NESCAUM
www.nescaum.org
The Clean Air Association of the Northeast States
101 Merrimac Street, 10th Floor Boston, MA 02114
Phone 617-259-2000 Fax 617-742-9162
Arthur N. Marin, Executive Director

November 26, 2008

Stephen L. Johnson, Administrator
U.S. Environmental Protection Agency
Air and Radiation Docket and Information Center
Mail Code 2822 T
1200 Pennsylvania Avenue, NW
Washington, DC 20460

Attention: Docket ID No. EPA-HQ-OAR-2008-0318

Re: *Regulating Greenhouse Gas Emissions under the Clean Air Act – Advance Notice of Public Rulemaking*

Dear Administrator Johnson:

The Northeast States for Coordinated Air Use Management (NESCAUM) offer the following comments on the U.S. Environmental Protection Agency's (EPA's) Advance Notice of Proposed Rulemaking (ANPR), published on July 30, 2008 in the Federal Register, entitled *Regulating Greenhouse Gas Emissions under the Clean Air Act* (73 FR 44354 – 44520). NESCAUM is the regional association of air pollution control agencies representing Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, and Vermont.

EPA is to be commended for putting forth a broad vision for regulating greenhouse gases (GHGs) under the Clean Air Act (CAA). In the ANPR, EPA presents a number of issues and reasoned considerations along with substantial opportunities for comment on each issue. We congratulate EPA for opening the public discourse over the CAA's role in addressing the greatest environmental challenge of our time in a thoughtful and reasoned manner.

In commending EPA for its broad efforts, we also request that EPA focus on its immediate responsibility to respond to the Supreme Court's decision in the case of *Massachusetts v. EPA*, 127 S.Ct. 1438 (2007). In that case, the Court found that EPA was obliged under the law to issue an "endangerment" finding to determine whether GHGs "cause, or contribute to, air pollution which may reasonably be anticipated to endanger public health or welfare" [CAA § 202(a)]. Specifically, the Court ruled that EPA must decide whether new motor vehicle GHG emissions meet that endangerment test, or explain why scientific uncertainty is so profound that it prevents making a reasoned judgment on such a determination. If EPA finds that new motor vehicle GHG emissions meet the endangerment test, then CAA § 202(a) requires EPA to set motor vehicle emission standards for GHG pollutants. While there are significant challenges associated with regulating GHGs under the CAA, many of the issues raised by EPA in the ANPR are outside the scope of the Supreme Court's opinion; resolving them must not serve to delay the issuance of an endangerment finding and the promulgation of motor vehicle GHG standards.

With regard to endangerment under CAA § 202(a), there is broad consensus that manmade emissions are contributing to adverse changes in climate and that these impacts will get worse over time without corrective action. The international scientific community, under the auspices of the International Panel on Climate Change (IPCC), has concluded, "*Observational evidence from all continents and most oceans shows that many natural systems are being affected by regional climate changes, particularly temperature increases*."[1] We believe the science reveals that the onset of climate change-related threats is already affecting our member states, this nation, and the world. Further, EPA has already prepared and vetted a positive endangerment finding as part of the work done for the President's Executive Order from May 14, 2007, "*Cooperation among Agencies in Protecting the Environment with Respect to Greenhouse Gas Emissions from Motor Vehicles, Nonroad Vehicles, and Nonroad Engines.*" Given the clear direction provided by the Supreme Court, the strong consensus of the international scientific community, and EPA's own analysis regarding the threat posed by climate change, EPA is obliged to list GHGs as pollutants under the CAA, make an affirmative endangerment finding under CAA § 202(a)(1), and establish federal motor vehicle GHG emission standards.

EPA deserves much credit for bringing forward in the ANPR the numerous aspects of GHG regulation under the CAA. These aspects, however, should not detract EPA from moving decisively on the matter immediately at hand – making the required endangerment finding under CAA § 202(a). While we provide comments on these other issues in attachments to our main comments, they are not offered with the view that they are germane to the required CAA § 202(a) endangerment finding, nor is it necessary that all these issues be resolved prior to EPA making the required § 202(a) finding. Many of the additional issues raised by EPA that are outside the scope of a § 202(a) finding will benefit from fuller commentary in separate, more focused future notices of proposed rulemakings (NPRs).

Greenhouse Gases are Air Pollutants under Clean Air Act § 202(a) (73 FR 44423)

There is no question that EPA should define GHGs as air pollutants under CAA §202(a). As held by the Supreme Court, "Because greenhouse gases fall well within the Clean Air Act's capacious definition of air pollutant, we hold that EPA has the statutory authority to regulate the emission of such gases from new motor vehicles" [*Massachusetts v. EPA*, 127 S.Ct. 1438 (2007)].

NESCAUM supports defining GHGs for purposes of "air pollution" under the CAA as the combined six GHGs – carbon dioxide, nitrous oxide, methane, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride rather than defining each GHG species as individual air pollutants.

[1] IPCC, Summary for Policymakers. 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 (2007).

EPA's Public Pronouncements Compel It to Find that GHGs Endanger Public Health or Welfare (73 FR 44427)

We strongly reiterate that for purposes of an endangerment finding in accordance with *Massachusetts v. EPA* [127 S.Ct. 1438 (2007)], EPA must focus its reasoning solely on the statutory language of CAA § 202(a). What flows from this finding with regards to other provisions of the CAA should be the subject of future rulemakings, and can not be a consideration in making the finding required by CAA § 202(a).

The relevant language of CAA § 202(a) states:

> The Administrator shall by regulation prescribe (and from time to time revise) in accordance with the provisions of this section, 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 his judgment cause, or contribute to, air pollution which may reasonably be anticipated to endanger public health or welfare. [42 U.S.C. § 7521(a)(1)]

It is clear from the Supreme Court's opinion in *Massachusetts v. EPA* and EPA's own statements in various venues that it would be difficult for EPA at this stage to make anything other than an affirmative finding that GHGs cause or contribute to air pollution endangering public health or welfare.

In *Massachusetts v. EPA*, the Supreme Court wrote:

> The harms associated with climate change are serious and well recognized. Indeed, the NRC [National Research Council] Report itself -- which EPA regards as an "objective and independent assessment of the relevant science," 68 Fed. Reg. 52930 -- identifies a number of environmental changes that have already inflicted significant harms, including "the global retreat of mountain glaciers, reduction in snow-cover extent, the earlier spring melting of rivers and lakes, [and] the accelerated rate of rise of sea levels during the 20th century relative to the past few thousand years ...." NRC Report 16. [127 S.Ct. at 1455]

The Supreme Court further pointed out, "EPA does not dispute the existence of a causal connection between man-made greenhouse gas emissions and global warming." [127 S.Ct. at 1457]

EPA has issued statements in other instances indicating that the EPA Administrator has completed his scientific review of climate change science and concluded that greenhouse gas emissions have adverse effects on the climate.[2] In his decision to deny California's wavier request under CAA § 209 [73 Fed. Reg. 12156 (March 6, 2008)], the Administrator cited the IPCC that global warming "is unequivocal and is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global sea level." 73 Fed. Reg. 12165/2, *citing* IPCC (2007) Summary for Policymakers. EPA recognized that "[t]he IPCC projects with virtual certainty declining air quality in U.S. and other world cities due to warmer and fewer cold days and nights and/or warmer/more frequent hot

[2] *See, for example,* Writ of Mandamus filed by the Commonwealth of Massachusetts et al. in the U.S. Court of Appeals for the District of Columbia Circuit re: *Massachusetts v. EPA*, Docket No. 03-1361 (April 2, 2008).

days and nights over most land areas." *Id., citing* IPCC (2007) Summary for Policymakers. The EPA Administrator also expressly concluded that greenhouse gas emissions, including from motor vehicles, are contributing to global warming. *Id.* at 12165 ("It is widely recognized that greenhouse gases have a climatic warming effect."); *Id.* at 12162 (acknowledging the contribution of motor vehicle emissions to global greenhouse gas concentrations). The Administrator also catalogued the diverse dangers that such warming will pose to public health or welfare. For example, he specifically found that "[s]evere heat waves are projected to intensify in magnitude and duration over portions of the U.S. where these events already occur, with likely increases in mortality and morbidity, especially among the elderly, young, and frail." *Id.* at 12167/2. The Administrator made these findings after a full notice and comment process.

Furthermore, EPA states in the present ANPR;

> The range of potential impacts that can result from climate change spans many elements of the global environment, and all regions of the U.S. will be affected in some way. The U.S. has a long and populous coastline. Sea level rise will continue and exacerbate storm-surge flooding and shoreline erosion. In areas where heat waves already occur, they are expected to become more intense, more frequent, and longer lasting. Wildfires and the wildfire season are already increasing and climate change is expected to continue to worsen conditions that facilitate wildfires. Where water resources are already scarce and overallocated in the western U.S., climate change is expected to put additional strain on these water management issues for municipal, agricultural, energy and industrial uses. Climate change also introduces an additional stress on ecosystems which are already affected by development, habitat fragmentation, and broken ecological dynamics. There is a wide range in the magnitude of these estimated impacts, with there being more confidence in the occurrence of some effects and less confidence in the occurrence of others. [73 FR 44427]

It is clear from the extent of pronouncements publicly put forth by EPA and the scientific body of information it has cited that the Administrator has determined for all intents and purposes that GHG emissions endanger public health and/or welfare. This compels the EPA to follow through with an affirmative endangerment finding for the pending decision under CAA § 202(a).

