
# Cars, Trucks, and Climate: EPA Regulation of Greenhouse Gases from Mobile Sources

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# Summary

As Congress and the Administration considered new legislation to reduce the greenhouse gas (GHG) emissions that contribute to climate change over the last year and a half (a process that has now stalled), the Environmental Protection Agency simultaneously began to exercise its existing authority under the Clean Air Act to set standards for GHG emissions. The Administration has made clear that its preference would be for Congress to address the climate issue through new legislation. Nevertheless, it is moving forward on several fronts to define how the Clean Air Act will be used and to promulgate regulations.

On April 1, 2010, EPA used existing authority under Section 202 of the act to set the first national GHG emission standards: the standards will control emissions from new cars and light trucks beginning in model year 2012. The standards will require cars, SUVs, minivans, and other light trucks to meet combined emissions levels that the agency estimates will average 250 grams/mile of carbon dioxide ($CO_2$) in model year 2016, about a 30% reduction in emissions compared to current levels. The standards will be gradually phased in, with the first reduction targets set for model year 2012. As part of an agreement brokered by the White House, EPA's standards were issued jointly with fuel economy (CAFE) standards developed by the National Highway Traffic Safety Administration, and the state of California agreed to harmonize state-level GHG emission standards, so that the auto industry would have a single national set of standards to meet.

The key to using the Clean Air Act's authority to control greenhouse gases was for the EPA Administrator to find that GHG emissions are air pollutants that endanger public health or welfare. Administrator Jackson promulgated such an endangerment finding in December 2009. With the endangerment finding finalized, the agency can proceed to regulate emissions from motor vehicles of all kinds. Medium- and heavy-duty trucks are next in line: EPA proposed GHG emission standards for them October 25, 2010.

EPA has received 11 petitions asking that it make endangerment findings and proceed to regulate emissions of greenhouse gases. Ten of the 11 petitions address mobile sources: besides motor vehicles, the petitions cover aircraft, ships, nonroad vehicles and engines, locomotives, and fuels, all of which are covered by Title II of the Clean Air Act. In addition to describing the motor vehicle regulations, this report discusses the range of EPA's authority under Title II and provides information regarding other mobile sources that might be regulated under this authority.

Regulation of GHGs from mobile sources will lead the agency to establish controls for *stationary* sources, such as electric power plants, as well. Stationary source options, the authority for which comes from different parts of the Clean Air Act, are addressed in CRS Report R40585, *Climate Change: Potential Regulation of Stationary Greenhouse Gas Sources Under the Clean Air Act* and CRS Report R41212, *EPA Regulation of Greenhouse Gases: Congressional Responses and Options*.

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# Introduction

Although much of the debate on climate legislation has focused on cap-and-trade[1] and tax options,[2] establishing greenhouse gas controls is not simply a choice between those two alternatives. A third set of options, using the more traditional regulatory approaches of the Clean Air Act (CAA), is available. These regulatory approaches might be modified through new legislation, but unlike a cap-and-trade system or a carbon tax, regulation does not require new congressional action: the ability to limit GHG emissions already exists under various Clean Air Act authorities that Congress has enacted, a point underlined by the Supreme Court in an April 2007 decision, *Massachusetts v. EPA*.[3]

Thus, while Congress and the Administration have discussed new legal authority (for cap-and-trade, carbon tax, and/or targeted emission controls) the Administration, through the Environmental Protection Agency (EPA), has proceeded to exercise existing authority under the Clean Air Act to begin regulation of greenhouse gas emissions.

The agency has taken several steps to regulate GHG emissions. Nevertheless, EPA Administrator Jackson and others in the Administration have made clear that their preference would be for Congress to address the climate issue through new legislation. In an April 2009 press release, for example, the agency stated, "notwithstanding this required regulatory process, both President Obama and Administrator Jackson have repeatedly indicated their preference for comprehensive legislation to address this issue and create the framework for a clean energy economy."[4] Similar statements have been made on several occasions since that time; in the meantime, though, the agency has concluded that current law, including a 2007 Supreme Court decision discussed below, compels the agency to act.

This report focuses on EPA's recent and potential actions regarding regulation of GHG emissions from mobile sources under Title II of the Clean Air Act. We begin with a brief discussion of the petitions and court action that have led to EPA's regulatory decisions.

# *Massachusetts vs. EPA* and Its Effects

Whether EPA could regulate GHGs through existing Clean Air Act authority was under consideration at EPA for more than a decade before the agency took action. In 1998, during the Clinton Administration, EPA General Counsel Jonathan Cannon concluded in a memorandum to the agency's Administrator that greenhouse gases were air pollutants within the Clean Air Act's

[1] For a more detailed discussion of cap-and-trade approaches to GHG emission control, see CRS Report RL33799, *Climate Change: Design Approaches for a Greenhouse Gas Reduction Program.* For additional information on allowance allocation methods, see CRS Report RL34502, *Emission Allowance Allocation in a Cap-and-Trade Program: Options and Considerations*.

[2] For a more detailed discussion of a carbon tax approach to GHG emission control, see CRS Report R40242, *Carbon Tax and Greenhouse Gas Control: Options and Considerations for Congress.*

[3] For a discussion of the Court's decision, see CRS Report RS22665, *The Supreme Court's Climate Change Decision: Massachusetts v. EPA*, by Robert Meltz.

[4] "EPA Finds Greenhouse Gases Pose Threat to Public Health, Welfare / Proposed Finding Comes in Response to 2007 Supreme Court Ruling," Press Release, April 17, 2009, at http://yosemite.epa.gov/opa/admpress.nsf/d0cf6618525a9efb85257359003fb69d/0ef7df675805295d8525759b00566924.

definition of the term, and therefore could be regulated under the act.[5] Relying on the Cannon memorandum as well as the statute itself, on October 20, 1999, a group of 19 organizations petitioned EPA to regulate greenhouse gas emissions from new motor vehicles under Section 202 of the act.[6] Section 202 gives the EPA Administrator broad authority to set "standards applicable to the emission of any air pollutant from any class or classes of new motor vehicles" if in her judgment they cause or contribute to air pollution which "may reasonably be anticipated to endanger public health or welfare."

Under the Bush Administration, EPA denied the petition August 28, 2003,[7] on the basis of a new General Counsel memorandum the same day, in which it concluded that the CAA does not grant EPA authority to regulate carbon dioxide ($CO_2$) and other GHG emissions based on their climate change impacts.[8] The denial was challenged by Massachusetts, 11 other states, and various other petitioners in a case that ultimately reached the Supreme Court. In an April 2, 2007, decision (*Massachusetts v. EPA*), the Court found by 5-4 that EPA *does* have authority to regulate greenhouse gas emissions, since the emissions are clearly air pollutants under the Clean Air Act's definition of that term.[9] The Court's majority concluded that EPA must, therefore, decide whether emissions of these pollutants from new motor vehicles contribute to air pollution that may reasonably be anticipated to endanger public health or welfare. When it makes such a finding of endangerment, the act requires the agency to establish standards for emissions of the pollutants.[10]

In nearly two years following the Court's decision, the Bush Administration's EPA did not respond to the original petition or make a finding regarding endangerment. Its only formal action following the Court decision was to issue a detailed information request, called an Advance Notice of Proposed Rulemaking (ANPR), on July 30, 2008.[11]

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[5] Memorandum from Jonathan Z. Cannon, EPA General Counsel, to Carol M. Browner, EPA Administrator, "EPA's Authority to Regulate Pollutants Emitted by Electric Power Generation Sources," April 10, 1998.

