Summary

Air pollutant emissions from mobile sources have been regulated for almost half a century. During this time, the focus has largely been on tightening emissions standards for on-road vehicles and engines, particularly passenger cars and small trucks (light-duty vehicles). Light-duty-vehicle emissions control grew out of research that implicated the increasing use of vehicles in the deterioration of air quality conditions in the 1950s in Southern California. Control of motor vehicle emissions began in the early 1960s with the introduction of positive crankcase ventilation, a simple approach consisting of a hose and valve that reduced the venting of uncombusted gases to the atmosphere. From that simple beginning, light-duty-vehicle emissions control evolved to today's complex regulation of fuel properties, exhaust emissions, and evaporative emissions, which require the use of sophisticated engine and emissions-control technologies. These strategies enabled per-mile-exhaust emissions of new, properly operating light-duty vehicles to decrease by 95-99% in 2004 compared with emissions of 1967 model-year vehicles.

The focus of mobile-source emissions control expanded to include on-road heavy-duty engines and later nonroad engines. The broadening in regulatory attention arose from the increasing fraction of mobile-source emissions that come from sources other than light-duty vehicles and the relative lack of emissions controls on these sources. On-road heavy-duty-vehicle engines were first regulated for air pollutants in the 1970s, and engines used in off-road applications were first regulated in the mid-1990s. Over the next decade, regulations already approved for new sources will substantially reduce emissions from on-road diesel vehicles, nonroad diesel engines, and gasoline-powered nonroad engines.

The federal Clean Air Act (CAA) establishes the framework for controlling mobile-source emissions in the United States. During the development of the CAA in 1967, Congress recognized that the imposition of many different state standards could result in inefficiencies in vehicle markets. Therefore, state-established emissions standards were preempted by federal emissions standards in what is now section 209 of the CAA. A special exemption to this federal preemption was made in section 209 for California because of the state's special air quality problems and pioneering efforts in the control of air pollutants. This exemption, still in existence, gives the state of California the authority to set on-road vehicle standards that differ from the federal standards as long as they are as protective in the aggregate as federal standards. Later amendments to section 209 granted California the authority to set emissions standards and regulations for some nonroad engines, and section 177 was added to allow other states to adopt California standards.

The National Research Council (NRC) convened the Committee on State Practices in Setting Mobile Source Emissions Standards in response to a request from Congress in its fiscal 2003 appropriations report for the U.S. Environmental Protection Agency (EPA) to arrange for an independent study of the

practices and procedures by which states develop separate emission standards. For this report, the committee was asked to assess the scientific and technical procedures used by states to develop or adopt different emissions standards and to compare those policies and practices with those used by EPA. The committee was also asked to consider the factors that caused states to move toward more stringent emissions standards and to consider the impacts of state emissions standards on various factors, including emissions, compliance costs, energy consumption, air quality, and human health. As part of its work plan, the committee was directed to consider the effects of California's experience in setting separate emissions standards and the effects of California's standards on federal emissions standards. The full Statement of Task for the committee is provided in Chapter 1.

CONCLUSIONS AND RECOMMENDATIONS

Role of New Mobile-Source Emissions Standards

Despite the substantial progress made over the past few decades in reducing air pollutant emissions from many sources, including mobile sources, some locations continue to exceed National Ambient Air Quality Standards (NAAQS).[1] Further improvements in air quality will be needed, particularly to attain the new ambient standards for fine particulate matter and ozone at concentrations averaged over 8 hours. Although many emissionscontrol programs have been developed and regions with air quality problems have implemented a variety of programs, stricter new mobile-source emissions standards are an important component of overall emissions-control plans for locations that need air quality improvements. Federal mobile-source emissions standards set by EPA ensure that all regions of the country have some emissions reductions and that the mobility of these emissions sources does not undermine other air quality initiatives. California emissions standards, which are set by the California Air Resources Board (CARB), provide additional emissions reductions for the state's most populated and worst polluted regions, including the Los Angeles area and San Joaquin Valley. In many cases, CARB has tightened mobile-source emissions standards earlier and to a greater extent than the federal government. Other states that seek mobile-source emissions reductions from new-vehicle standards beyond those provided by federal standards have adopted California standards to supply the additional benefits.

While this study was in progress, CARB adopted light-duty-vehicle emissions standards for greenhouse gases. These standards have been challenged in the courts. The committee did not develop findings and recommendations specific to these standards because of their timing, the uncertainty surrounding their standing, and the lack of comparable federal standards.