Science Supports a Finding that GHGs Endanger Public Health or Welfare (73 FR 44428)

In addition to focusing only on CAA § 202(a) in the Administrator's endangerment deliberations, he must also base his decision solely on science. As stated by the Supreme Court in *Massachusetts v. EPA*, "The statutory question is whether sufficient information exists to make an endangerment finding." [127 S.Ct. at 1463] "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, EPA must say so." *Id.* Otherwise, it must make an affirmative or negative endangerment determination.[3]

EPA's Endangerment Analysis Technical Support Document (TSD) clearly provides more than sufficient scientific information supporting an affirmative endangerment determination. In the TSD, EPA recognizes that the body of scientific information, as summarized by the IPCC's

---

[3] *See* Writ of Mandamus filed by the Commonwealth of Massachusetts *et al.* in the U.S. Court of Appeals for the District of Columbia Circuit re: *Massachusetts v. EPA*, Docket No. 03-1361 (April 2, 2008).

Fourth Assessment Report in 2007, clearly connects GHG emissions with a warming planet as the result of climate change.

> 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.[4]

EPA also recognizes that the IPCC projected continued GHG emissions at or above current rates will "cause further warming and induce many changes in the global climate system during the 21st century that would very likely [90–99% probability of occurrence] be larger than those observed during the 20th century."[5] The TSD catalogues numerous harmful effects to human health and welfare from current and projected global warming. The information presented by EPA in the TSD reflects a large and robust body of scientific information developed over many years on the impacts of GHGs on climate change. The scientific evidence has been peer reviewed, and many of the studies have been subject to and withstood robust scrutiny. In light of the scientific evidence as catalogued by EPA and the IPCC, the views given in EPA's public statements, and the large contribution of mobile sources to U.S. GHG emissions, the Administrator can reach no other reasonable conclusion but to determine that GHG emissions endanger public health or welfare under CAA § 202(a).

<u>Promulgation of Regulations to Reduce GHG Emissions from Mobile Sources (73 FR 44432)</u>

According to EPA, mobile sources accounted for 29 percent of total U.S. GHG emissions in 2006. It is also the fastest growing source of U.S. GHGs, having increased by 47 percent since 1990. It is the largest collective end-use source of carbon dioxide emissions among U.S. source sectors, and its share is even higher when considering full lifecycle emissions associated with motor vehicles, such as extraction and refining of fuel, and vehicle manufacturing.[6]

We are faced with the need to reduce 80 percent of GHG emissions by 2050 if we are to stabilize the earth's climate at a 2.0 to 2.4 C global average temperature increase over today's average temperature.[7] It is a reasonable assumption that in order to reach the 80 percent goal, deep reductions will need to be made across all sectors – including both mobile and stationary sources. These reductions must be achieved from today's emissions levels, and must be over and above increases that result from growth in mobile source fleets and activity. This goal cannot be achieved without major reductions from all mobile sources. Given the enormity of this task, we cannot afford to leave on the table any potentially available GHG reductions.

---

[4] EPA. Technical Support Document for Endangerment Analysis for Greenhouse Gas Emissions under the Clean Air Act, Sixth Order Draft (June 21, 2008) (hereinafter "EPA Endangerment Analysis TSD"), at 21; *citing* IPCC, Summary for Policymakers. 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 (2007).

[5] EPA. Endangerment Analysis TSD at 42 with accompanying footnote 31; *citing* IPCC, Summary for Policymakers (2007) (see above citation). As noted by EPA, the IPCC's use of "very likely" conveys a 90 percent to 99 percent probability of occurrence.

[6] EPA. Transportation and Climate, available at http://www.epa.gov/otaq/climate/ (accessed November 3, 2008).

[7] IPCC. *Climate Change 2007 Synthesis Report,* November, 2007.

As the ANPR states, the President's 2004 State of the Union speech outlining the "20 in 10" proposal formed the basis for the mobile source GHG reductions developed by EPA in this document. A primary goal of the "20 in 10" proposal was to reduce the nation's dependence on foreign oil. The proposed reductions that would result from light-duty vehicles as outlined in the ANPR would be sufficient to meet the "20 in 10" goal, but are insufficient to set the nation on a path to meet the long-term GHG reductions required to stabilize the climate. Likewise, EPA relies on the National Highway Traffic Safety Administration (NHTSA) analysis conducted for the light-duty corporate average fuel economy (CAFE) standards in the ANPR. This analysis is sufficient to allow the U.S. Department of Transportation (DOT) to further its mission of reducing oil consumption as required by federal energy legislation. This analysis and its conclusions, however, are not sufficient for EPA's obligation under the CAA to reduce GHG emissions for purposes of protecting public health and welfare. As the Supreme Court ruled in *Massachusetts v. EPA*, EPA and DOT have different missions under different laws that can coexist together;

> EPA has been charged with protecting the public's 'health' and 'welfare,' 42 U.S.C. 7521(a)(1), a statutory obligation wholly independent of DOT's mandate to promote energy efficiency. See Energy Policy and Conservation Act. S.2(5). 89 Stat. 874, 42U.S.C. s.6201(5). The two obligations may overlap, but there is no reason to think the two agencies cannot both administer their obligations and yet avoid inconsistency. [549 U.S. ____ (2007); slip op. at 29]

The recent passage of the Energy Independence and Security Act of 2007 (EISA) did nothing to alter this. After the Supreme Court handed down its opinion in *Massachusetts v. EPA*, Congress had the opportunity to modify the respective roles of EPA and DOT under their separate statutory authorities. Congress explicitly did not do so:

> Except to the extent expressly provided in this Act, or an amendment made by this Act, nothing in this Act or an amendment made by this Act supersedes, limits the authority provided or responsibility conferred by, or authorizes any violation of any provision of law (including a regulation), including any energy or environmental law or regulation. [*See* EISA § 3, 121 Stat. 1492, 1498]

As is clear from the different statutory goals, NHTSA's CAFE analysis is not sufficient to meet EPA's requirements under the CAA. The CAA is a technology-forcing statute and EPA can and should promulgate mobile source control measures that are considerably more aggressive than those described in this ANPR. A GHG regulation for mobile sources must force the development of new technologies in order to achieve the greatest feasible reductions in mobile source GHG emissions. NESCAUM urges EPA to establish the most stringent feasible GHG regulations for all highway and nonroad mobile sources in order to meet climate stabilization targets by 2050. Specific comments on those sources are provided in Attachment A. As a starting point, we recommend that EPA review the study conducted in 2004 by Northeast States Center for a Clean Air Future (NESCCAF, a non-profit sister organization of NESCAUM), entitled "*Reducing Greenhouse Gas Emissions from Light-Duty Motor Vehicles*," which is provided in Attachment G. The study concluded that light-duty GHG emissions can be reduced more than 45 percent in the 2009 to 2015 timeframe in a cost-effective manner assuming a gasoline price of $2.00 per gallon. Further, the results showed it is technically feasible to achieve even greater reductions in GHGs – up to 54 percent – with advanced technologies by 2015. Since the publication of the study in 2004, significant changes in the industry have occurred, such as announcements by several manufacturers of plans to sell plug-in hybrid and all-electric vehicles in 2010. These recent developments mean that substantial, additional reductions will be technically feasible between now and 2015, as well as beyond.

Summary of Comments

We congratulate EPA for presenting a wide range of issues and options available for regulating GHGs under the Clean Air Act. Many of these issues and options, however, should not detract EPA from making the necessary endangerment finding under CAA § 202(a) as directed by the Supreme Court in *Massachusetts v. EPA*. First and foremost among all available CAA options, EPA must quickly and immediately act in this specific regard.

The climate change threat is imminent. Much time has been lost at the federal level through delays, deferrals, and denials. Congress has not been able to pass climate legislation to date, and while it is poised to act in the next session, passage of new law is not a given. Even if Congress can agree on acceptable climate policy in the coming year, implementation is likely to take some time. In the meantime, states acting individually and in regional concert have taken strong and decisive steps, such as the Regional Greenhouse Gas Initiative (RGGI) in the Northeast.

We need effective federal climate legislation, but we no longer have the luxury of waiting for it. EPA must move forward now with the tools on hand. These tools include implementing CAA § 202(a) and the other provisions of the CAA, as well as encouraging, enhancing, and honoring state climate initiatives. The CAA and state initiatives are important bridges to future comprehensive federal climate policy, and can help install the building blocks needed for any forthcoming national climate program.

While these comments focus on the pressing and immediate issue of CAA § 202(a), we also provide commentary on other aspects of the CAA in the attachments (see Attachments A-G). These other aspects deserve more focused future consideration through separate and timely NPRs.

In summary:

- Under CAA § 202(a), EPA must make a decision solely within the confines of § 202(a) and EPA must base its decision solely on the available climate change science;
- EPA should define GHGs as air pollutants under CAA §202(a);
- EPA should make an affirmative endangerment finding that GHGs endanger public health or welfare under CAA § 202(a);
- In making an affirmative endangerment finding under § 202(a), EPA must quickly move to regulate GHGs from mobile sources;

- EPA should quickly issue future NPRs that focus on other tools and options available under the CAA for fuller and more complete consideration of all potential aspects of the full suite of available measures to address GHGs, as well as how to integrate these tools with climate efforts already being developed and implemented by regional initiatives such as RGGI.

If you or your staff has any questions regarding the issues raised in our comments, please contact Coralie Cooper (617-259-2022) or Paul Miller (617-259-2016) of NESCAUM.