[6] The lead petitioner was the International Center for Technology Assessment (ICTA). The petition may be found on their website at http://www.icta.org/doc/ghgpet2.pdf.

[7] The agency argued that it lacked statutory authority to regulate greenhouse gases: Congress "was well aware of the global climate change issue" when it last comprehensively amended the Clean Air Act in 1990, according to the agency, but "it declined to adopt a proposed amendment establishing binding emissions limitations." Massachusetts v. EPA, 549 U.S. 497 (2007).

[8] Memorandum from Robert E. Fabricant, EPA General Counsel, to Marianne L. Horinko, EPA Acting Administrator, "EPA's Authority to Impose Mandatory Controls to Address Global Climate Change Under the Clean Air Act," August 28, 2003.

[9] Massachusetts v. EPA, 549 U.S. 497 (2007). The majority held: "The Clean Air Act's sweeping definition of 'air pollutant' includes '*any* air pollution agent or combination of such agents, including *any* physical, chemical ... substance or matter which is emitted into or otherwise enters the ambient air.... ' ... Carbon dioxide, methane, nitrous oxide, and hydrofluorocarbons are without a doubt 'physical [and] chemical ... substances[s] which [are] emitted into ... the ambient air.' The statute is unambiguous."

[10] For further discussion of the Court's decision, see CRS Report RS22665, *The Supreme Court's Climate Change Decision: Massachusetts v. EPA*, by Robert Meltz.

[11] U.S. EPA, "Regulating Greenhouse Gas Emissions Under the Clean Air Act," 73 *Federal Register* 44354, July 30, 2008. The ANPR occupied 167 pages of the Federal Register. Besides requesting information, it took the unusual approach of presenting statements from the Office of Management and Budget, four Cabinet Departments (Agriculture, Commerce, Transportation, and Energy), the Chairman of the Council on Environmental Quality, the Director of the President's Office of Science and Technology Policy, the Chairman of the Council of Economic Advisers, and the Chief Counsel for Advocacy at the Small Business Administration, each of whom expressed their objections to regulating greenhouse gas emissions under the Clean Air Act. The OMB statement began by noting that, "The issues raised during interagency review are so significant that we have been unable to reach interagency consensus in a timely way, and as a result, this staff draft cannot be considered Administration policy or representative of the views of the (continued...)

The Obama Administration's EPA, however, made review of the endangerment issue a high priority. On April 17, 2009, it proposed a finding that GHGs do endanger both public health and welfare and that GHGs from new motor vehicles contribute to that endangerment.[12] These findings were finalized in the December 15, 2009 *Federal Register*.[13]

# Standards for New Light-Duty Motor Vehicles

The proposed endangerment finding of April 2009 was followed in a matter of weeks by an announcement that the Administration had reached agreement with nine auto manufacturers and California (which had developed its own GHG emission standards for motor vehicles), as well as other interested parties regarding the major outlines of a joint greenhouse gas/fuel economy rulemaking. As announced by the President, May 19, 2009, EPA and the National Highway Traffic Safety Administration (which administers fuel economy standards for cars and trucks) would integrate corporate average fuel economy (CAFE) standards for new cars and light trucks (collectively known as "light-duty motor vehicles") with national greenhouse gas emission standards to be issued by EPA. The objective of the joint standards is to achieve GHG reduction levels similar to those adopted by California, which harmonized its own standards with EPA's as part of the agreement.[14]

Four greenhouse gases are emitted by motor vehicles ($CO_2$, methane, nitrous oxide, and hydrofluorocarbons).[15] According to EPA, emissions of the four gases from motor vehicles (including trucks) accounted for 23.6% of the total inventory of U.S. GHG emissions in 2006. Most of the emissions are in the form of $CO_2$ (see **Figure 1**), which is the product of combusting any fuel containing carbon. Hydrofluorocarbons (HFCs), the chemicals used as coolants in vehicle air conditioning systems, are the second-most important motor vehicle GHG; but, as the figure shows, they are a distant second.

(...continued)

Administration." (p. 44356) It went on to state that "... the Clean Air Act is a deeply flawed and unsuitable vehicle for reducing greenhouse gas emissions." The other letters concurred. The ANPR, therefore, was of limited use in reaching a conclusion on the endangerment issue.

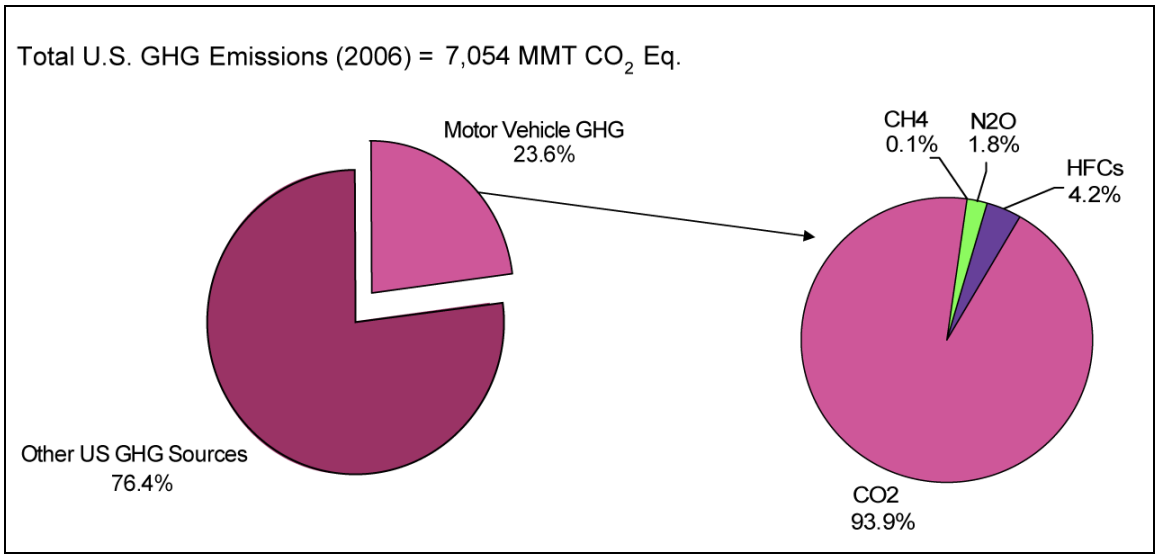
[12] U.S. EPA, "Proposed Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act," 74 *Federal Register* 18886, April 24, 2009.

[13] 74 *Federal Register* 66496. Although generally referred to as simply "the endangerment finding," the EPA Administrator actually finalized two separate findings: a finding that six greenhouse gases endanger public health and welfare, and a separate "cause or contribute" finding that the combined emissions of greenhouse gases from new motor vehicles and new motor vehicle engines contribute to the greenhouse gas pollution that endangers public health and welfare.

