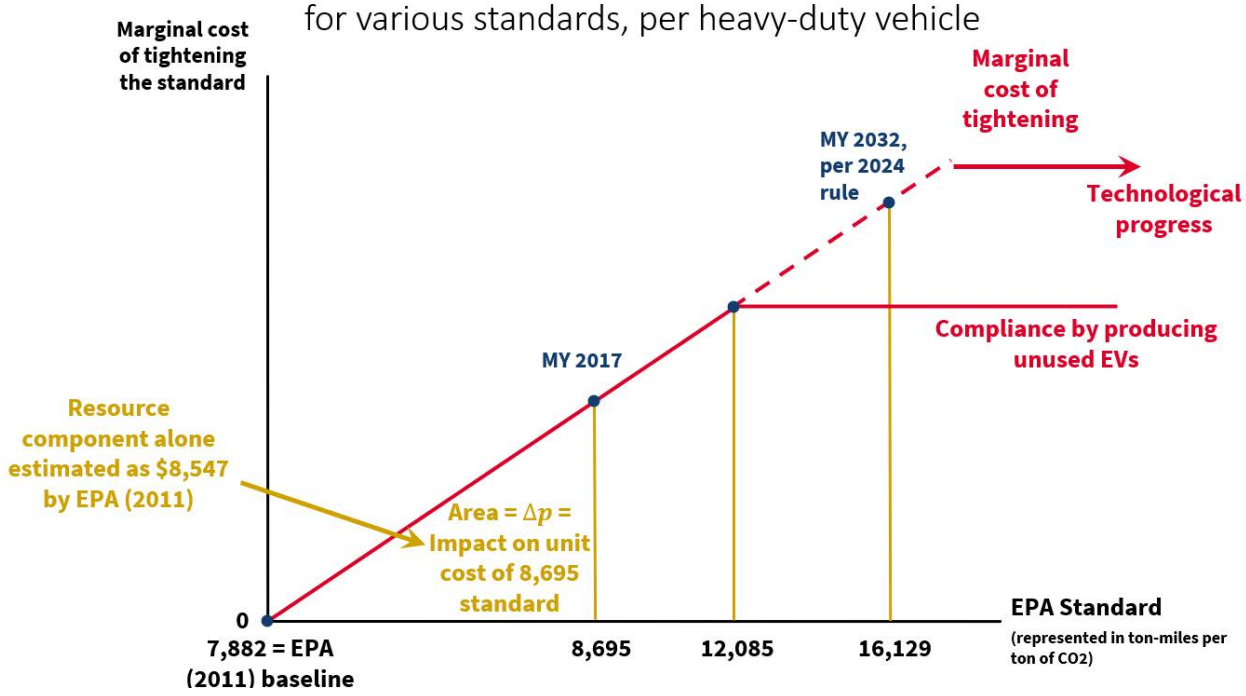
2.5 Costs of Heavy-duty standards

Figure RIA-6 shows the analogous chart for the HD market, except that standards are expressed in freight ton-miles per metric ton of CO_2 emitted. Extrapolating the 2011 rule's estimates (76 FR 57321, converted to 2022 dollars) to the 2024 vehicle rulemaking's target emissions for HD vehicles results in "triangle" costs exceeding the cost of a new HD EV. As Figure RIA-5 does, Figure RIA-6 therefore shows a more economical "unused EV" production compliance pathway beginning at a standard of 12,085 freight-ton miles per ton of CO_2. The 2024 vehicle rulemaking's target for the EV

[89] To put it another way, the near-50 percent EV share target (MY 2032) for MD-vehicles is more than twenty times what the EV share was when the rule was finalized.

share of new HD trucks (89 FR 29440) is also near 50 percent and as such even further outside the range of historical experience than the MD target. As an example of the amount of ambition in the 2024 vehicle rulemaking, its standards were expected to move the EV share of new sleeper-cab tractors–among the heaviest vehicles regulated by the EPA–from zero to 25 percent in a mere three years. Recall from Figure RIA-1 that, in percentage points, that change would be more than triple the fastest three-year change ever experienced by the much lighter LD vehicles.

Figure RIA-6. Opportunity and Resource Costs for various standards, per heavy-duty vehicle



2.6 Model-year specific costs

For each MY 2027-2055 and vehicle-class-scenario, the corresponding per-vehicle combined opportunity and resource cost of the proposed rule is calculated from that year's no-action standard and projected miles (or ton-miles) per ton of CO_2 under the proposed rule as shown in Table RIA-2. The method used in each case is summarized in the following Table.