Sincerely,

Arthur N. Marin
Executive Director

Attachment A: Specific Comments on GHG Regulations for Mobile Sources
Attachment B: Economic Analyses Approaches
Attachment C: Aircraft Emission Reduction Approaches
Attachment D: NAAQS as a Potential Regulatory Mechanism
Attachment E: Considerations for GHG Trading
Attachment F: Regulating GHGs from Stationary Sources
Attachment G: Reducing Greenhouse Gas Emissions from Light-Duty Motor Vehicles

Cc: NESCAUM Directors
Brian McLean, EPA/OAR
Rob Brenner, EPA/OPAR
Margo Oge, EPA/OTAQ
Steve Page, EPA/OAQPS
Carol Holmes, EPA/OGC
John Hannon, EPA/OGC
Joe Dougherty, EPA/OAR

Attachment A
Specific Comments on GHG Regulations for Mobile Sources

General Comments on Light-duty Vehicles

EPA has requested comment on the results of its analysis to evaluate potential GHG reductions from light-duty vehicles. We provide two general comments on the analysis here. First, the updated EPA 2008 light-duty vehicle analysis presented in the ANPR assumes a 4 percent per year reduction in GHG emissions between 2011 and 2020. This level of reduction corresponds to both the requirements of the President's "20 in 10" proposal as outlined in the 2004 State of the Union speech and also to the U.S. DOT's analysis conducted in response to the Energy Independence and Security Act of 2007 (EISA). NESCAUM notes that while the levels of GHG reductions presented in the ANPR are sufficient to meet the goals of the President's proposal and the EISA legislation, they are not sufficient to address the urgent problem of global climate change. It is the mission of the EPA to address this pressing environmental problem.

Second, the updated 2008 analysis departs from traditional mobile source standard setting analyses that EPA has conducted in the past. For other regulations, including but not limited to Tier 2, heavy-duty highway diesel, nonroad diesel, and locomotive and marine rules, EPA has established standards that achieve the greatest technically feasible reductions in the sector, taking costs into consideration. In the approach outlined in the ANPR, EPA has chosen to abandon this traditional approach and instead relies on approaches that either: 1) assume a predetermined GHG reduction per year, or 2) establish a GHG standard at a level where the estimated benefits to society exceed the estimated cost of the rule by the highest amount. We urge EPA in the NPR for GHGs that will follow this ANPR to return to its traditional, technology-forcing approach for developing mobile source emission standards. In addition, we encourage EPA to extend the timeframe for the light-duty GHG evaluation to 2030 or later. Historically, in technical analyses for mobile source emission reduction programs, EPA has evaluated the emissions benefits of a program for 20 to 30 years from the date of implementation. We urge EPA to return to this approach in this instance as well.

Results of the Volpe Modeling Exercise (73 FR 44443)

The "fixed percent per year" and the "optimized approach" as detailed in EPA's Technical Support Document (TSD) give conservative estimates of potential light-duty vehicle GHG reductions. Given the importance of the model outputs to the stringency of future regulation, the inputs or assumptions used in the model must be accurate. Unfortunately, EPA's assumptions on potential GHG reductions and technology availability are too conservative. Below, NESCAUM comments on specific assumptions and inputs used in the modeling exercise and detailed in the ANPR TSD and mobile source section.

Technology Adoption Rates (73 FR 44443)

These comments are based on a review of Table II.D.3-10 in the document entitled "Vehicle Technical Support Document: Evaluating Potential GHG Reduction Programs for Light Vehicles." Table II.D.3-10 indicates the assumed percent penetration of different types of light-duty technologies in different calendar years in the optimized Volpe model scenario. The assumptions about the penetration of technologies generally are very conservative – too conservative given product plans already announced by manufacturers. Examples for conventional technologies are the following:

Turbocharging and downsizing – the assumption used in the optimized scenario analysis is that in 2018, 3 percent of vehicles will include turbocharging and downsizing technology. Manufacturers have announced recently very aggressive changes to their product designs that include the use of turbocharging and downsizing on a significant number of vehicles. For example, Ford Motor Company has stated that it will include turbocharging and downsizing ("Ecoboost" technology) on 90 percent of Ford nameplates by 2013.[8] Other manufacturers are also expanding their use of turbocharging and downsizing.

Cylinder deactivation – the model assumes that approximately 18 percent of the fleet will have cylinder deactivation by 2018. Given the number of models with cylinder deactivation currently on the market, a higher penetration rate for this technology should be assumed.

Electric power steering – Ford has stated that 100 percent of its nameplates will have electric power steering by 2018. The assumption in EPA's modeling was that 25 percent of vehicles will have electric power steering.

Future Assumptions about Advanced Technologies (73 FR 44441)

Plug-in hybrids – A number of companies including GM, Ford, Toyota, and Chrysler have announced the production of plug-in hybrid vehicles. EPA assumed in its modeling for the GHG ANPR that 12 percent of cars and 7 percent of pick-up trucks would be plug-in hybrids by 2020. EPA's assumed penetration of plug-in hybrids should be higher in a technical analysis of potential light-duty GHG reductions, given the great interest in this emerging technology.

Battery Electric Vehicles – EPA did not assume the introduction of any pure electric vehicles in their modeling. Given the announcements by Nissan and other automobile manufacturers of plans to introduce battery electric vehicles in the 2010 timeframe, this technology should be included in any analysis of potential GHG reductions for light-duty vehicles.

Use of light-weight materials – The use of light-weight materials such as composites and aluminum should be assumed beginning in 2015 or earlier. These materials hold the potential to reduce GHG emissions significantly and are available now for use by the automotive industry. A Northeast States Center for a Clean Air Future (NESCCAF) study of potential light-duty vehicle GHG reductions estimated that for each percent reduction in the mass of a vehicle, a corresponding 0.6 percent change in CO_2 emissions would result. This means a 10 percent reduction in mass would result in a 6 percent reduction in CO_2. This could be achieved at a cost

[8] Ford Motor Company "Blueprint for a Sustainable Future," presented by Bob Holycross at the Mobile Source Technical Review Subcommittee meeting on September 17, 2008; available at http://www.epa.gov/air/caaac/mstr_sep_2008.html (accessed November 7, 2008).

ranging from $360 to $600 per vehicle.[9] This cost does not assume any engineering advances in the production of light-weight materials and, thus, potentially overestimates the cost of this approach. Given the significant potential of mass reduction to reduce motor vehicle GHGs, we urge EPA to incorporate an analysis of light-weight materials into the mobile source GHG reduction analyses.

Comments on Inputs to Volpe Model (73 FR 44443)

Given the significant recent developments in the light-duty vehicle market, including the move toward more fuel efficient vehicles, EPA should re-evaluate the assumptions about cost, cost-benefit, discount rate, and other factors that are inputs into the Volpe model to ensure that the model outputs reflect the greatest technically achievable reductions in fleet GHGs in the given timeframe. Importantly, the assumed cost of gasoline should be re-evaluated. In the TSD, EPA used the Annual Energy Outlook (AEO) 2007 forecasted fuel prices – $2.00 per gallon. Given recent high gasoline prices, EPA should use the AEO "high" price scenario. EPA should also include an even higher price scenario as long-term AEO forecasts in the "high" range are relatively low at about $2.80 per gallon – an assumption of at least $4.00 per gallon should be used.

Fixed vs. Optimized Approach (73 FR 44443)

Neither the fixed nor the optimized approach as outlined in the ANPR is appropriate for EPA to use in its analysis for a motor vehicle GHG regulation. As stated above, neither approach would lead to the development of technology-forcing standards needed for the nation to achieve GHG reductions capable of stabilizing the climate. To illustrate that point, the model-optimized approach yields a GHG emissions level of 266 grams of CO_2 per mile in 2018. The updated fixed approach yields a 232 gram per mile emissions level in 2020. If the nation is to meet an 80 percent GHG reduction target by 2050, then light-duty vehicles on average will need to emit approximately 70 grams of CO_2 per mile by 2030 or 2035, given the long time needed for the vehicle fleet to turn over.

Air Conditioning Comments (73 FR 44448)

NESCAUM commends the EPA for its detailed analysis of air conditioning emissions from passenger cars and light trucks. While the EPA analysis is well summarized, we request a detailed presentation of the specific data underlying the analysis as an integral component of any future proposal. While the ANPR acknowledges air conditioning emissions from light-duty vehicles and other mobile sources (e.g., medium and heavy trucks, locomotives, marine vessels), it does not propose any specific methods to assess the significance of these emissions or control their production or release. It is critical that the same level of analysis expended in assessing air conditioning emissions and potential controls for light duty vehicles be expended for the control of similar emissions from all other sources, including those in the mobile and stationary sectors.

[9] Northeast States Center for a Clean Air Future (NESCCAF). Reducing Greenhouse Gas Emissions from Light-Duty Motor Vehicles (2004); available at http://www.nesccaf.org/activities/reports.

The ANPR itself cites potential air conditioning standards for light duty vehicles that would require a 40 percent reduction in indirect emissions and a 75 percent reduction in direct emissions by model year 2015. There is little in the way of actual data presented in the ANPR documents that would allow for a necessary evaluation of these suggested standards. It is especially important to evaluate alternatives to the proposed reductions given that alternative refrigerants have the potential to reduce direct CO_2-equivalent emissions by nearly 100 percent, and refrigerant replacement is being actively promoted in the European Union.