[14] 74 *Federal Register* 49468, September 28, 2009.

[15] Two other commonly mentioned greenhouse gases, sulfur hexafluoride ($SF_6$) and perfluorocarbons, are not emitted by motor vehicles.

**Figure 1. Motor Vehicle Greenhouse Gas Emissions**




**Source:** U.S. EPA, March 6, 2009 Draft Deliberative Presentation

**Notes:** Motor vehicles = passenger cars, light duty trucks, other trucks, buses, and motorcycles, including releases of HFCs from motor vehicle air conditioning. CH4=methane; N2O=nitrous oxide; HFCs=hydrofluorocarbons.

The EPA/NHTSA joint regulations for light-duty motor vehicles were finalized April 1, 2010. They require the vehicles (cars, SUVs, minivans, and other light trucks) to meet combined emissions levels that EPA estimates will average 250 grams/mile of $CO_2$ in model year 2016, about a 30% reduction in emissions compared to current levels. NHTSA has set corresponding fuel economy standards, achieving a combined estimated fuel economy of 34.1 miles per gallon for cars and light trucks by 2016. In both cases, the standards will be gradually phased in, with the first reduction targets set for model year 2012.

In setting the GHG standards, EPA used the concept of a vehicle's "footprint" to set differing standards for different size vehicles. As explained by EPA

> These standards are based on $CO_2$ emissions-footprint curves, where each vehicle has a different $CO_2$ emissions compliance target depending on its footprint value (related to the size of the vehicle). Generally, the larger the vehicle footprint, the higher the corresponding vehicle $CO_2$ emissions target. As a result, the burden of compliance is distributed across all vehicles and all manufacturers. Manufacturers are not compelled to build light vehicles of any particular size or type, and each manufacturer will have its own standard which reflects the vehicles it chooses it [sic] produce.[16]

In general, manufacturers are expected to reduce $CO_2$ emissions by improving the vehicles' fuel economy, but they can also take advantage of options to generate $CO_2$-equivalent credits by reducing emissions of hydrofluorocarbons (HFCs) and $CO_2$ through improvements in their air

[16] "EPA and NHTSA Finalize Historic National Program to Reduce Greenhouse Gases and Improve Fuel Economy for Cars and Trucks," Fact Sheet, April 2010, p. 3, at http://www.epa.gov/otaq/climate/regulations/420f10014.htm.

conditioner systems or by the use of idle reduction technologies. Manufacturers will also be allowed to average, bank, and trade emission credits.[17]

The light-duty vehicle rule affects a large group of emission sources that accounts for a significant percentage of total U.S. GHG emissions, but the effectiveness of the standards in reducing total GHG emissions is limited in that they will apply only to new motor vehicles. The auto and light truck fleet turns over slowly: the median survival rate for 1990 cars, for example, was 16.9 years, and that for light trucks was 15.5 years.[18] Given this durability, the impact of GHG standards on the total emissions of the motor vehicle fleet will take a long time to be felt. If historic experience is any guide, reductions in GHG emissions per new vehicle, unless they are very aggressive, may be largely offset by growth in vehicle miles traveled.

# Other Mobile Sources

The endangerment finding and emission standards for new light-duty vehicles make it likely that EPA will proceed to set GHG emission standards for other mobile sources of air pollution, especially medium- and heavy-duty trucks. Since the *Massachusetts v. EPA* decision, the agency has received ten petitions asking it to regulate GHGs from other categories, all but one focused on mobile sources and their fuels (see **Table 1**). These petitions cover aircraft, ocean-going ships and their fuels, motor fuels in general, locomotives, and nonroad vehicles and engines—a category that includes construction equipment, farm equipment, logging equipment, outdoor power equipment, forklifts, marine vessels, recreational vehicles, and lawn and garden equipment.

The specifics of the Clean Air Act sections that give EPA authority to regulate pollution from these sources vary somewhat, but it is generally believed that the endangerment finding and decision to regulate GHGs in response to the first of the petitions will make it difficult for the agency to avoid regulating at least some of the other categories. With that in mind, we look at other mobile source categories, the authorities provided under Title II for each, and what EPA's use of these authorities for conventional pollutants emitted by these sources indicates with regard to its ability to regulate greenhouse gases. (Separate reports, CRS Report R40585, *Climate Change: Potential Regulation of Stationary Greenhouse Gas Sources Under the Clean Air Act*, and CRS Report R41212, *EPA Regulation of Greenhouse Gases: Congressional Responses and Options*, by James E. McCarthy and Larry Parker, discuss the potential Clean Air Act regulatory tools for stationary sources.)

[17] For additional detail on the EPA/NHTSA joint standards, see CRS Report R40166, *Automobile and Light Truck Fuel Economy: The CAFE Standards*, by Brent D. Yacobucci and Robert Bamberger.

[18] Oak Ridge National Laboratory, for the U.S. Department of Energy, *Transportation Energy Data Book: Edition 27*, 2008, Tables 3.10 and 3.11.

**Table 1. Petitions for Regulation of Greenhouse Gas Emissions Under the Clean Air Act**

| Date | Subject | CAA Section | Petitioner |
|---|---|---|---|
| 10/20/99 | New Motor Vehicles | 202(a)(1) | International Center for Technology Assessment (ICTA) and 19 other organizations |
| 10/3/07 | Ocean Going Vessels | 213(a)(4) | California Attorney General |
| 10/3/07 | Marine Shipping Vessels and their Fuels | 213(a)(4) and 211 | Oceana, Friends of the Earth, and the Center for Biological Diversity |
| 1/10/08 | New Marine Engines and Vessels | 213(a)(4) | South Coast Air Quality Management District |
| 12/5/07 | Aircraft | 231 | States of California, Connecticut, New Jersey, New Mexico, Pennsylvania, City of New York, District of Columbia, South Coast Air Quality Management District |
| 12/5/07 | Aircraft Engines | 231(a)(2)(A) and 231(a)(3) | Friends of the Earth, Oceana, the Center for Biological Diversity, and the Natural Resources Defense Council |
| 1/29/08 | New Nonroad Vehicles and Engines and Rebuilt Heavy-Duty Engines, excluding Aircraft and Vessels | 202(a)(3)(D) and 213(a)(4) | ICTA, Center for Food Safety, and Friends of the Earth |
| 1/29/08 | New Nonroad Vehicles and Engines, excluding Aircraft, Locomotives, and Vessels | 202 and 213(a)(4) | States of California, Connecticut, Massachusetts, New Jersey, Oregon, and Pennsylvania |
| 7/29/09 | Fuels Used in Motor Vehicles, Nonroad Vehicles, and Aircraft | 211 and 231 | NYU Law School Institute for Policy Integrity |
| 9/21/09 | Concentrated Animal Feeding Operations | 111(b) and (d) | Humane Society of the United States and 8 other organizations |
| 9/21/10 | Locomotives | 213(a)(5) | Center for Biological Diversity, Friends of the Earth, and ICTA |

**Source:** U.S. EPA and the petitioning organizations.

## Medium and Heavy-Duty Trucks

Section 202(a) of the Clean Air Act, the section that provided authority for the light-duty vehicle GHG standards, requires the Administrator to set "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" (emphasis added). This authority covers medium- and heavy-duty trucks: in fact, the December 15, 2009, endangerment and cause-or-contribute findings

specifically identified the medium- and heavy-duty truck categories as among those that contributed to the GHG emissions for which it found endangerment. As a result, EPA has already begun work on GHG emission standards for these vehicles, and proposed standards on October 25, 2010.