Table RIA-4. Cost-per-vehicle methods by vehicle class and scenario

Vehicle class	Data source	Method
Light-duty	EPA 2021	Table RIA-3 plus technological change
Light-duty	Market	Figure RIA-3 plus technological change
Medium-duty	EPA 2011	Figure RIA-5 plus technological change
Heavy-duty	EPA 2011	Figure RIA-6 plus technological change

To estimate a rate of technological progress in LD vehicles, we used our automotive trends data for MY 1978 through 2011, before GHG standards were imposed. When real-world MPG was regressed

on year and horsepower, the coefficient on year was 0.553. When weight was added to the regression, the year coefficient was 0.133. Except for sensitivity analysis, the annual rate of progress is taken to be the average of these two, 0.343. It is converted to miles per ton by multiplying by the factor 1,000,000/8,887.

With technological progress modeled in this way, eventually even a strict standard has no cost. Arithmetically, MPT_0 eventually catches up with the MPT-equivalent of target set for the out years by the 2024 vehicle rulemakings. The rate of technological progress for MD vehicles, and the rate for HD vehicles, are each set so that the year of zero cost is the same as it is for LD vehicles.

The average-cost impact of the no-action target $MPT_{no\text{-}action}$ relative to the $MPT_{proposed}$ that would prevail under the proposed rule is $\Delta(MPT_{no\text{-}action})$ - $\Delta(MPT_{proposed})$. Because Table RIA-2's bottom row for MD and HD vehicles corresponds to $\Delta(MPT_{proposed}) = 0$, without technological progress these vehicle classes have:

$$\Delta(MPT_{no-action}) - \Delta\big(MPT_{proposed}\big) = \Delta(MPT_{2018})\left(\frac{MPT_{no-action} - MPT_0}{MPT_{2018} - MPT_0}\right)^2 \quad (5)$$

where and MPT_{2018} and $\Delta(MPT_{2018})$ are the 2018 standard and the EPA per-vehicle cost finding in its 2011 MHDV RIA, respectively, indicated in Figure RIA-5 or RIA-6, depending on the vehicle class. With technological progress, the *MPT* intercept in equation (5)'s numerator is incremented by the amount of technological progress assumed to have occurred between 2018 (2017 for HD, as indicated in the figure) and the MY for which impact is being estimated.

Take, for example, MY 2027 MD vehicles. From Table RIA-2, the no-action *MPT* is 1,000,000/461 = 2,169. From Figure RIA-5, MPT_{2018}, MPT_0, and $\Delta(MPT_{2018})$ are 1,718, 1,503, and $1,048, respectively. The *MPT* intercept for the numerator of (5) is augmented by 81 for technological progress since 2018. Therefore, the deviations in the numerator and denominators are 585 and 215, respectively. When rescaled by the square of the ratio of these two deviations, the 2011 rule's per-vehicle cost of $1,048 shown in the figure becomes $7,782 for the no-action outcome.