In addition, the lack of specific analysis data makes evaluating the implied proposal for indirect emissions related to air conditioning more problematic. Importantly, according to the ANPR, compliance with an indirect emissions standard would be based on a specific (idle) test procedure not reflected in the standard city and highway test cycles for which the baseline emission rate estimates and proposed control level (i.e., 40 percent reduction) were derived. While there is some assertion that such an idle test would capture the effects of "most significant" air conditioning improvements, there is no demonstration that this is the case, nor is there any demonstration that averaging emissions under minimum and maximum cooling conditions is appropriate or that a 40 percent reduction under such idle test conditions is equivalent to a 40 percent reduction under either city and highway test cycle or real world operating conditions. While NESCAUM supports a performance based compliance program that minimizes the impact on vehicle manufacturers, it is critical that any mechanism produce predictable real world emission reductions.

Support documents to the ANPR imply that EPA is considering not establishing useful life requirements for air conditioning emissions due to the absence of CO_2 emissions control devices. NESCAUM respectfully disagrees with this position and requests that EPA include useful life certification requirements for both direct and indirect emissions.

<u>Setting Potential Light-duty Vehicle GHG Standards (73 FR 44445)</u>

EPA requests comments on the utility of including a mechanism for the Agency to revisit the GHG standards and incorporate changes in the light-duty vehicle fleet into baseline assumptions. NESCAUM believes this is an important element to include in the final proposal. The dramatic shift in the market towards technologies that reduce GHG emissions, such as turbocharging and downsizing, that has resulted from high gasoline prices and other market conditions could continue or could wane. If it continues, then EPA's business-as-usual case will greatly underestimate the penetration of technologies into the vehicle market and, as a result, set standards that are too lax for vehicle GHGs. For this reason, EPA should put in place a mechanism to revisit and revise the light-duty GHG standards to correct for mistaken future projections.

<u>Considering Potential for Future Changes in Vehicles (73 FR 44448)</u>

EPA requests comment on how the Agency should consider the potential for future changes in vehicle weight and performance (e.g., acceleration time) in assessing the costs and benefits of standards for reducing GHG emissions. We urge EPA to assume a constant rate of performance, e.g., hold performance at current levels. For one, the dramatic recent shift in the market away from 8 and 6 cylinder engines toward 4 cylinder engines demonstrates consumers' preference for lower displacement engines and more fuel efficient vehicles. Thus, EPA should hold performance (acceleration, towing capacity, and horsepower) constant at 2008 levels in the anticipation that the general trend away from higher displacement engines will offset any performance increases realized in some market segments. If the trend toward smaller displacement engines reverses itself, future technical innovation will allow performance to improve while still meeting emissions targets. If EPA incorporates a mechanism to revisit these assumptions, it will be able to adjust if necessary in the case of mistaken future projections.

Cost-Benefit Analysis Results: NESCAUM urges EPA to present, in addition to "payback period" and "lifetime monetary impact," a monthly cost to the consumer taking into account fuel cost savings and incremental increase in monthly car payments.

Heavy-Duty Truck GHG Emissions (73 FR 44454)

NESCAUM agrees with EPA's assessment that a 40 percent reduction in GHG emissions from a typical heavy-duty truck in the 2015 timeframe is possible, with greater reductions possible beyond 2015. NESCCAF, NESCAUM's partner organization, is currently undertaking a study to evaluate the technical feasibility and costs associated with reducing heavy-duty truck GHG emissions. The purpose of the study is to evaluate the maximum technically feasible reductions in the 2012 and 2017 timeframes. Table 1 presents preliminary GHG reduction results achieved for corresponding engine, transmission, vehicle, and operational changes.

Table 1: Summary of Preliminary Results from NESCCAF Heavy-Duty GHG Study

Technology	**GHG Reduction**
Improved aerodynamics	8-25%
Improved tires	6%
Heavy-duty hybrid (long haul truck application)	4% on a line haul cycle and 7% on a suburban drive cycle
Electrical turbocompound	4%
Rankine bottoming cycle + variable valve actuation	9%
GVW increase + longer trailer	19-39%
Reduced road speed	1-8%

Table 1 shows that improvements in heavy-duty truck engine, transmission, vehicle, and operational measures can substantially reduce heavy-duty GHG emissions. The assessments were made with simulation modeling performed by the Southwest Research Institute for NESCCAF using accepted industry modeling tools, including RAPTOR, GT-DRIVE, and GT-POWER. In addition to the simulation modeling, TIAX, LLC conducted a cost-benefit assessment for NESCCAF based on the technologies modeled by the Southwest Research Institute. The preliminary cost-benefit analysis shows that a 40 percent GHG improvement can be achieved in a cost-effective manner. The NESCCAF study will not take into consideration future improvements in technology that have not yet been designed. For example, improvements in thermal efficiency beyond those associated with bottoming cycle and other technologies were not assumed. Thus, additional improvements above and beyond the initial results presented above are likely achievable with engineering advances.

Given the substantial benefit that can be achieved by increasing the allowable length of the trailer or the weight of the trailer, NESCAUM recommends EPA choose a metric for regulating heavy-duty GHGs that will capture these benefits. Regulating grams of CO_2 per ton mile or per cube mile are approaches that would capture the benefits of these important strategies.

Highway Motorcycles (73 FR 44458)

NESCAUM encourages EPA to require reductions in GHG emissions from motorcycles. GHG-reducing technologies include more precise feedback fuel controls, controlling enrichment on cold starts and under load by electronically controlling choke operations, allowing lower idle speeds when the opportunity exists, optimizing spark for fuel and operating conditions through the use of a knock sensor, and reducing the engine size and incorporating a turbo-charger. The cost of these GHG reducing technologies may be offset by the fuel savings over the life of the motorcycle.

Marine Engine and Vessel Petitions (73 FR 44458)

Achieving significant reductions in ocean going vessel (OGV) GHG emissions is technically feasible. NOx, PM (carbon black), and CO_2 emissions are all greenhouse forcing agents emitted by OGVs. Approaches to reduce emissions include: 1) reducing OGV fuel sulfur levels to the point where PM and NOx aftertreatment devices can be used; 2) installation of PM filters on OGVs; 3) use of NOx aftertreatment such as urea SCR; 4) use of other measures to reduce NOx such as water emulsion; and 5) operational measures to reduce all pollutants, such as restrictions on vessel speeds. NESCAUM urges EPA to propose significant reductions in OGV GHG emissions for domestic and foreign flagged vessels.

Aircraft Petitions (73 FR 44460)

A number of approaches to reduce aircraft GHG emissions exist. These approaches include improvements to engine design, redesigned airplane bodies, and operational measures. Mechanisms to reduce aircraft criteria pollutants are detailed in Attachment C to these comments and are taken from a 2003 NESCAUM report on airport-related emissions.

Nonroad Engine and Vehicle Petitions (73 FR 44461)

A number of technical approaches are available to reduce nonroad engine and vehicle GHG emissions. Some of the same approaches that were presented in the heavy-duty truck section above could be applied to nonroad machines, such as those used for construction. Hybridization, turbocompounding, bottoming cycle, and electrification of accessories are some examples. Some of these approaches may be very well suited to nonroad machinery. For example, the highly transient duty cycle of construction equipment may make these machines good candidates for hybridization. A forklift in a warehouse may lift a heavy load to a shelf and in doing so expend work. Just as often, the forklift will lower such a load from the shelf, and recover that load’s potential energy, if a means is provided to store that energy on board. Hybridization of the forklift could provide the means to store that energy. There is no reason not to pursue the application of these and other technologies to nonroad construction-type machinery to achieve substantial GHG reductions.

Locomotives have significant potential to recover energy otherwise dissipated as heat during braking. An 8,000 ton coal train descending through 5,000 feet of elevation converts 30 MWh of potential energy to frictional and dynamic braking energy. Storing that energy onboard quickly enough to keep up with the energy generation rate presents a challenge, but may provide a major viable GHG emissions reduction strategy even if only partially effective.

Idle reduction approaches also offer the potential to significantly reduce locomotive GHG (and other air pollutant) emissions. NESCAUM is currently undertaking a locomotive idle reduction project with the Providence & Worcester Railroad (P&W). During a typical week, P&W locomotives idle for 20 hours. In addition, when ambient temperatures are expected to be below 45°F, they must idle to prevent the engine coolant from freezing and causing damage to the block. During a four month winter period, each locomotive idles for as much as 60 hours over a weekend. Installing idle reduction technology on P&W locomotives will eliminate approximately 1,040 hours of overnight winter idling. Auxiliary power units (APUs) are an especially cost-effective solution, as they not only significantly reduce emissions, but also provide a substantial economic benefit in fuel savings, which is not captured in the standard cost-benefit calculation of dollars per ton of emissions reduced. The project will achieve reductions over the 10-year life of 22 installed APUs of approximately 2,288,000 gallons of fuel and 22,000 tons of $CO_{2,}$ in addition to 13 tons of PM and 387 tons of NOx. This is only one example of a cost-effective approach to reducing locomotive GHG emissions.

Marine Engines (C1 and C2) (73 FR 44466)

According to EPA, marine engines and vessels emitted 84.2 million metric tons of CO_2 in 2006, or 3.9 percent of total mobile source CO_2 emissions. There are significant opportunities to reduce GHG emission from marine vessels through both conventional and innovative approaches. Some of the approaches are similar to those that can be used for highway diesel engines, such as: higher compression ratios, higher injection pressure, shorter injection periods, improved turbocharging, and electronic fuel and air management. Much of the energy produced in a compression ignition engine is lost to the exhaust, thus some of the waste heat strategies that can be used to improve the efficiency of a highway diesel engine, such as turbocompounding, can also be used in marine engines.

Conclusion

For the sources discussed above, including highway heavy-duty diesel, motorcycle, aircraft, ocean going marine, locomotive, nonroad diesel, and marine (C1 and C2) diesel, NESCAUM urges EPA to propose and implement technology-forcing GHG reduction standards.