In addition, in the Energy Independence and Security Act of 2007 (EISA, P.L. 110-140), NHTSA was directed to set the first-ever fuel economy standards for medium- and heavy-duty trucks, reflecting the "maximum feasible improvement" in fuel efficiency.[19] Thus, as with light duty vehicles, EPA and NHTSA are cooperating on the setting of standards.

**Table 2. Motor Vehicle GHG Emissions, 2008, by Source Category**

(million metric tons, $CO_2$-e)

| Category | Total GHG Emissions | % of Motor Vehicle Total |
|---|---|---|
| Passenger Cars | 632.1 | 39.5% |
| Light Duty Trucks | 552.4 | 34.5% |
| Medium- and Heavy-Duty Trucks | 401.2 | 25.1% |
| Buses | 12.1 | 0.8% |
| Motorcycles | 2.2 | 0.1% |
| Total | 1600.0 | |

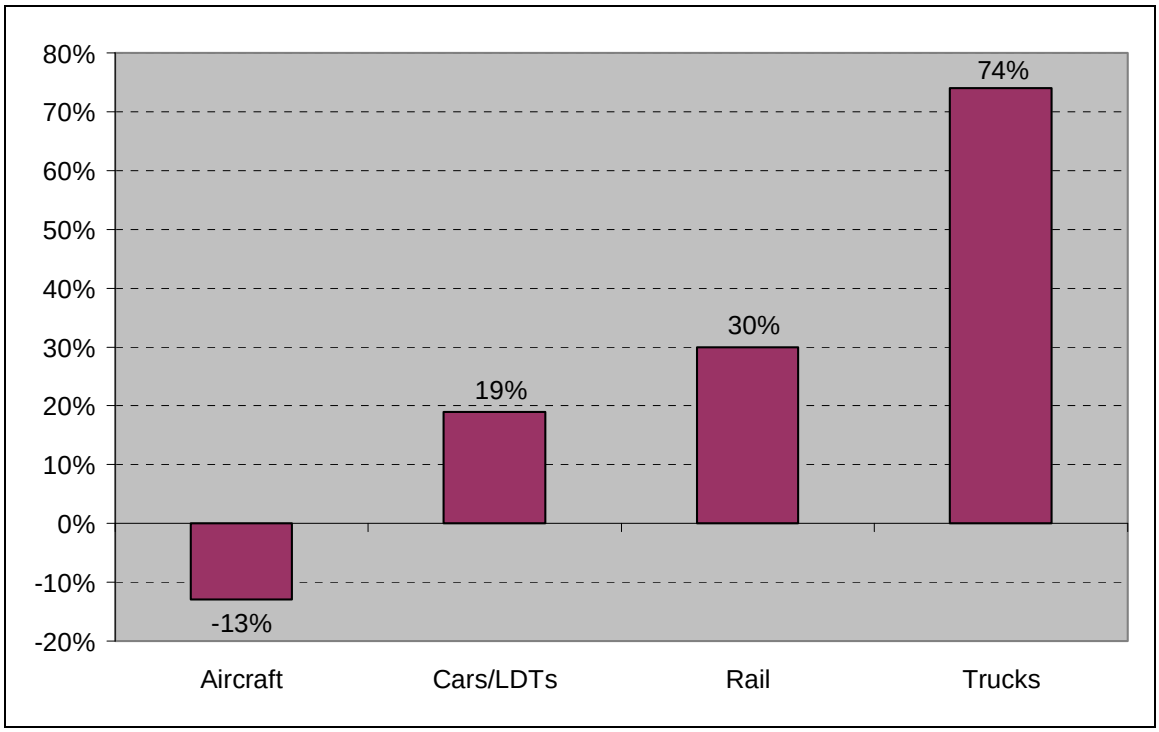
**Source:** U.S. EPA, Inventory of U.S. Greenhouse Gas Emissions and Sinks, 1990-2008, Table 2-15.

Medium- and heavy-duty trucks are trucks with a gross vehicle weight of 10,000 pounds or more. The largest emitters, tractor-trailers (Class 8 trucks), account for slightly less than 20% of the total number of vehicles, but, because they are heavier and are driven longer distances, they consume 61% of all fuel used by trucks.[20] Presumably, they emit about the same percentage of all trucks' GHGs. Box trucks, which tend to be lighter and are more frequently used in urban settings, are a distant second in terms of GHG emissions. As shown in **Table 2**, medium- and heavy-duty trucks emitted about 400 million metric tons of GHGs in 2008, about 25% of GHG emissions from motor vehicles. Between 1990 and 2008, emissions from these trucks grew 74%, the fastest growth for any major category of GHG sources. (See **Figure 2**.)

[19] Section 102.

[20] National Research Council, *Technologies and Approaches to Reducing the Fuel Consumption of Medium- and Heavy-Duty Vehicles*, Overview Presentation of Report, March/April 2010, p. 26.

**Figure 2. Growth of GHG Emissions from Mobile Sources, 1990-2008**




**Source:** U.S. EPA, Inventory of U.S. Greenhouse Gas Emissions and Sinks, 1990-2008, Table 2-15.

The EPA Administrator is given substantial leeway in the design and implementation of motor vehicle regulations. The act states that the Administrator may establish categories for purposes of regulation based on "gross vehicle weight, horsepower, type of fuel used or other appropriate factors." In addition, she may delay the effective date of regulations as long as she finds necessary "to permit the development and application of the requisite technology, giving appropriate consideration to the cost of compliance within such period." Using this authority in regulating conventional pollutants, EPA has used weight or power classifications to set differing levels of emission standards, particularly for trucks; it has given manufacturers as much as four years lead time to develop emission controls; and it has set different standards based on the type of fuel an engine uses. Except for specific conventional pollutants mentioned in Section 202, the act does not specify a level of stringency (e.g., best available control technology) for prospective regulations.

Although flexible in many respects, motor vehicle standards have often been used to force the development of new technology. In adopting technology-forcing regulations, EPA has generally followed the lead of California. Because of its more severe air pollution and its pioneering role in establishing motor vehicle emission control requirements in the 1960s, California is allowed to adopt standards more stringent than federal requirements. The state must apply for a waiver of federal preemption under CAA Section 209(b) in order to enforce its more stringent standards, which EPA is to grant if the state meets certain criteria, primarily a showing that the standards are needed to meet "compelling and extraordinary conditions." If California is granted a waiver, other states may adopt identical requirements, thus reinforcing the potential impact of California's technology-forcing standards.