California's Role In Mobile-Source Emissions Regulation

The CAA gives California the authority to set its own mobile-source emissions standards. Over the history of mobile-source regulation to date, California has usually led EPA in establishing emissions standards on light-duty vehicles and small nonroad gasoline engines, and EPA has usually led California in establishing standards for on-road heavy-duty diesel vehicles and off-road diesel engines. This shared

[1] NAAQS set maximum allowable ambient air concentrations for six so-called "criteria" pollutants; the standards are to be protective of public health (primary standards) and welfare (secondary standards). The six criteria pollutants are carbon monoxide, lead, nitrogen dioxide, ozone, particulate matter, and sulfur dioxide.

leadership promotes improvements in the efficiency of EPA's and CARB's regulatory efforts and allows sharing of expertise.

The mobile-source emissions standards developed by CARB, like those developed by EPA, have typically been "technology forcing."[2] In forcing technology development, California has been a laboratory for emissions-control innovations. An advantage of having a state laboratory for innovation is that the risk of failure to develop the required technologies is restricted to a limited geographic area. CARB's regulatory process is supportive of this laboratory role in that California's standards can be amended rapidly in the face of changing market and technological conditions in contrast to EPA's regulatory process.

The original reasons for which Congress authorized California to have a separate set of standards remain valid. California still has some of the worst air quality conditions in the country, and certain emission-reduction needs are greater in California than in the rest of the country. California has used its authority as Congress envisioned: to implement more aggressive measures than the rest of the country and to serve as a laboratory for technological innovation. These have resulted in successes, such as CARB's early recognition of the need to couple fuel composition with emissions control, and failures, such as the promotion of widespread use of electric vehicles under the original zero-emissions vehicle mandate.

California's authority to set its own mobile-source emissions standards inevitably imposes additional risks and costs, such as design, production, and distribution costs, although the costs and benefits are difficult to quantify. However, experience to date indicates that the California program has been beneficial overall for air quality by improving mobile-source emissions control.

Recommendation

California should continue its pioneering role in setting mobile-source emissions standards. The role will aid the state's efforts to achieve air quality goals and will allow it to continue to be a proving ground for new emissions-control technologies that benefit California and the rest of the nation.

EPA and CARB Technical and Scientific Practices in Setting Standards

CARB and EPA have essentially the same starting point and motivation for setting new or stricter standards: attainment of the NAAQS. Each agency follows a series of procedural steps leading to a finalized regulation. These steps include identification of the need for new emissions standards, evaluation of potential control strategies, publication of proposed regulations, and solicitation of public comments on proposals before promulgating the regulations. Some differences exist in the scope of CARB and EPA regulatory assessments as a result of the different procedures that the agencies must follow.

Some important similarities in the practices of setting standards followed by the two agencies are the following:

- CARB and EPA establish emissions standards based on assessments of technological feasibility and estimated engineering costs.

[2] "Technology forcing" refers to the establishment by a regulatory agency of a requirement to achieve an emissions limit, within a specified time frame, that can be reached through use of unspecified technology or technologies that have not yet been developed for widespread commercial applications and have been shown to be feasible on an experimental or pilot-demonstration basis.

- CARB and EPA periodically update their practices as emissions estimation models and procedures continue to evolve and improve over time.
- CARB and EPA study technical practices of industry and perform engineering and market cost analyses.
- CARB and EPA test new technologies in the laboratory, using their own staffs, as well as outside contractors.

Some important differences in the practices of setting standards followed by the two agencies are the following:

- EPA's rule-making practices are subject to federal requirements defined in multiple acts and executive orders. Because emissions-standard regulations are typically deemed "significant,"[3] the rule-making process is overseen by the Office of Management and Budget. CARB's emission-standard rule-making is subject to state laws and to oversight by the California Office of Administrative Law. As a result of the particular requirements, each agency's rule making includes some special components. For example, EPA is required to perform a cost-benefit analysis in which it estimates the monetary benefits of improved air quality to public health. CARB in turn is required to perform various California-specific economic impact assessments, such as employment impacts on in-state businesses.
- California is required to submit state implementation plans (SIPs) to EPA. In 1988, California passed its own California CAA, which includes additional standards with which the state must comply. The SIPs must describe the emissions reductions required to reach NAAQS attainment. Within these individual SIPs, the air quality impacts of California mobile-source emissions standards are assessed, although not in isolation from other emissions-control strategies. In recent years, EPA assessed the air quality impacts of its major mobile-source emissions standards in regulatory impact assessments (RIAs), which accompany all major federal regulations. The assessments estimate the air quality impacts in some or all of the country for each proposed set of standards in isolation from other emissions-control policies.
- EPA's RIAs have evolved to require assessments of the public health effects and estimates of monetary benefits. CARB does not directly consider public health benefits in its regulatory analysis of emissions standards because it uses its proposed standards to attain health-based NAAQS, which EPA has already assessed for public health benefits. California estimates health impacts of air pollutants in its reviews of California ambient air quality standards.[4]
- CARB routinely considers only the costs or impacts of its standards in its jurisdiction (California) and not in other states that might later adopt California standards, whereas EPA accounts for the costs and benefits for the entire nation in its assessments.
- CARB adopts emission-standard regulations in a public meeting with a public vote by board members. Public comments during this hearing can result in modifications to final standards. CARB may also include requirements for periodic review of standards during which standards can be modified. EPA's emissions standards, although subject to lengthy public-comment and technical-review periods, are issued through a finalized notice in the *Federal Register*. (A 2004 EPA regulation includes a requirement to conduct a periodic review of technical progress in attaining an emission standard.) In contrast to the flexibility CARB has in revising standards based on new scientific and technical information, EPA has