Attachment B
Economic Analyses Approaches

Analytical Challenges for Economic Analysis of Potential Regulation (73 FR 44414)

Under Executive Order 12866, EPA is required to conduct economic analyses that evaluate the costs and benefits of major policy options.[10] Economic analysis of climate change policy is particularly challenging, because the costs and benefits of such policies are likely to be realized over very long timeframes, and because they may involve issues of equity between generations and between wealthy and developing nations and regions. As such, EPA's use of key assumptions and analytical techniques typically employed in economic analyses bear additional scrutiny. NESCAUM has concerns that the use of more traditional techniques and assumptions for economic analysis of environmental policy are not appropriate for analysis of many facets of climate change policy, and that reliance on these approaches while new techniques are under development may result in erroneous decision-making. The following sections discuss our further analyses and recommendations on these issues.

Analysis of Benefits and Costs over a Long Time Period (73 FR 44414)

EPA solicited comment on whether the long lifetime of global warming gases merits the use of lower discount rates than a 7 percent average pre-tax rate, which is at the higher end of the range EPA has used in previous economic analyses. Given the very long time horizon over which the impacts of climate change are expected to unfold, the discount rate is arguably the single most important variable used in analysis of climate change policy. What is an appropriate value for the discount rate used in economic analysis has been the source of very heated debate among economists, ethicists, and policymakers.

The discount rate is a tool that adjusts for the fact that individuals prefer to incur benefits sooner rather than later. Again, because of the very long timeframes associated with climate change, the results of economic analysis are extremely sensitive to the choice of discount rate, which is used to convert benefits and costs realized in future periods to a common currency known as "net present value." Even when all other variable and values are held constant, the use of different discount rates for climate policy analysis results in net benefit estimates that in some instances vary by orders of magnitude.

One line of reasoning, outlined by Heal (2007) in his meta-analysis of recent literature addressing climate change economics, contends that the use of a pure rate of time preference, rather than a consumption discount rate, is the only appropriate approach to discounting the costs and benefits of climate change.[11] A pure rate of time preference is the rate at which we discount the welfare of future generations. By definition, any value for the rate of time preference greater than zero places less value on the incomes and utility enjoyed by future generations than that of the current generation.

---

[10] Executive Order 12866. "Regulatory Planning and Review," *58 Federal Register 51735*, October 4, 1993.
[11] Heal, Geoffrey. "Climate Economics: A Meta-Review and Some Suggestions." National Bureau of Economic Research (NBER) Working Paper No. 13927 (issued in April 2008).

Another approach to discounting, which uses a consumption-based rate of discount, is based on how the economy actually values inter-temporal tradeoffs within the current generation, as expressed by rate of return on capital. NESCAUM agrees with Heal and others (2005) that a consumption-based discount rate is inherently biased upwards because it is based on a rate of economic productivity that omits the depletion of natural capital.[12] Because the consumption rate of discount is an outcome of the level of economic activity, it is a function of consumption levels. However, when the measurement of consumption does not account for depletion of natural capital assets (e.g., timber, drinking water), a consumption discount rate is necessarily biased upwards. Application of a consumption-based rate would therefore consistently underestimate the net benefits of climate mitigation.

Although Weitzman (2007)[13] disagrees with many aspects of the approach by Stern (2006)[14] to benefits valuation of climate mitigation policies, he also finds that given the level of debate about the discount rate, we should consider discount rates as uncertain, and therefore, should use the lowest rate of discount possible.

As such, NESCAUM advocates for consideration of a range of very low discount rates (e.g., 0 to 1 percent) for use in EPA's economic analysis of climate change policy, based on a pure rate of time preference that places equal value on the benefits enjoyed by current and future generations. In the absence of any compelling rationale to the contrary, NESCAUM finds that there is no reason why EPA should choose a discount rate that values the utility of future generations less than that of the present. It is appropriate to do sensitivity analysis on the value of the discount rate to understand its importance to results, but these values should not exceed 3 percent under any circumstances.

Consideration of Uncertainty in Benefits and Costs (73 FR 44415)

EPA requests comment on the treatment of uncertainty in the analysis of climate policy. We agree with EPA that these uncertainties, due to the very long timeframes involved as well as the different potential scenarios associated with the magnitude of climate change impacts and their influence on natural and human systems, present a major challenge for traditional economic analysis.

NESCAUM agrees with Weitzman and others that climate change presents a unique set of circumstances that limit the applicability of existing analytic tools for addressing uncertainty and performing economic evaluations. For example, most of our tools for addressing decision-making under uncertainty assume known probabilities. A critical distinction that EPA should make clear in its economic analysis of climate policy is that uncertainty differs from risk. While risks are known and quantifiable through probability distributions, the uncertainty over the magnitude and geographic distribution of climate impacts have no known probability distributions. While we are learning much about possible climate impacts through regional

[12] Heal, Geoffrey. Intertemporal Welfare Economics and the Environment, Handbook of Environmental Economics, Vol. 3, edited by K-G Mäler and J.R. Vincent, Elsevier, Chapter 21, 1105-1145 (2005).
[13] Weitzman, Martin. The Stern Review of the Economics of Climate Change, *Journal of Economic Literature*, 45 (3): 703-724 (2007).
[14] Stern, Nicholas. The Economics of Climate Change: The Stern Review, H.M. Treasury, U.K. (2006).

downscaling and other recent science,[15] we only have some information on which to begin developing robust probability distributions for use in policy analysis.

Moreover, Stern, Weitzman and others have found that despite disagreement over the appropriate discounting approach, there is agreement that the recent science suggesting the prospect of potentially catastrophic, non-linear impacts of climate change supports the application of a precautionary approach to mitigation. For example, Stern estimates that losses associated with a "no action" or business-as-usual scenario could result in losses of global income between 5 and 20 percent,[16] and Hanemann *et al.* (2006) find that potential losses in U.S. agricultural productivity of 70 percent by the end of the century.[17] Stern and the IPCC also note that many economic analyses of climate change to date have completely ignored the potential for non-market impacts, such as species extinction and the loss of coral reefs.

Given that the potential for irreversible consequences from climate change exists, NESCAUM recommends that EPA make explicit how it intends to treat option values within economic analysis. Option values reflect our willingness to pay for the preservation of a resource or ecosystem service to maintain the option of future use of that resource. Irreversibility imposes a sever externality across different generations; future generations would suffer from the loss of unique natural assets such as tropical forests, and it is not clear how such a loss could be compensated. In the case of climate change, climate change mitigation provides a type of insurance against the potential for irreversible outcomes.

NESCAUM also agrees with EPA that given the limitations on estimation techniques resulting from uncertainty, it will be difficult to identify or even approximate economically efficient outcomes and net benefits. As such, we recommend that EPA employ more of a cost-effectiveness approach that evaluates the relative costs of different approaches to achieving a pre-specified level of GHG reductions.

Estimating the Benefits of GHG Reductions (73 FR 44415)

EPA requests comment on whether benefits estimation should consider benefits of climate change mitigation at the global level, or whether economic analysis of U.S. climate policy should consider only those benefits that accrue domestically. As EPA itself notes, global warming policy differs from most EPA policies, whose benefits and costs are primarily domestic. Because the U.S. has historically been the global leader in GHG emissions, our actions have created severe externalities that are borne by the international community.

NESCAUM finds that the impacts of global warming, more than any other environmental externality, are truly global in nature. Likewise, the benefits of climate mitigation, whether realized through collective international agreement or through unilateral domestic policies, will also be global in their distribution. At this point in time it is virtually impossible to anticipate the

[15] Union of Concerned Scientists. Northeast Climate Impacts Assessment (2006).
[16] Stern, Nicholas. The Economics of Climate Change: The Stern Review, H.M. Treasury, U.K. (2006).
[17] Hanemann, W. Michael, Anthony C. Fisher and Wolfram Schlenker. The Impact of Global Warming on U.S. Agriculture: An Econometric Analysis of Optimal Growing Conditions, *Review of Economics and Statistics* 88 (1): 113-125 (2006).

magnitude or type of long-term benefits to the U.S. that might result from stabilizing the climate for other countries. Nonetheless, we can be confident that reducing climate damages elsewhere will unambiguously benefit the U.S.

In conclusion, we agree with EPA's proposed approach to consider the global benefits of GHG reductions as well as potential domestic benefits. These estimates should be clearly disaggregated and all uncertainties should be made as transparent as possible.

Integrating Economic and Non-economic Considerations (73 FR 44417)

EPA requests comment on the role of policy, legal, and ethical issues in addition to economic outcomes when evaluating climate mitigation policy. Traditional economic analysis states that distributional or equity considerations should not be included in calculations of net benefits associated with a policy choice. NESCAUM finds, however, that the traditional economic efficiency test of "Pareto optimality," which is based on the concept that in any economically efficient case where marginal benefits exceed marginal costs, the "winners" of any given policy outcome can more than fully compensate "losers," simply lacks validity when applied to climate change.

IPCC has summarized recent science that points towards the potential for non-linear and/or potentially irreversible impacts resulting from climate change. Such impacts would obviously not be marginal in nature. Clearly, given the potential for catastrophic and irreversible outcomes, winners associated with a given policy choice would be unable to compensate losers. For example, it is not obvious how members of the current generation could fairly compensate future generations for species extinctions or the collapse of critical ecosystem services such as the provision of drinking water.