EPA discussed several potential strategies for reducing GHG emissions from medium- and heavy-duty trucks in its July 2008 Advance Notice of Proposed Rulemaking,[21] including:

1. **Improvements in Engine Technology.** Most trucks, particularly tractor-trailers, are powered by diesel engines, which are already quite efficient; but EPA thinks that a number of small improvements (such as better lubricants and higher cylinder pressure) could increase diesel engine efficiency by up to 20%. For urban trucks, which engage in stop-and-go driving and may idle frequently in traffic, hybrid engine technologies show promise of substantial reductions in emissions.
2. **Eliminating Aerodynamic Drag.** Aerodynamic drag is an important factor in fuel consumption, particularly for tractor-trailers. EPA estimates that drag accounts for 21% of energy consumed by tractor-trailers at 65 miles per hour. The agency has promoted a number of relatively simple redesigns (high roof fairings, side skirts, side fairing gap reducers, aerodynamic mirrors and bumpers) through its SmartWay voluntary program. These measures can have a significant impact on fuel use.
3. **Reducing Rolling Resistance.** Tire rolling resistance accounts for about 13% of energy consumed by tractor trailers, according to EPA. The agency says that 10% or greater reductions in rolling resistance have already been demonstrated and continued innovation has the potential to achieve larger improvements. In addition to better tires with less rolling resistance, tire inflation indicators can improve fuel efficiency.
4. **Addressing Operational Factors.** Operational factors refer to a wide variety of measures that can reduce truck fuel use, including the installation of speed governors (widely used in Europe and by some fleets in the United States). According to EPA, vehicle speed is the single largest operational factor affecting $CO_2$ emissions from trucks: every one mile per hour increase above 55 mph increases $CO_2$ emissions by more than 1%. Engine idling is another operational factor affecting fuel consumption and GHG emissions. The addition of auxiliary power units or truck stop electrification could eliminate the need for extended idling, reducing emissions.

All in all, EPA stated in its 2008 analysis of the issues, "we see a potential for up to a 40% reduction in GHG emissions from a typical heavy-duty truck in the 2015 timeframe, with greater reductions possible looking beyond 2015...."[22]

EPA and NHTSA jointly proposed GHG and fuel economy standards on October 25, 2010. For a variety of reasons, including agency decisions not to address trailer design issues, the proposed standards would not achieve anywhere near the 40% reduction that the agency found achievable in 2008.

[21] U.S. EPA, "Regulating Greenhouse Gas Emissions Under the Clean Air Act," Advance Notice of Proposed Rulemaking, July 30, 2008, 73 *Federal Register* 44453-44458.

[22] Ibid., p. 44454.

The proposed standards would divide trucks into three main categories: (1) heavy-duty pickup trucks and vans; (2) combination tractors (the power unit of a tractor-trailer combined vehicle); and (3) vocational vehicles.[23]

The standards for heavy-duty pickups and vans use an approach similar to that for light duty vehicles, in which each manufacturer would be required to meet an average standard that would vary depending on its sales mix, with higher capacity vehicles (based on payload, towing capacity, and 4-wheel drive) having less stringent targets. The standards, which would be phased in from 2014 to 2018, are estimated by EPA to cut GHG emissions an average of 17% in diesel vehicles when fully implemented in 2018, and 12% in comparable gasoline-powered vehicles.[24]

For the other categories of trucks, referred to as vocational vehicles or combination tractors, the standards vary significantly depending on the size of the truck. These standards are expected to reduce GHG emissions 7% to 20% for combination tractors and 7% to 10% for vocational vehicles by model year 2017, according to the EPA Regulatory Announcement.[25]

In addition to engine emission standards, the proposal would set a standard for refrigerant leaks, in order to address emissions of HFC greenhouse gases. But trailer design, a major source of efficiency losses (and, thus, higher GHG emissions), is not addressed. According to EPA:

> Trailers are not covered under this proposal, due to the first-ever nature of this proposal and the agencies' limited experience working in a compliance context with the trailer manufacturing industry. However, because trailers do impact the fuel consumption and CO2 emissions from combination tractors, and because of the opportunities for reductions, we are soliciting comments on controlling GHG emissions and fuel consumption from trailers, to prepare a foundation for a possible future rulemaking.[26]

## Ships

Three of the 10 petitions to EPA asking the agency to control greenhouse gas emissions concern ocean-going ships (also referred to as marine engines and vessels) and (in two of the petitions) their fuel. Although there is a wide range of estimates, the International Maritime Organization's consensus is that international shipping emitted 843 million metric tons of carbon dioxide, 2.7% of global $CO_2$ emissions in 2007. Including domestic shipping and fishing vessels larger than 100 gross tonnes, the amount would increase to 1.019 billion metric tons, 3.3% of global emissions.[27]

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[23] In the preamble to the proposed rule, EPA says, "… vocational vehicles consist of a wide variety of vehicle types. Some of the primary applications for vehicles in this segment include delivery, refuse, utility, dump, and cement trucks; transit, shuttle, and school buses; emergency vehicles, motor homes, tow trucks, among others. These vehicles and their engines contribute approximately 15 percent of today's heavy-duty truck sector GHG emissions." EPA and NHTSA, "Greenhouse Gas Emissions Standards and Fuel Efficiency Standards for Medium and Heavy-Duty Engines and Vehicles," pre-publication copy, p. 30, at http://www.epa.gov/otaq/climate/regulations/hd-preamble-regs.pdf.

[24] "EPA and NHTSA Propose First-Ever Program to Reduce Greenhouse Gas Emissions and Improve Fuel Efficiency of Medium- and Heavy-Duty Vehicles: Regulatory Announcement," October 2010, p. 5, at http://www.epa.gov/otaq/climate/regulations/420f10901.pdf.

[25] Ibid., pp. 5-7.

[26] Ibid., p. 4.

[27] International Maritime Organization, *Updated Study on Greenhouse Gas Emissions from Ships*, Executive Summary of Phase 1 Report, 1st September 2008, p. 5 at egserver.unfccc.int/seors/attachment/file_storage/6ep77qqvcujba7k.doc. Both estimates exclude emissions from naval vessels.

At these levels, only five countries (the United States, China, Russia, India, and Japan) individually account for a higher percentage of the world total of $CO_2$ emissions.[28]

In addition to the $CO_2$ emissions, the low-quality bunker fuel that ships use and the absence of pollution controls result in significant emissions of black carbon and nitrogen oxides, which also contribute to climate change. Refrigerants used on ships (hydrofluorcarbons and perfluorocarbons—HFCs and PFCs) are also potent greenhouse gases when released to the atmosphere. Thus, the total impact of ships on climate is likely greater than the 3.3% estimate above.

The authority to control pollution from ships is found in Section 213(a)(4) of the Clean Air Act, which provides general authority to the Administrator to promulgate standards for emissions other than carbon monoxide, oxides of nitrogen, and volatile organic compounds from "nonroad engines and vehicles."[29] Fuels are regulated separately under Section 211 of the act.