3. Vehicle quantities and opportunity costs of reduced vehicle sales

3.1 The price elasticity of vehicle demand

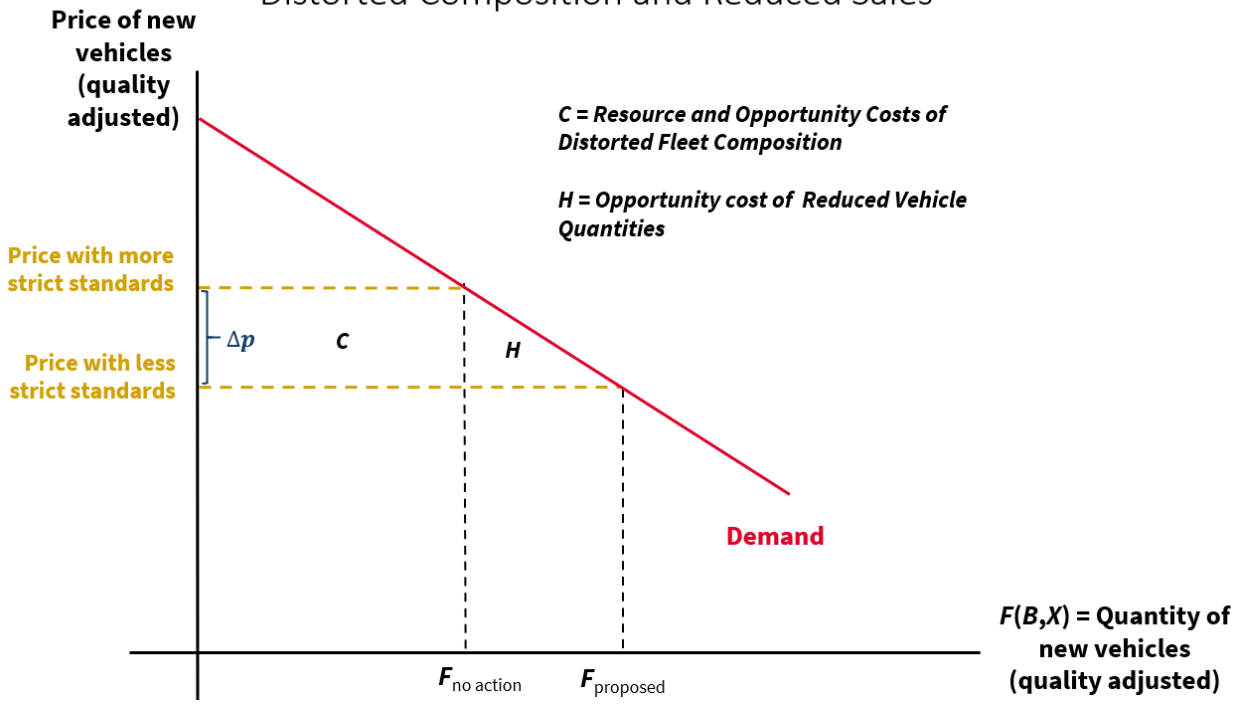
When regulations add to vehicle costs, consumers will purchase fewer vehicles, at least as measured by the quantity index. To quantify this effect, we add a market demand curve to the analysis. Specifically, let $D(F)$ denote the inverse market demand for F. This pins down the equilibrium value of the quantity index F and the price P of a unit of F. Namely, price is related to the quantity index by the demand equation $P = D(F)$, which also equals the marginal cost of supplying F.[90]

Figure RIA-7 illustrates. The resource and opportunity costs savings from the proposed rule for vehicle buyers are equal to the combined area *C* and *H*. The rectangular area *C* by itself represents

[90] Adding constant seller markups between marginal cost and F would further add to the opportunity costs calculated here. The EPA invites comment on whether and how to include markups.

the resource and opportunity costs of distorted vehicle composition. The height of the rectangle is the quality-adjusted price impact calculated with the methods listed in Table RIA-4. In principle, the price impact is applied to the no-action quantity. However, lacking data on the price and quantity without action, we (a) express the price impact as a ratio to the average vehicle price measured in 2025, which is somewhere in between the no-action price and the price that would prevail under the 2024 vehicle rulemaking; (b) multiply the proportionate impact by the corresponding demand factor $F_{no\text{-}action}/F_{proposed}$; and (c) multiply by 2024 revenue for the vehicle class.[91]

Figure RIA-7. Resource and Opportunity Costs
Distorted Composition and Reduced Sales



Regulations that reduce the quantity index have an additional opportunity cost measured as the usual Harberger triangle B in the market diagram having F on the horizontal axis and P on the vertical axis. The EPA continues to assume that the market-level price elasticity of vehicle demand is -0.4 for LD vehicles. When demand has price elasticity equal to the constant $\eta < 0$, the opportunity cost area H is no greater than vehicle-class revenue times $\frac{\left(\frac{P_{no\ action}}{P_{proposed}}\right)^{1+\eta} - 1}{1+\eta}$. The assumed price elasticity for MD and HD is -1, which is in the range of price elasticities used by the EPA in the past.

For example, when LD costs are sourced from the EPA (2021, 86 FR 744, 86 FR 7440), the MY 2032 cost is $6,338 (recall section 2.1), which is at least 13 percent of what the average transaction price would be under the proposed rule. With a price elasticity of -0.4, that translates into a quantity reduction of five percent. The area C is thereby 12.4 percent of revenue under the proposed rule,

[91] As long as the demand for vehicles is price inelastic, this calculus slightly underestimates the dollar amount represented by the area *C* in Figure RIA-7.

and the area H another 0.3 percent. Because that revenue a bit less than revenue in recent years ($765 billion), a slightly conservative estimate of the combined area C+H is $97 billion annually. C+H is less for the years 2027-2031 due to the less stringent standards in those years.