Despite the obvious challenges in arriving at estimates of economic efficiency for climate policy, NESCAUM is recommending that EPA continue to conduct economic analyses of climate change, and especially to support the development and refinement of new analytic techniques tools for such evaluations. We simply recommend that in doing so, EPA acknowledges and makes explicit the limitations of the current toolbox originally developed and refined to evaluate environmental policies that are less far-reaching in their scope and impacts than climate mitigation. As such, effective decision-making by EPA must rely upon a much broader set of considerations beyond strict economic efficiency criteria, including evaluations of equity impacts (e.g., across generations and income groups), legal analysis, and ethical concerns, to a much greater degree than has been the case in the past.

Attachment C
Aircraft Emission Reduction Approaches
From NESCAUM Airport Report Entitled:
"Controlling Airport-Related Air Pollution," June, 2003

A. Options for Reducing Aircraft Emissions

As noted previously in this report, aircraft typically account for the great majority of total airport emissions. A variety of aircraft types operate at commercial airports, including large commercial jets, smaller commuter aircraft powered by turboprop engines, piston–engined general aviation aircraft and other miscellaneous aircraft. In addition, military aircraft also operate at some commercial airports. This chapter primarily focuses on measures relating to large commercial jets, since their emissions typically represent 80 percent of the total emissions inventory for all types of aircraft (i.e., air carriers, commuter, cargo and general aircraft). Sources of aircraft emissions include airplane engines and auxiliary power units used to provide electricity, ventilation and air conditioning to the airplane at the gate. Control options for APUs will be discussed in the GSE section since measures to reduce APU usage also reduces ground power unit usage (ground power units are a category of GSE).

A.1 Technology Options

Past trends in engine performance and efficiency improvements provide compelling evidence for the potential of technological advancement. Overall, the intensity of aircraft energy use has fallen by 60 percent since 1968. Most (57 percent) of that reduction is attributable to enhanced engine efficiency; the remainder is due to improvements in aerodynamic performance and load factor. Specifically, cruising fuel economy has improved 40 percent over the last three decades (1.5 percent per year), while aerodynamic efficiency has improved at a rate of 0.4 percent per year and structural efficiency has remained constant despite greater passenger loads and more rigorous noise requirements. Aircraft energy use over the next 25 years is projected to decrease by over 30 percent as airlines continue to make improvements.[18] Thus, even with the considerable gains of recent decades, opportunities for further improvement in aircraft engine design and engineering remain significant.

Significant improvements in aircraft engine design are feasible and have been demonstrated by a number of manufacturers. For instance, General Electric as well as other aircraft engine manufacturers are currently selling cleaner engines with "dual annular combustors" (DACs). DAC engines emit approximately 40 percent less NOx than conventional aircraft engines. Future engine designs could be even cleaner. NASA is currently working on a research program to develop an aircraft combustor that emits 60 – 70 percent less NOx than current designs. The goal is to develop a new design by 2006. While the most dramatic improvements are available in new engines, the emissions characteristics and performance of older engines can also be improved through retrofit options such as high-pressure turbine nozzles, steam injection and upgraded gas turbines.

Many of the improvements cited above are projected to be achieved using the existing "swept wing" aircraft body configuration, without making significant design changes to the

[18] Waitz, Ian, A. Aircraft, Gas Turbine Engines and Emissions Primer, (presentation August 3, 2001).

aircraft body. By developing new aircraft body materials and improving aerodynamic efficiency, greater reductions in fuel use and emissions could be realized. For example, the B2 bomber and the Raytheon business jet have achieved radical reductions in weight through the extensive use (over 80%) of composite materials in those aircraft bodies. While these aircraft designs are unique today, they could become the industry standard in the future.

Regulatory mechanisms for promoting the introduction of cleaner aircraft (such as emissions standards or emissions-based landing fees) are discussed in the next chapter. Even absent regulatory intervention, of course, some technological advances naturally penetrate the aircraft fleet as older planes are retired and replaced. Newer aircraft typically have lower emissions of NOx, HC and CO per passenger seat than the aircraft they replace, although given the current trend toward improving efficiency through increased combustor pressure, engines now being designed and developed will likely have higher NOx emissions than ones currently being introduced. Fleet modernization also tends to lead to the phase-out of smaller aircraft and the introduction of larger models, thereby reducing the number of landing and take-off cycles per passenger. Depending on the engines used, one large airplane may generate less pollution – on a per passenger basis – than two smaller craft.

Most of the advances that reduce noise or noxious emissions have occurred at the same time as reductions in fuel burn. In the future, as the focus turns to increasing pressure ratio to further reduce fuel burn, measures to improve fuel economy are likely to be in conflict with measures to reduce noise and NOx and vice versa. However, there are active research programs in Europe and the USA aimed at demonstrating new combustor and engine design concepts that reduce NOx emissions substantially while improving fuel burn. If these are successful, they could enter service on production engines within the next ten to fifteen years. Existing technologies are also available to improve efficiency without a resulting NOx increase. For example, improving by-pass air ratio will simultaneously reduce NOx and fuel burn. Under current ICAO standards, however, NOx emissions are allowed to increase linearly with engine pressure ratio. Thus, the structure of the current regulations does not encourage simultaneous efficiency increases and NOx reductions.

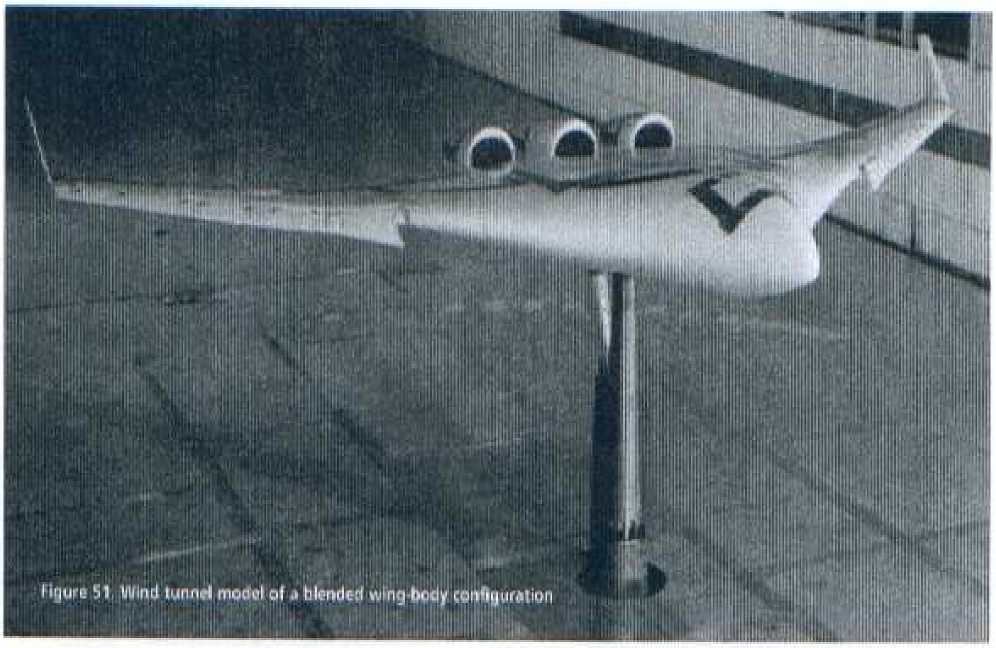
A number of options for reducing aircraft emissions and fuel burn have been proposed in a report entitled "Air Travel – Greener by Design, The Technology Challenge."[19] The report examines aircraft engine and body designs that offer considerable promise to reduce aircraft engine fuel consumption and criteria pollutants. Some conclusions of the report are summarized below:

- Absent regulatory pressure or government support, the Greener by Design study predicts an improvement of 30–35 percent over the next 50 years in fuel burn from improving efficiencies to the existing swept winged, turbofan powered aircraft.[20]
- Other technology could be introduced to improve the fuel efficiency of swept winged aircraft which will require regulatory pressure and or/government support. In airframe technology, the application of hybrid laminar flow control (HLFC) offers reductions of

[19] Royal Aeronautical Society, Society of British Aerospace Companies, British Air Transportation Association, British Department of Trade and Industry (2001).
[20] This is less optimistic than a report published by the Intergovernmental Panel on Climate Change (IPCC), *Aviation and the Global Atmosphere*, where a 40-50 percent improvement was predicted.

- 15 to 20 percent fuel burn. When applied to engine nacelles, HLFC can result in both noise and fuel burn reductions.
- Design high bypass ratio turbofan engines with substantially reduced NOx and CO_2 emissions.
- The trend toward larger aircraft provides an opportunity for large flying wing or blended wing-body configuration. This configuration offers significantly greater aerodynamic efficiency and also greater structural efficiency, with the prospects of appreciably reduced operating costs. There is no reason to doubt the viability of this concept and work should continue to identify and resolve the key engineering issues. Figure III-1 below shows a blended wing body configuration.
- Kerosene is assumed to be the only likely aviation fuel in the next 50 years. Eventually, however, it is envisaged that liquid hydrogen may become available as an alternative. All the aircraft configuration considered in the Greener by Design report could be adapted to liquid hydrogen. Substantial reduction in emissions could be realized with this fuel change.
- The payload fuel efficiency of the current and projected families of large wide bodied aircraft, typically designed to operate over ranges from 13,000 km to 16,000 km, is substantially inferior to that of an aircraft of the same technology standard designed to carry the same payload over a range of 5,000 km or less. The long-range aircraft is itself substantially heavier than an aircraft designed to carry the same payload over the shorter range. A full system study of the feasibility of undertaking long distance travel in stages not exceeding 7,500 km is recommended. Increasing the number of stages per trip may, of course, encounter opposition from the flying public.