The language of Section 213 is similar to that for new motor vehicles in Section 202, except that in place of the words "cause, or contribute," Section 213 uses the phrase "significantly contribute": if the Administrator determines that emissions of GHGs from ships significantly contribute to air pollution which may reasonably be anticipated to endanger public health or welfare, she may promulgate such regulations as she deems "appropriate." Except for the specific conventional pollutants mentioned in Section 213(a)(2), there is no level of stringency (such as best available control technology) specified for prospective regulations. The Administrator may establish classes or categories of ships for the purposes of regulation. There is no deadline for the promulgation of standards, and in setting them, the Administrator may take into account costs, noise, safety, and energy factors associated with the application of technology.

A wide variety of measures might be undertaken to reduce emissions from shipping, from simple operational measures, such as reducing speed or using cleaner fuels, to various hull and propeller design features that would increase fuel economy. Reducing speed can save substantial amounts of fuel. A.P. Moller-Maersk, which operates the world's largest fleet of containerships, reported that it reduced fuel consumption by its ships 6% in 2008, compared to the fuel used for the same level of business activity in 2007. According to the company, "reducing speed 5-10% does increase the number of days at sea, but reduces both fuel consumption and $CO_2$ emission by more than 15%."[30] The petitions also mention improved fleet deployment planning, use of shore-side power while in port, heat recovery systems, the use of sails as supplemental propulsion sources, and NOx controls, such as selective catalytic reduction (SCR) or exhaust gas recirculation, as potential emission control measures.

A complicating factor in the regulation of emissions from ocean-going vessels would be that, for the most part, their GHG emissions occur in international waters, and the sources (the ships) are not registered in the United States: according to California's petition, 95% of the fleet calling on U.S. ports is foreign-flagged. The petitioners assert that these factors are not a bar to EPA regulation, however, citing as precedent a Supreme Court case that held that the Americans with

[28] Oceana, *Shipping Impacts on Climate: A Source with Solutions*, p. 2, at http://www.oceana.org/fileadmin/oceana/uploads/Climate_Change/Oceana_Shipping_Report.pdf.

[29] CO, NOx, and VOCs are regulated under Section 213(a)(3), which requires the imposition of best available control technology, and set a deadline for such regulation.

[30] See *Preparing for the Future*, The A.P. Moller – Maersk Group's Health, Safety, Security and Environment Report 2008, pp. 28-30, at http://media.maersk.com/da/PressReleases/2009/Documents/Maersk%20HSSE%202008_Final.pdf.

Disabilities Act could be applied to foreign-flagged cruise ships so long as the ADA-required accommodations did not interfere with the ships' internal affairs or require major, permanent modifications to the ships.[31]

In addition to petitioning for regulation of emissions from ships, the petitions from California and from Oceana et al. stated that EPA should regulate the composition of marine shipping vessel fuel to control global-climate-change-related emissions, or should require use of marine diesel fuel oil instead of bunker fuel. The purpose would be to limit the sulfur content of marine fuels and reduce NOx emissions. We discuss EPA's authority to regulate fuels in a separate section below, but note here that EPA, the state of California, and the International Maritime Organization are all moving forward with regulations to limit the sulfur content of bunker fuel for the purpose of reducing conventional pollutants. California's low sulfur fuel requirements went into effect July 1, 2009. In addition, on March 26, 2010, the International Maritime Organization approved an EPA proposal that the entire U.S. coastline except portions of Alaska be designated as an Emission Control Area, subject to lower sulfur limits in bunker fuel.

Sulfur emissions form fine particles of sulfate in the atmosphere, with significant impacts on public health and welfare. (For a further discussion of these impacts, see CRS Report RL34548, *Air Pollution and Greenhouse Gas Emissions from Ships*.) Although harmful as a conventional pollutant, sulfur emissions are thought by most experts to be beneficial or at least neutral in the climate context. Sulfates have a cooling effect on the atmosphere, since the particles tend to reflect solar radiation back into space rather than absorbing it. On the other hand, removing sulfur might be necessary to prevent the fouling of pollution control equipment that reduces other pollutants that do lead to warming.

## Other Nonroad Engines

Section 213 can also be used to regulate other nonroad vehicles and engines. A similar endangerment finding would first be required, following which the Administrator may promulgate such regulations as she deems appropriate to control emissions from the classes or categories of nonroad engines that she determines "significantly contribute" to the air pollution that endangers public health or welfare. The Administrator is to take into account costs, noise, safety, and energy factors in setting standards. There is no deadline for setting standards.

The nonroad sector is a broad category that includes construction equipment, farm equipment, forklifts, outdoor power equipment, lawn and garden equipment, and recreational vehicles. This group accounted for 199.7 million metric tons of $CO_2$ emissions in 2007, according to the two petitions requesting regulation (see **Table 3**), 3.3% of total U.S. emissions of $CO_2$ in that year. According to the ICTA petition, GHG emissions from the nonroad sector increased 49% between

[31] Spector v. Norwegian Cruiseline, 545 U.S. 119 (2005). In addition, according to the California petition, the United States can and does enforce pollution standards on ships in its territorial waters, "as can be seen by the fact that the National Park Service has imposed air pollutant emissions controls on cruise ships, including foreign-flagged cruise ships (the vast majority of such ships are foreign-flagged), that sail off the coast from Glacier Bay National Park, in Alaska." See People of the State of California Acting by and Through Attorney General Edmund G. Brown, Jr., "Petition for Rule Making Seeking the Regulation of Greenhouse Gas Emissions from Ocean-Going Vessels," October 3, 2007, p. 13. The cited regulations are at 36 CFR 13.65(b)(4). The *Federal Register* citation is 61 *Federal Register* 27008, 27011 (May 30, 1996).

1990 and 2005, a higher rate of emissions increase over the same period than for on-road vehicles (32%), aircraft (3%), boats and ships (36%), and rail (32%).[32]

**Table 3. Nonroad Sector $CO_2$ Emissions, 2007, by Source Category**

(million metric tons)

| Category | $CO_2$ Emissions | % of Nonroad Total |
|---|---|---|
| Construction and Mining Equipment | 63.9 | 32.0% |
| Agricultural Equipment | 39.6 | 19.8% |
| Industrial Equipment | 27.8 | 13.9% |
| Lawn and Garden Equipment | 23.8 | 11.9% |
| Commercial Equipment | 16.4 | 8.2% |
| Pleasure Craft | 15.8 | 7.9% |
| Recreational Equipment | 9.4 | 4.7% |
| Logging Equipment | 1.9 | 1.0% |
| Airport Equipment | 1.0 | 0.5% |
| Railroad Equipment | 0.2 | 0.1% |
| Total | 199.7 | |

**Source:** ICTA et al., *Petition for Rulemaking Seeking the Regulation of Greenhouse Gas Emissions from Nonroad Vehicles and Engines*. According to the petition, the emissions data were compiled by the Western Environmental Law Center using EPA's nonroad emissions model.

Given their smaller impact on overall emission levels, EPA has been slower to regulate conventional (criteria) pollutants from nonroad engines than from motor vehicles. Many of these engines had few emission control requirements for as many as 25 years after the regulation of automobiles. In the last decade, however, often following the lead of California, EPA has promulgated standards for many nonroad categories. Some of these standards, particularly for diesel-powered equipment and for lawn and garden equipment, have been technology-forcing. Others, such as for snowmobiles, have been less so.