[3] "Significant rules" are defined as those that have an annual impact of $100 million or greater, raise novel regulatory issues, or have other significant impacts.

[4] California has its own ambient air quality standards that are lower than the NAAQS for some pollutants. However, California ambient air quality standards do not have any deadlines for attainment.

historically developed new or revised mobile-source emissions standards only when directed or authorized to do so by Congress.

Recommendations

Consistent with a 2000 NRC report on modeling mobile-source emissions,[5] CARB and EPA should work in tandem to improve mobile-source emissions models. In particular, consistent with the NRC report, CARB and EPA should complete long-range plans that address improvements or new approaches to mobile-source emissions models. Such plans will improve estimations of emissions reductions. The estimations are a major part of assessing the impacts of emissions standards. The committee also recommends that CARB and EPA include, to the extent possible, air quality impact assessments as part of each rule-making, because the effect of reducing mobile-source emissions on ambient pollutant concentrations will vary from region to region.

Although the committee did not have sufficient information to evaluate the safety issues associated with past regulations, it recommends that safety issues continue to be given careful consideration by EPA and CARB when setting mobile-source emissions standards.

Given that CARB and EPA emissions standards tend to require new technological developments, the committee also recommends that periodic assessments of technological feasibility be continued by the agencies for some of the more important standards. Examples of such assessment include CARB's biennial review of the zero-emission-vehicle mandate and EPA's biennial review of on-road diesel-engine standards. Periodic assessments will allow the standards to be based on the most current understanding of the science and technology.

The Waiver Process

Each time CARB sets or substantially revises a California mobile-source emission standard, it must seek a waiver from EPA. The waiver review process usually takes several years to complete, and waivers are often granted shortly before the vehicles and engines that meet the standards are in the market. In some cases, waivers have been approved after vehicles and engines that meet the standards are already in the market.

EPA's consideration of a California waiver request requires substantial EPA resources in terms of personnel and time. EPA is required to provide an opportunity for interested parties to provide comment and to participate in public hearings, if hearings are requested. Each of these steps is time-consuming and perhaps duplicative. EPA must also conduct technical analyses of all comments provided by California, manufacturers, and other interested parties, further extending the time needed to issue a waiver decision. Although many California waiver requests are relatively straightforward and uncontroversial, EPA must nevertheless provide the opportunity for full public participation and subsequent technical analyses. This time-consuming process creates uncertainty for California, other states considering adopting those California standards, and manufacturers.

[5] NRC (National Research Council). 2000. Modeling Mobile Source Emissions. Washington, DC: National Acadmies Press.

Recommendations

California, other states, and manufacturers all have a strong interest in obtaining EPA waiver decisions well before the applicable standards take effect. The committee recommends establishment of a two-track system for waiver requests. Many California waiver requests have not been controversial, and EPA has not received any significant comments. EPA could expedite waiver requests that it considers noncontroversial, approving the waiver with a minimal analysis in a direct final decision without a full notice-and-comment process. The final decision would be published in the *Federal Register*, and if any interested party raised a substantive objection to the decision, it would be withdrawn and subjected to the full waiver process. This expedited process would allow EPA to process quickly and efficiently those waiver requests that are noncontroversial, freeing up resources to focus on those that require more time and discussion.

The committee also recommends consideration of a mandatory time limit for EPA to review and issue a waiver decision for controversial waiver requests. The time limit could be based on existing timetables for the EPA waiver process. California is required to provide adequate lead time between adoption of state regulations and their implementation: usually at least 2 years for on-road sources and at least 2 years for nonroad sources. A time limit of 2 years or less for EPA review would place the review process between the adoption of the standards by California and the time that the standards take effect. Given the importance of the EPA waiver review and the need to conclude such reviews more quickly, EPA should ensure that sufficient resources are devoted to the waiver review process so that the quality of the review is not sacrificed to comply with new time limits.