Figure III-1: Blended Wing-Body Aircraft Configuration



In sum, engine and aircraft designers have choices as they move forward which could improve efficiency and simultaneously reduce noise and NOx emissions. Researching and developing engines with increased bypass ratio is one approach. Taking steps to improve aircraft structurally and aerodynamically will also improve efficiency and simultaneously lower criteria pollutants. Structural and aerodynamic designs being discussed by the industry include blended wing body, turbo engine fans, and the development of a wholly laminar flying wing. These designs have the potential to make quieter aircraft with decreased fuel burn and substantial NOx emissions reductions. New engine emission standards which encourage a move toward increased efficiency *and* reduced fuel consumption are needed in order to signal to the industry the importance of developing engines that meet both goals.

A.2 Operational Options

A variety of options are available for reducing aircraft emissions that do not involve changes to current engines or aircraft design. These options generally fall into three categories:

- Improving airlines' overall operational efficiency (in terms of emissions per passenger served),
- Reducing taxi time, and
- Reducing power output during taxi, take-off and landing.

Airlines can improve their operational efficiency by maximizing the number of passengers on each flight, thereby minimizing emissions per passenger. Obviously, airlines already have a strong profit incentive to increase their "load factors" – the percent of occupied seats on a given flight. For example, a single flight serving more passengers on a larger airplane may reduce emissions – and airline costs – compared to multiple flights using smaller airplanes to serve the same route. However, other considerations often apply, such as the desire to provide customers with frequent flight options. Depending on how landing fees are structured it may also be more expensive in some cases to land one large airplane compared to two smaller craft. Beyond improving load factors, airlines could reduce emissions per passenger by managing their fleets to maximize the use of their cleanest aircraft, particularly into heavily trafficked airports that are especially susceptible to delays. The opportunity for this type of optimization depends, of course, on the size and diversity of a given airline's fleet.

Aircraft emissions of CO and HC tend to be particularly high during taxi-in and taxi-out when aircraft engines are operating at less than maximum efficiency. Hence, operational changes that reduce aircraft idling and taxi time can directly reduce pollutant emissions. A variety of options exist for reducing taxiing time. For example, so-called "dispatch towing" – especially with high-speed tugs – can be used to move aircraft between the terminal gate and runway more efficiently and with less frequent stops. Since taxi-out time tends to be longer than taxi-in time, this option is likely to be most feasible on departing flights. Potential emissions benefits for this option are, of course, somewhat offset by additional emissions from the tow tug engine and from continued operation of the aircraft's APU for ventilation and electricity during towing.

Taxi time can also be reduced by airport designs that allow for planes to stay close to runways between take-off and landing. This can be accomplished by decentralized gate designs wherein passengers are brought to and from the aircraft by other transport vehicles. Dulles International Airport near Washington, DC, for example, was originally designed to work this way. Again, the resulting reduction in aircraft emissions would be somewhat offset by increased emissions from ground passenger transport vehicles.

Finally, a broad set of congestion reduction measures can be used to further reduce aircraft taxi time. Such measures can include gatehold procedures that keep planes at the gate until they are ready for take-off, thereby limiting unnecessary idling time on the runway. Widening, extending or building new taxiways can help reduce intermittent stops, increase access between taxiways and allow for more direct taxi routes. Taxi turnouts designed to allow aircraft to enter or exit the runway at higher speeds can also reduce stops and expedite clearing of the runway to minimize delays. Another option that may be appropriate, provided safety concerns can be addressed, is allowing aircraft to access the runway at the intersection of the taxiway and the runway. Most aircraft do not need to use the full length of runway for takeoff.

In addition to congestion reduction measures on the ground, strategies to address in-air congestion can help reduce delays and unnecessary taxi time by minimizing the time that departing aircraft spend waiting for incoming aircraft – which have priority – to land. Strategies for reducing in-air congestion include using separate runways for commercial and smaller aircraft, which operate at lower speed, and reducing the longitudinal separation between inbound and outbound flights in the air to maximize the rate at which airplanes can leave and enter the airport vicinity.

A third category of operational strategies to reduce aircraft emissions involves minimizing engine use, particularly in inefficient, low-power modes during taxi, take-off and landing. For example, most large aircraft have two to four engines, one or more of which can be shut down during taxi. This step not only reduces emissions, it allows the remaining engines to operate more efficiently at higher RPM, producing fuel savings as well as lower HC and CO emissions per pound of fuel consumed. Potential reductions from this relatively simple measure are highest for departing flights, which generally have longer taxi times than incoming flights. Airports that encourage this practice, such as Heathrow Airport in the United Kingdom, typically leave it to the pilots' discretion, as shutting down some engines can reduce aircraft control and may be infeasible under certain conditions or with certain aircraft. In addition, it is necessary to take into account the fact that engines must be run 2 minutes prior to take off to achieve thermal stability and 2 minutes after landing to cool down.

A related measure that can help to substantially reduce NOx emissions is "derated take-off" wherein engine power is reduced during takeoff. Typically, full engine thrust is only needed under extreme conditions, such as in hot weather or with a heavily loaded plane, and engine thrust can be safely reduced from the maximum during take-off.[21] Again, this option is relatively simple to implement, but may be constrained by other considerations, such as the need to clear the runway quickly to avoid congestion or to follow a steep flight path to minimize noise impacts on surrounding communities. Engine power and emissions can sometimes also be reduced during landing, by minimizing the use of reverse thrust to help slow the aircraft. On larger, heavier planes and at airports with relatively shorter runways, engines are often run near full power with the thrust reversers engaged during landing. This can produce substantial NOx emissions. Safety, runway length and airport design (some airports require aircraft to slow significantly before exiting the runway) are key considerations in implementing this option. In addition, most pilots – in an effort to land the aircraft smoothly – will use as much of the runway as possible instead of forcing the plane down earlier. This promotes heavier use of reverse thrust. Air carriers have stated that they currently minimize engine use when feasible, so the extent to which further introduction of these measures is possible needs further exploration.

An approach currently being discussed to reduce aircraft emissions is improvement to the National Airspace System (NAS) with a focus on improvements in the Communication, Navigation, and Surveillance/Air Traffic Management (CNS/ATM). CNS/ATM offers a number of operational measures to reduce aviation emissions. The U.S. community is focusing on the concept of Free Flight[22] for its CNS/ATM modernization. Free flight would reduce the amount of air traffic control restrictions placed on flight routes. It would allow wind optimized cruise trajectories and altitudes and more efficient surface traffic operations. In recent years, free flight has become technically feasible with advances in information systems. An FAA report estimated that 10 billion pounds of fuel could be saved in 2015 with National Airspace System (NAS) modernization.[23] This would translate to an annual reduction of 209 million pounds of NOx, 211 million pounds of CO, and 59 million pounds of HC; these are reductions of over 9 percent, 12 percent, and 18 percent, respectively. Most of the savings would occur above 3,000 feet in altitude (up to 94 percent). However, the proposed operational changes would still reduce approximately 4 million pounds of NOx below 3,000 feet in 2015 according to the FAA study.

---

[21] FAA also requires one full throttle takeoff per month to ensure that the engines are capable of full thrust if necessary.

[22] "Free flight" is where operators have the freedom to select their path and speed in real-time. Restrictions are placed on some aspects to ensure separation, to preclude exceeding airport capability, and to ensure safety, among others.

[23] FAA. The Impact of National Airspace System (NAS) Modernization of Aircraft Emissions (September 1998).

In Table III-1, costs per ton of NOx, HC, and CO reduced are presented for some of the operational measures described above. The information in the table was taken from the 1994 and 1997 EEA reports. Emission reduction percentages were calculated in several steps. First, baseline emissions for one aircraft (a Boeing 737 or 767 in most cases) were calculated. This was calculated for the engine(s) used in those aircraft by multiplying emission standards for the engine (in lb/1,000 lb fuel) X fuel consumption (in lb/min) X estimated time in mode for taxi-out, takeoff, climbout, approach, and taxi-in. For each control measure considered, the baseline emission calculation is repeated with the affected time in mode reduced. For example, the affects of congestion relief measures were calculated by reducing the taxi-out time in the post-baseline calculation. The post baseline emissions are then subtracted from the baseline emissions to arrive at tons of emissions reduced from implementing the measure. In the table, emission reductions are expressed as a percent of pollutant reduced for one aircraft operating in a particular phase of the landing/take-off cycle.

Table III-1: Operational Options for Reducing Aircraft Emissions

Option	NOx emissions reduction	HC emissions reduction	CO emissions reduction	Other Benefits	Costs (NOx + HC + CO reductions)
Dispatch Towing	0.5–1%	0.2–5%	2–5%	Reduces fuel consumption; may also help reduce ground congestion (esp. if high speed tugs are used).	Lower fuel costs result in reduced operational costs, thus emissions reductions accrue for free.[24]
Decentralized Gates	3%	10%	10%	Reduced fuel consumption.	"
Ground Congestion Reduction Measures	3%	10%	10%	Reduced fuel consumption and travel delays for passengers; more efficient airport operation.	"
Reduced Engine Taxi	10%	30%	30%	Reduced fuel consumption; simple to implement.	"
Derated Take-off[25]	10%	0%	0%	Reduced fuel consumption; simple to implement.	"
Reduced Reverse Thrust	5–10%	<1%	<1%	Reduced fuel consumption; simple to implement.	"

[24] While aircraft operational costs can be expected to decrease, some of these measures could increase capital costs. For example, use of decentralized gates could require airlines to provide shuttle services between the terminal and the aircraft. These potential costs are not included in the above table.