In general, given the wide variety of engine types and sizes and the configurations of the equipment itself, the agency has based its standards on a review of individual subcategories and the technologies available to reduce emissions from specific types of machinery or equipment, rather than applying one across the board standard. Presumably, any GHG standards for this sector would take the same approach.

## Locomotives

On September 21, 2010, EPA received a petition from three environmental organizations to regulate GHG emissions and black carbon from locomotives. In 2008, locomotives emitted 50.6 million metric tons of greenhouse gases. Although this is less than 1% of total U.S. GHG

[32] International Center for Technology Assessment, et al., "Petition for Rulemaking Seeking the Regulation of Greenhouse Gas Emissions from Nonroad Vehicles and Engines," January 29, 2008, p. 5.

emissions, GHG emissions from railroads increased by 30% between 1990 and 2008, more than twice the rate of increase for total U.S. emissions. In addition, locomotives emit substantial amounts of black carbon (i.e., soot), which is thought to have significant global warming potential through its ability to absorb solar radiation and to reduce the reflectivity of snow and ice. According to a report from NASA's Goddard Institute for Space Studies cited in the locomotive petition, "… black soot may be responsible for 25 percent of observed global warming over the past century."[33] As a result, in addition to requesting that EPA set GHG emission standards for locomotives, the petition asks EPA to set standards for locomotives' black carbon emissions.

The Clean Air Act requires EPA to set emission standards for new locomotives (and new engines used in locomotives) in Section 213(a)(5). Unlike almost every other Clean Air Act section dealing with mobile sources, the locomotive subsection does not require an endangerment finding for the Administrator to act. Instead, it requires the Administrator to set standards that achieve the greatest degree of emission reduction achievable through the application of technology which she determines will be available, giving appropriate consideration to cost, noise, energy, and safety factors.

As with the medium- and heavy-duty truck category, EPA discussed several potential strategies for reducing GHG emissions from locomotives in its July 2008 Advance Notice of Proposed Rulemaking (ANPR).[34] The ANPR identified more than 20 strategies for reducing emissions from rail transport, including idle reduction equipment, auxiliary power units, hybrid engines, regenerative braking, and reduction of refrigerant leaks from railcars.

## Aircraft

EPA has also received petitions to regulate GHG emissions from aircraft and aircraft engines. In the United States, aircraft of all kinds are estimated to emit between 2.4% and 3.4% of the nation's total greenhouse gas emissions.[35] When other factors are considered, the impact of U.S. aviation on climate change is perhaps twice that size. These factors include the contribution of aircraft emissions to ozone formation, the water vapor and soot that aircraft emit, and the high altitude location of the bulk of aircraft emissions. (For additional information on aircraft GHG emissions, see CRS Report R40090, *Aviation and Climate Change*.)

As noted in **Table 1**, two December 2007 petitions requested that EPA address aircraft GHG emissions. Specifically, the petitions asked that EPA make a finding that aircraft GHG emissions endanger public health or welfare, and that the agency adopt regulations that allow a range of compliance approaches: these might include emission limits, operational practices, fees, a cap-and-trade system, minimizing engine idling time, employing single engine taxiing, or use of ground-side electricity measures to replace the use of fuel-burning auxiliary power units at airport gates.[36]

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[33] U.S. National Aeronautics and Space Administration, Goddard Institute for Space Studies, "Black Soot and Snow: A Warmer Combination," December 22, 2003, at http://www.gcrio.org/OnLnDoc/pdf/black_soot.pdf.

[34] U.S. EPA, "Regulating Greenhouse Gas Emissions Under the Clean Air Act," Advance Notice of Proposed Rulemaking, July 30, 2008, 73 *Federal Register* 44463-44464.

[35] The lower percentage includes $CO_2$ emissions from consumption of fuel by military aircraft, general aviation, and domestic operation of commercial aircraft. The higher estimate includes $CO_2$ emissions from international air travel originating in the United States, as well.

[36] For a brief discussion of the petitions, see 73 *Federal Register* 44460, July 30, 2008. Some of these measures, such (continued...)

EPA has authority to regulate emissions from aircraft under Section 231 of the Clean Air Act. The language is similar to that for other mobile sources. It requires the Administrator to issue standards for the emission of any air pollutant from any class or classes of aircraft engines which, in her judgment, causes or contributes to air pollution which may reasonably be anticipated to endanger public health or welfare. The regulations are to take effect "after such period as the Administrator finds necessary ... to permit the development and application of the requisite technology, giving appropriate consideration to the cost of compliance." But compared to other mobile sources, EPA's Clean Air Act authority vis-à-vis aircraft and aircraft engines contains an important difference: the Administrator must consult with the Administrator of the Federal Aviation Administration and the Secretary of Transportation in developing emission standards, and is not allowed to impose new standards if doing so would significantly increase noise and adversely affect safety. The President may also disapprove any such standards if the Secretary of Transportation finds that they would create a hazard to aircraft safety.

Unlike ships, aircraft operating in the United States are generally registered here: EPA has cited data that foreign carriers accounted for only 3% of major carrier operations in the United States in 1999.[37] Thus, whether GHG regulations could be applied to foreign flag carriers might seem to pose less of an issue, at least in terms of whether any potential regulations would address the bulk of the sector's U.S. emissions. On the other hand, international air travel is extremely competitive, and issues of whether regulations can be imposed on foreign carriers have already been raised in the context of the European Union's adoption of cap-and-trade requirements for international aviation. U.S. airlines generally maintain that the imposition of requirements on foreign-flag airlines (i.e., themselves, in the European Union) violates international trade agreements. Their preference is that any controls be negotiated through the International Civil Aviation Organization (ICAO) and be applied equally to all carriers.

EPA has rarely regulated emissions from aircraft without first negotiating international agreements through ICAO. ICAO's regulation of conventional pollutants from aircraft, unlike EPA's regulation of the same pollutants from motor vehicles, has consistently avoided forcing technology. The most recent standards for nitrogen oxides, for example, essentially ratified what the principal aircraft manufacturers had already achieved.[38]

## Fuels

Fuel regulation, whether of bunker fuel, gasoline, or any other type of fuel, is authorized under Section 211 of the Clean Air Act. Section 211 gives the Administrator authority to control or prohibit the manufacture and sale of any fuel or fuel additive if she concludes that its emission products may endanger public health or welfare, or if they will impair to a significant degree the performance of emission control devices. As with the regulation of engines and vehicles, the

(...continued)

as minimizing engine idling time, employing single engine taxiing, and use of ground-side electricity measures to replace the use of fuel-burning auxiliary power units, are already widely used by the airlines as fuel-saving measures.

[37] U.S. EPA, Office of Air and Radiation, *Emission Standards and Test Procedures for Aircraft and Aircraft Engines, Summary and Analysis of Comments*, November 2005, p. 10, at http://www.epa.gov/oms/regs/nonroad/aviation/420r05004.pdf

[38] "EPA Proposal to Bring Certain Aircraft Up to International Engine Standard," *Daily Environment Report*, September 30, 2003.

Administrator is given substantial leeway in the design and implementation of fuel regulations and there is no deadline for their promulgation even after an endangerment finding is made.