3.2 Vehicle cost categories by model year

Dollar values for the areas *C* (vehicle composition) and *H* (vehicle quantity) are calculated for each vehicle class, scenario, and MY 2027-2055. MYs are combined using either a three or seven percent annual discount rate. The class/scenario summary is either an annualized value for the years 2027-2055 or a net present value from the perspective of the year 2025. These results are shown in the upper rows of Table RIA-5.

Table RIA-5. Benefits and Costs of Eliminating Vehicle GHG Standards
billions of 2022 dollars, annualized over years 2027-2055

	Scenarios			
Scenario name:	EPA3	Market3	EPA7	Market7
Discount %/yr:	3%	3%	7%	7%
LD Cost Source:	EPA	Market	EPA	Market
Benefits				
Opportunity (consumer surplus) and resource cost savings				
Vehicle composition				
Light-duty	81	324	75	302
Medium-duty	9	9	9	9
Heavy-duty	32	32	30	30
Vehicle quantity	17	44	18	42
Strained electric grid	17	21	10	13
Savings on Insurance	2	2	2	2
Savings on EVSE Ports	14	14	14	14
Benefit Total	171	444	157	411
Costs				
Increased congestion	1	1	1	1
Fossil-fuel risk	2	1	2	1
PM emissions	4	3	3	2
Costs Total	8	5	7	5
NET BENEFITS				
Annualized 2027-2055	**164**	**439**	**150**	**406**
NPV to 2025	**3,051**	**8,184**	**1,722**	**4,664**

As expected, the proposed rule is expected to have annualized benefits in the hundreds of billions of dollars for buyers of new LD vehicles. Although small in comparison to the LD benefits, the benefits for buyers of new MD and HD vehicles are substantial, ranging from $9 billion to $32 billion annually, depending on the scenario and class.

4. Opportunity costs of a strained electric grid

EV charging can soak up spare generation and transmission capacity that would otherwise power everything from factories to data-center servers to air-conditioning on the hottest days. At a time when only about five percent of California's registered vehicles were electric, state officials urged residents to "avoid … charging electric vehicles" because "California and the West are expecting extreme heat that is likely to strain the grid."[92] The 2024 vehicle rulemaking aimed for 50 percent EVs nationwide, or about ten times the California grid burden. Additional grid burden would come from electrifying MD and HD vehicles.

The 2021 and 2024 vehicle rulemakings quantified such opportunity costs by assuming that the rules would have little effect on electricity prices or average costs. In contrast, Fitzgerald and Mulligan (2023) modeled EV charging in the face of renewable energy standards and EPA emission standards for LD vehicles. They assumed that essentially all LD vehicles would become electric, which is more ambitious than the EPA's 2024 target. However, they did not consider any additional electricity demand from the more energy intensive MD and HD vehicles that would also be about half electric under the 2024 vehicle rulemakings.

The Fitzgerald and Mulligan approach assumes that supply meets demand and is allocated to the highest-value uses. The cost of electrifying vehicles would be even greater if it led to blackouts or misallocation of the available supply. With these caveats, this Appendix uses the Fitzgerald and Mulligan estimates.

The green curve in Figure RIA-2 represents the supply of electricity generated from renewables. The black curve is the supply of fossil-fuel generated electricity, shown as a mirror so that movements to the right in Figure RIA-2 represent a substitution on the supply side from fossil-fuel generation to renewable energy. The point *a* indicates the quantity and wholesale price of electricity produced from renewable sources under the proposed rule, assuming that the Biden administration's 80 percent renewable goal is realized. The point *b* corresponds to fossil-fuel produced electricity under the proposed rule. The points *c* and *d* are their analogues under the baseline of the 2024 vehicle rulemakings.[93] Together, they involve 1 TWh more electricity usage than under the proposed rule.

Figure RIA-2's combined areas *A*, *B*, and *C* measure the proposed rule's annual savings of resources for generating electricity. Part of this savings is already counted in consumer surplus, which reflects the choices of consumers who considered vehicles options at a time when the wholesale price of electricity was about $50 per MWh. The additional cost of $57 per MWh would

[92] California ISO. (August 30, 2022). "Excessive heat starting tomorrow will stress energy grid" https://www.caiso.com/Documents/excessive-heat-starting-tomorrow-will-stress-energy-grid.pdf.
[93] The heights of *a*, *b*, *c*, and *d* are, in dollars per MWh, 117, 29, 136, and 30. See Fitzgerald, T. and Mulligan, C.B. (2023). The Economic Opportunity Cost of Green Recovery Plans, Table 2.

either require government subsidies, or be passed onto consumers.[94] In aggregate, the additional cost shown in Figure RIA-2 would amount to $57 billion annually. We assume that one-third is associated with HD vehicles and the other two-thirds to LD and MD.