[25] In some cases de-rated takeoff may already be the norm. Anecdotal information supplied by air carriers indicates that many airlines already practice derated takeoff. In addition, while it is cost-effective as a control options, barriers besides cost exist.

As can be seen from Table III-1, the above measures are extremely cost-effective without taking into account the reductions in pollutants that occur as a result of the operational changes. As would be expected, reductions in HC and CO are greatest for those measures that reduce idling time. Similarly, reductions in NOx are greatest for those measures that reduce full load engine operation.

More stringent standards could provide impetus for substantial further improvement in the emissions performance of new aircraft engines. However, EPA has historically deferred to ICAO in setting standards and while the Agency has authority to establish new engine standards they must coordinate with FAA on the level of control proposed. Of the measures available to state and local authorities, the four most likely to be implemented as retrofit measures at existing airports are aircraft towing, congestion reduction, reduced engine taxi, and derated take-off. Each of these measures has low or moderate costs when compared to potential emissions benefits. In each case, the high volume of aircraft traffic through many airports means that the relatively small percentage emissions reduction achievable from each measure on a per flight basis translates into large potential emissions reduction in aggregate. Importantly, these types of strategies can also be implemented at existing airports without major changes to current structures and systems. Indeed, all of them have been implemented to some extent at certain airports, though the extent to which they are routinely practiced is unknown. Many other measures mentioned in this section will be feasible only for new airports, where they can be incorporated into airport design. Others that require changes to the aircraft fleet or to airline schedules will have to be examined in the context of cost and customer service constraints.

Attachment D
NAAQS as a Potential Regulatory Mechanism

National Ambient Air Quality Standards (NAAQS) (73 FR 44477)

NESCAUM does not take a position on whether EPA should establish a GHG NAAQS because this issue is outside the scope of a § 202(a) endangerment finding and deserves fuller and more focused consideration in a separate notice of proposed rulemaking. EPA raises a number of issues and important considerations regarding GHGs and the Clean Air Act (CAA), but many of these do not have to be addressed in the context of a § 202(a) endangerment finding. Whatever might flow from a finding under CAA § 202(a) to other parts of the CAA, such as its NAAQS implications, can not alter EPA's legal obligations and scientific basis for making an endangerment finding that is confined to the bounds of CAA § 202(a).

While we take no position on a GHG NAAQS, we believe it should remain on the table as one of the tools in the CAA at our disposal worthy of more careful consideration at the appropriate time. We need prompt action to begin slowing and ultimately reversing the juggernaut of GHG emissions in the U.S. Pending the arrival of comprehensive climate legislation, we must thoroughly consider all options currently available that can help launch the efforts so critically needed to address climate change.

Even though NESCAUM is not endorsing a GHG NAAQS in these comments, we do not believe, as some critics of this approach suggest, that regulation of GHGs under a NAAQS approach (and the CAA in general) necessarily leads to a "parade of horribles" as a result. EPA identifies a number of provisions coupled with a GHG NAAQS that can provide flexibility for the states, and sufficient compliance time horizons to allow for an orderly succession to any future national climate legislation. For example, as EPA indicates in the ANPR, CAA § 179B can take into account the international scope of GHG emissions, thus providing the impetus for achieving in-state reductions through state efforts while removing short term compliance deadlines along with the threat of sanctions for not meeting these deadlines.

EPA also identifies a second option of establishing only a secondary GHG NAAQS based on welfare impacts of climate change. As EPA notes, a secondary NAAQS does not have statutory attainment deadlines, but instead requires states to achieve attainment as expeditiously as practicable. This approach also lends itself to longer term planning for attaining a GHG stabilization level at some yet to be determined future point.

National Attainment/Nonattainment Designations (73 FR 44480)

Due to the global nature of greenhouse gases in the atmosphere, it is highly likely that for purposes of a potential GHG NAAQS, the entire country may be designated either in or out of attainment. This is consistent with the well-mixed nature of greenhouse gases, and is not inherently problematic for the CAA. Provisions in the CAA, such as the previously mentioned

§ 179B, can provide flexibility for states in dealing with transport between states and across international borders.

Even if Not Included in GHG Definition, EPA Must Consider Climate Impacts of Other NAAQS Pollutants (73 FR 44424)

Although the collective definition of GHGs need not include other GHGs already regulated under an existing NAAQS, this does not necessarily mean an existing NAAQS has been set with an appropriate form and level to protect against the harms of climate change. For example, ozone affects climate through long-term average concentrations in the atmosphere. The current primary and secondary ozone NAAQSs are based on short-term 8-hour averages during warm weather months. This form of a NAAQS does not address the long term impacts of ozone on climate change, hence does not adequately address ozone as a GHG. This could also be true in the case of PM2.5 and its constituents, such as black carbon. EPA must give specific consideration to climate change in determining whether the form and level of an existing primary or secondary NAAQS has been set appropriately for a criteria pollutant's radiative forcing impact.

Attachment E
Considerations for GHG Trading

Considerations for GHG Emissions Trading

GHGs are long-lived and uniformly mixed on the global scale, so in essence all states are "upwind" of all other states, and GHG reductions in any one state equally benefits all "downwind" nonattainment areas throughout the U.S. As a result, the objection to emissions trading for pollutants with strong spatial concentration gradients does not apply for GHGs. With GHGs, obtaining emission reductions at any location throughout the U.S. (and the world) will result in the same benefit for a "downwind" area, regardless of its location.

To the extent EPA investigates pursuing GHG emissions trading under the CAA, it must take great care to establish its legal authority for such an approach and provide concurrent "back stop" options should a trading program be struck down in court. This is particularly important in light of the vacatur of the Clean Air Interstate Rule [*North Carolina v. EPA*, D.C. Cir., decided July 11, 2008 (petitions for rehearing pending)] and the urgency needed to move forward on climate change. We note for the reasons given in the previous paragraph, GHG trading may be distinguishable from other air pollutants under the CAA because of the uniform global distribution of GHGs. As a result, GHG reductions, wherever they may occur, will have the same "downwind" impact.

Any potential GHG trading scheme pursued by EPA also must not penalize states and emission sources that are already part of multi-state GHG trading programs, such as the Regional Greenhouse Gas Initiative (RGGI) in the Northeast. In any future federal GHG trading program, EPA must recognize and accommodate existing allowances and early reductions achieved by states and sources through their own GHG programs. Any GHG allowance allocation scheme created by EPA must also account for those states and sources that have already made GHG reductions in a manner that could reward early actors in addressing our climate change problem.

Attachment F
Regulating GHGs from Stationary Sources

Regulating GHGs under the Clean Air Act – Considerations for Stationary Sources (73 FR 44476)

The "Standards of Performance" provisions in CAA § 111 provide an appropriate framework for regulating new and existing stationary sources in the near term. The CAA affords numerous opportunities for EPA to take a leadership role in developing approaches to regulating stationary source GHGs. The process under CAA § 111 for identifying best demonstrated technology (BDT) for new and existing stationary sources is one example (73 FR 44486). Similarly, EPA's "emission guidelines" development procedure is a means to establish uniform performance standards under § 111 for existing sources (73 FR 44487). The presumptive BACT (73 FR 44508) and a possible analogous approach for LAER (73 FR 44509) may also provide opportunities to bring uniformity to the program while at the same time streamlining the permit process.

EPA acknowledges its discretion under CAA § 111(b)(1)(B) to periodically review existing new source performance standards (NSPS), but then emphasizes that it has not been past practice to add standards for pollutants currently unregulated for a particular source category at the time of the eight-year review (73 FR 44486). It is not entirely clear to us as to why EPA includes this statement in the ANPR, and it causes us concern that perhaps EPA may intend to continue to forego such an opportunity after GHGs become regulated air pollutants. We contend that the eight-year review cycle may provide one of the best opportunities to address GHG emissions as appropriate for source categories already subject to NSPS for other pollutants. We therefore encourage EPA, as part of its overall program design, to utilize the eight-year review cycle as one means to achieve GHG reductions from the stationary source sector.

EPA presents several scenarios for major source and significance thresholds (73 FR 44505), with the primary goal being to limit the numbers of GHG emission sources subject to NSR, PSD and Title V permitting requirements. We understand the logic of reducing the numbers of sources subject to major permitting requirements in order to effectively manage workloads for state permitting programs. Likewise, we can appreciate the financial burden on small businesses becoming subject to such programs for the first time by virtue of their GHG emissions. The approaches presented, however, appear to emphasize the above principles at the expense of what we believe to be a much more important premise: Major source permitting programs are effective tools for achieving emission reductions and verifying that those reductions are ongoing. Permitting thresholds for stationary sources should be established in light of overall GHG reduction goals.

Several of the northeast states have established mid- and long-range GHG reduction goals. In general, the goals are to reduce overall GHG emissions between 10 and 20 percent below 1990 levels by 2020 and to achieve a 75 to 80 percent reduction by 2050. Nationally in 2006, 39 percent of CO_2 was emitted from electricity generation sources. Another 14 percent of CO_2 was emitted from miscellaneous industrial sources.[26] Clearly, if the GHG reduction goals of individual northeast states are to be met, significant reductions must come from the stationary source sector. EPA must first establish an overall GHG reduction goal. Permitting thresholds can then be established at levels that will capture the universe of sources from which controls (e.g., BACT, LAER, NSPS) will be required as part of the overall reduction strategy.

[26] EPA. Inventory of U.S. Greenhouse Gas Emissions and Sinks; 1990-2006 (April 2008).