GHG emissions from fuels have already been targeted for regulation by the state of California.[39] On April 15, 2010, California's Office of Administrative Law approved regulations to implement the California Low Carbon Fuel Standard, which has been under development since 2007. The standard's goal is to reduce GHG emissions from transportation fuels per unit of energy 10% by 2020. The regulations address emissions from the production, transportation, and consumption of gasoline, diesel fuel, and their alternatives, including biofuels. They envision compliance both through the use of lower carbon fuels and through the development of more efficient, advanced-technology vehicles, such as plug-in hybrids, electric vehicles, and hydrogen fuel cells.

As has been the case with motor vehicles, California has often led the way in the development of cleaner conventional fuels through technology-forcing regulation, with U.S. EPA later adopting similar standards. Thus, many view the Low Carbon Fuel Standard as the prototype of another possible use of existing Clean Air Act authority to regulate greenhouse gas emissions nationally. On July 29, 2009, the Institute for Policy Integrity at NYU Law School petitioned EPA to establish a cap-and-trade system to limit greenhouse gas emissions from fuels used in motor vehicles, nonroad vehicles, and aircraft.

Regulation of fuels would be a way for California or U.S. EPA to obtain reductions from existing vehicles and engines. As noted earlier, the slow turnover of the vehicle fleet means that emission reductions from new vehicles will only gradually affect emission levels from the fleet as a whole. By requiring low carbon fuels, California and EPA could obtain GHG reductions from the entire fleet more quickly.

On the other hand, measuring the carbon content of fuels is more complicated than it may seem, particularly if one considers the life-cycle emissions, including indirect impacts of production. EPA has been embroiled in a controversy over this issue already, as it attempted to develop a methodology for measuring greenhouse gas emissions from biofuels, as required by the Energy Independence and Security Act of 2007 (P.L. 110-140).[40] For regulations implementing this provision, EPA developed and later modified a methodology to measure the GHG effects of indirect land-use changes, such as the switching of land from forest to cropland.[41]

# Conclusion

**Table 4** summarizes EPA's existing authorities over mobile source GHG emissions and the emissions of each of the sectors discussed in this report. Given the Supreme Court's remand in *Massachusetts v. EPA*, the agency has focused its efforts on motor vehicles (first of all, passenger cars and light trucks), which, as **Table 4** shows, account for the majority of mobile source GHG

[39] For more information, see http://www.arb.ca.gov/regact/2009/lcfs09/lcfs09.htm. For additional background, see archived CRS Report R40078, *A Low Carbon Fuel Standard: State and Federal Legislation and Regulations*, by Brent D. Yacobucci.

[40] Section 202 of the act mandates the use of "advanced biofuels"—fuels produced from non-corn feedstocks and with 50% lower lifecycle greenhouse gas emissions than petroleum fuel—starting in 2009. Of the 36 billion gallons of renewable fuel required in 2022, at least 21 billion gallons must be advanced biofuel.

[41] For information, see CRS Report R40460, *Calculation of Lifecycle Greenhouse Gas Emissions for the Renewable Fuel Standard (RFS)*, by Brent D. Yacobucci and Kelsi Bracmort.

emissions. Having finalized these standards, the agency has now moved on to the development of GHG emission standards for medium- and heavy-duty trucks, the next largest category of emissions. Both of these categories were covered by EPA's December 15, 2009, endangerment finding.

By issuing endangerment findings similar to the one it issued for motor vehicles, EPA could move forward to control GHG emissions from other categories of mobile sources and/or their fuels. On the other hand, once the agency has completed the setting of emission standards for passenger cars, light duty trucks, and medium- and heavy-duty trucks, it will have addressed the categories responsible for more than three-fourths of all mobile source GHG emissions. The next largest category, aircraft, has rarely been the subject of EPA regulation unless the International Civil Aviation Organization (ICAO) has first agreed on standards. Other mobile source categories are less significant: each accounts for less than 1% of total U.S. emissions.

Thus, EPA seems more likely to follow up its car and truck standards in two ways: (1) by considering a new round of emission standards for light duty vehicles, and (2) by expanding its focus to stationary sources. On May 21, 2010, President Obama directed the Environmental Protection Agency and the Department of Transportation to develop new fuel economy and greenhouse gas emissions standards for cars and light trucks for model year 2017 and beyond. As has often happened in the development of auto emission standards, EPA will likely be following the lead of California, which expects to adopt GHG emission standards for 2017-2025 model year cars and light trucks by the end of 2010.[42] The California standards would require a waiver of federal preemption from EPA in order to take effect. Emission reductions from these categories might also be addressed through regulation of the carbon content of their fuels.

Meanwhile, EPA can be expected to expand its focus to stationary sources, which account for nearly 70% of the nation's GHG emissions, and within that group to electric power plants. Power plants account for about one-third of all U.S. GHG emissions, a higher percentage of the nation's total than all mobile sources combined. New and modified power plants will automatically be subject to permit requirements and the imposition of Best Available Control Technology as of January 2, 2011, under EPA's interpretation of Section 165 of the Clean Air Act. The agency also appears likely to develop New Source Performance Standards for GHG emissions from electric power plants in the 2011 time period. (For additional discussion, see CRS Report R41212, *EPA Regulation of Greenhouse Gases: Congressional Responses and Options*, by James E. McCarthy and Larry Parker.)

[42] See "California Seeks to Lead in Strengthening Future Fuel Economy, Emissions Standards," *Daily Environment Report*, April 30, 2010, p. A-6.

**Table 4. Categories of Sources Whose GHG Emissions Can Be Regulated Under Title II of the Clean Air Act**

(assuming an endangerment finding for the category)

| Category | CAA Authority (Section #) | Estimated 2007 GHG Emissions (million tons $CO_2$-e) | % of Total U.S. GHG Emissions |
|---|---|---|---|
| Passenger Cars | 202 | 671.6 | 9.4% |
| Light Duty Trucks | 202 | 569.9 | 8.0% |
| Medium- and Heavy-Duty Trucks | 202 | 425.2 | 5.9% |
| Aircraft (domestic operation) | 231 | 171.8 | 2.4% |
| Construction and Mining Equipment | 213 | 63.9 | 0.9% |
| Ships and Other Boats[a] | 213 | 55.2 | 0.8% |
| Locomotives | 213 | 54.3 | 0.8% |
| Agricultural Equipment | 213 | 39.7 | 0.6% |
| Industrial Equipment | 213 | 27.8 | 0.4% |
| Lawn and Garden Equipment | 213 | 23.8 | 0.3% |
| Commercial Equipment | 213 | 16.4 | 0.2% |
| Pleasure Craft | 213 | 15.8 | 0.2% |
| Buses | 202 | 12.5 | 0.2% |
| Recreational Equipment | 213 | 9.4 | 0.1% |
| Motorcycles | 202 | 2.1 | <0.1% |
| Logging Equipment | 213 | 1.9 | <0.1% |
| Airport Equipment | 213 | 1.0 | <0.1% |
| Railroad Equipment | 213 | 0.2 | <0.1% |
| Total[a] | | 2162.5 | 30.2% |

**Source:** U.S. EPA and ICTA

a. Does not include international bunker fuel.

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