To the extent that the quantity of EVs increases even without regulatory incentives, or the EV share of the stock has yet to catch up to the EV share of new sales, only part of the $57 billion applies. For each MY and vehicle class, the full amount is rescaled by the ratio the impact of the rule on the EV share to the change in the EV share from the year 2025 that is required to meet the year 2032 standards. The annualized cost savings, combined across vehicle classes, ranges from $10 billion to $21 billion, depending on the discount rate and compliance scenarios. See Table RIA-5.

5. Market-equilibrium emissions

U.S. vehicles are not, and will not be, the only source of GHG and particulate emissions. It is therefore essential to anticipate the effect of vehicle regulations on other emission sources. The 2024 vehicle rulemaking recognized vehicle-market emissions substitution in the form of shifts toward EVs that increase the demand for fossil fuels by the electricity-generation sector. However, another source of substitution in the vehicle market is changes in the intensity of use. As the 2024 vehicle rulemakings would, by design, create a shortage of ICE vehicles and a surplus of EVs, per-vehicle utilization of ICE vehicles would increase while utilization of EVs would fall. Eliminating GHG standards for vehicles would have the opposite effect.

Substitution will also occur in fossil-fuel markets. Vehicle regulation shifts one component of fossil-fuel demand, which unmistakably spills over onto supply and other elements of fossil-fuel demand.

5.1. The Vehicle Inventory

Whereas the opportunity and resource costs of regulating vehicle manufacturer are primarily linked to each cohort of new vehicles, emissions effects depend on the Nation's entire inventory of vehicles and their utilization. To translate changes in the composition and number of new vehicles into inventory composition and number, we begin with an observed age distribution separately for LD, MD, and HD vehicles.[95] An age distribution is considered as a vector. The impact of the proposed action on the number of ICE vehicles in the Nation's inventory is estimated as the dot product of the age distribution vector and the vector whose elements are the impact factor of the proposed action (ratio of proposed action to no-action) for number of new ICE vehicles each year in the past. For example, if six percent of the vehicles are less than one year old and the first year of the rule cut ICE vehicle sales in half, then the impact factor for the number of ICE vehicles in inventory would be estimated as 0.06*0.5 + (1-0.06)*1 = 0.97. Solely for the purposes of simulating

[94] In the latter case, the sale of EVs would encounter even more consumer resistance than already modeled in the vehicle-cost sections of this DRIA.

[95] https://nepis.epa.gov/Exe/ZyPDF.cgi/P100OXEO.PDF?Dockey=P100OXEO.PDF and Table 3.16 of https://tedb.ornl.gov/wp-content/uploads/2022/03/TEDB_Ed_40.pdf.

inventories and emissions, the new-vehicle share of EVs is assumed to never fall below nine percent for LD, two percent for MD, and one percent for HD vehicles.

5.2. Fossil-fuel market equilibrium

Vehicle regulation shifts one component of fossil-fuel demand, which unmistakably spills over onto supply and other elements of fossil-fuel demand. This Appendix translates fleet emissions impacts into worldwide emissions using fossil-fuel supply and demand.

Worldwide fossil-fuel is the sum of demands for its various uses, one of which is powering vehicles in the U.S. The EPA vehicle standards potentially reduce the demand for fossil fuels to power U.S. vehicles. If the standards do not shift world supply or other components of world demand, then the equilibrium change in worldwide fossil-fuel use is between zero and the amount by which the EPA standards shift the demand coming from U.S. vehicles. Except in the one-for-one limiting case, reduced emissions from U.S. vehicles are at least partly offset by increased emissions from other uses due to a reduced world price of fossil fuels.[96]

By ignoring fossil-fuel market equilibrium, the 2021 and 2024 vehicle rulemakings implicitly assume the limiting one-for-one case. More realistically, if the worldwide supply and demand for fossil fuels are equally price elastic (or equally inelastic) but with opposite signs, then the equilibrium change in worldwide fossil-fuel use is half the shift from U.S. vehicles. This omission alone resulted in exaggerated emissions effects in the 2024 vehicle rulemakings. The EPA seeks comment on assessing the fossil-fuel market substitution effects resulting from U.S. GHG emissions standards.

5.3. Particulate emissions

The impact of the proposed action on worldwide PM emissions ($PM_{2.5}$) is assumed to be proportional to its impact on GHG emissions. For the purposes of projecting U.S. health consequences of PM emissions, it matters whether where the emission changes. That is, part of the GHG emissions offset is not an offset for U.S. PM emissions because some of the change in fossil-fuel use is outside the U. S. The EPA seeks comment on quantifying this part. For the purposes of this Appendix, this Appendix assumes that all of the offset is outside the U.S., or in a part of the U.S. that does not affect U.S. health. This assumption serves to exaggerate the increase in particulate matter emissions that would result from this proposed action.

5.4. Utilization scenarios

As the Nation's fleet of vehicles is pushed from the supply side to become more EV intensive, the lifetime utilization rate of EVs will fall. Earlier adopters of EVs tend to be more interested in driving them, as suggested by their willingness to pay the higher retail prices that prevail early in the market life cycle. For similar reasons, the lifetime utilization rate of ICE vehicles is expected to increase when new ICE vehicles become scarce. This Appendix models utilization responses with a function

[96] Due to the size of the worldwide market, an EPA emissions standard may have just a small effect on the world price, but that small price change applies to the much larger worldwide quantity.

$f(B/X)$ that maps the ratio of EVs to ICE vehicles to the relative utilization rate of ICE vehicles.[97] In this notation, the 2021 and 2024 vehicle rulemakings' assumption of constant lifetime mileage ("Vehicle miles traveled") amounts to an assumption that f is inelastic to B/X.

ICE vehicle usage patterns leave plenty of room for increased utilization rates in response to regulatory incentives. Especially, vehicles are parked more than 90 percent of the time. Consumers can also spend resources extending the life of their ICE vehicles, including the ICE vehicles they purchase in MY 2027 and beyond. This Appendix assumes that the elasticity of the ICE-vehicle utilization rate, as a ratio to the EV utilization rate, has an elasticity of 0.3 with respect to the number of registered EVs per registered ICE vehicle. In other words, the utilization-rate changes occur, but not enough to fully offset the reduction in ICE quantities that result from GHG standards. Indeed, 0.3 is closer to no change than a full offset.

[97] Although the 2024 LDHD RIA discusses "vehicle scrappage" in connection with maintenance costs, its emissions simulations assume that vehicles sold during model years 2027 and later are driven an average of 195,264 regardless of the vehicle standard or powertrain. It assumes 225,865 miles for light trucks (p. 12-12).

Introduction Form

(by a Member of the Board of Supervisors or the Mayor)

I hereby submit the following item for introduction (select only one):

- ☐ 1. For reference to Committee (Ordinance, Resolution, Motion or Charter Amendment)
- ■ 2. Request for next printed agenda (For Adoption Without Committee Reference)
  (Routine, non-controversial and/or commendatory matters only)
- ☐ 3. Request for Hearing on a subject matter at Committee
- ☐ 4. Request for Letter beginning with "Supervisor _____ inquires…"
- ☐ 5. City Attorney Request
- ☐ 6. Call File No. _____ from Committee.
- ☐ 7. Budget and Legislative Analyst Request (attached written Motion)
- ☐ 8. Substitute Legislation File No. _____
- ☐ 9. Reactivate File No. _____
- ☐ 10. Topic submitted for Mayoral Appearance before the Board on _____

The proposed legislation should be forwarded to the following (please check all appropriate boxes):

☐ Small Business Commission ☐ Youth Commission ☐ Ethics Commission

☐ Planning Commission ☐ Building Inspection Commission ☐ Human Resources Department

General Plan Referral sent to the Planning Department (proposed legislation subject to Charter 4.105 & Admin 2A.53):

☐ Yes ☐ No

(Note: For Imperative Agenda items (a Resolution not on the printed agenda), use the Imperative Agenda Form.)

Sponsor(s):

Walton, Sauter, Chen, Fielder, Chan

Subject:

[Opposing the U.S. Environmental Protection Agency's Proposal to Rescind the 2009 Greenhouse Gas Endangerment Finding]

Long Title or text listed:

Resolution opposing the U.S. Environmental Protection Agency's proposal to rescind the 2009 Greenhouse Gas Endangerment Finding, urging the Bay Area Air Quality Management District to adopt a similar position, and reaffirming the City and County of San Francisco's commitment to strong climate action and air quality protections.

Signature of Sponsoring Supervisor: /s/ Shamann Walton