Adoption of California Emissions Standards by Other States

The primary reason that other states adopt California emissions standards is to obtain additional emissions reductions to help attain and maintain the NAAQS. States first began using their authority under section 177 of the CAA in the early 1990s when New York and Massachusetts adopted California emissions standards for new light-duty vehicles. To date, section 177 authority has mostly been used to adopt light-duty-vehicle standards by various northeastern states, although a growing number of other states have adopted or expressed an interest in using this authority to adopt California standards for both light-duty and heavy-duty vehicles.

Some states have cited additional rationales for adopting California standards. When considering emissions standards for on-road heavy-duty diesel vehicles, some states have indicated that they consider the adoption of California standards to be a safety net in case EPA delays similar federal standards. When considering emissions standards for light-duty vehicles, even when current federal standards provide emissions reductions similar to those in California, some states expect that California will continue to reduce standards earlier than the federal program. In addition, some states have adopted or expressed interest in adopting the California greenhouse gas emissions standards.

Manufacturers of mobile sources have raised objections to the adoption of California standards by other states. Manufacturers contend that states overestimate the emissions benefits of adopting California standards and that California standards often provide no significant air quality benefits over the applicable federal standards. Other objections include the claims of incremental costs of producing additional California-certified engines, the risks of expanding technology-forcing experiments to a greater share of the national market, and the additional complexity of having to distribute products that attain different standards in different states. Disputes have also arisen between the states and the manufacturers over the abil-

ity of California-certified vehicles to meet emissions standards and function properly under conditions in their states.

Up to this point, adopting states and manufacturers have resorted to the courts to resolve their technical and legal disputes when direct negotiations have failed. Among the issues that have been litigated are whether adopting states also had to adopt California fuel regulations, whether electric vehicles designed for California (under the zero-emission-vehicle [ZEV] mandate) could be mandated in northeastern states where their batteries might not function properly in wintertime, and whether the California ZEV mandate met the definition of a standard that could be separately adopted by other states. Although EPA is an appropriate entity to comment on some of these disputes, it has no authority over states' adoption decisions.

Recommendations

The process by which a state adopts California emissions standards should be improved to aid in the resolution of the legal and technical disputes that often arise. As the agency that has the overall authority for implementing the CAA, including the mobile-source provisions, EPA should consistently participate in the process of the adoption of California standards by another state. EPA's current role in the state adoption process includes the authority to approve or disapprove the state SIP claims for emissions benefits from California emissions standards. The committee discussed additional roles for EPA to improve the state adoption process and considered two possible alternatives.

1. Each time a state intends to adopt a California emission standard, EPA would provide formal guidance to aid the state's adoption decision. EPA would determine whether any new issues have arisen that were not considered in the California waiver for the same standard (for example, issues related to technological feasibility, lead time, identicality, and cost) and whether these issues provide cause for states to reject the standard. EPA would further determine whether the state action is consistent with the requirements specified in section 177 of the CAA. EPA's determinations would be developed with the aim of deterring litigation over potential disputes. However, EPA's determinations would not be binding, and states would retain their ability to adopt California standards at their discretion.

2. EPA is given the authority to review and, under limited circumstances, deny a state adoption decision using a truncated waiver determination process. In its review, EPA would consider whether the state's adoption of the California standard raises any issues not considered in the original California waiver and whether the state action is consistent with section 177 of the CAA. In this scenario, it is important that EPA's waiver determination not delay or otherwise impede adoption of a California standard. EPA would be required to approve automatically any state's adoption request that had not been denied after 18 months of submittal. It is also important that EPA give the same deference to section 177 state findings as it does to California's findings when making a waiver determination. Under this alternative, EPA's determinations would be binding in the same manner as EPA's determination of a California waiver application.

The committee also discussed whether EPA's review under alternative 2 should include an assessment of the necessity or usefulness of the adoption for states to attain their air quality goals. Such an assessment would have to balance the benefits of additional emissions reductions, increased flexibility for states to develop air quality management plans, and wider distribution of new technologies against the costs to industry and consumers.

What role EPA is to have in the state adoption process is a policy decision that goes beyond scientific and technical considerations. The committee disagreed as to which of the two approaches described above would be most effective. However, even if there is no change in the adoption process, non-

California states should continue their efforts to work with manufacturers to minimize compliance burdens. As an example, the committee encourages northeastern states that have adopted California light-duty-vehicle emissions standards to implement a regionwide fleet-average emission standard rather than having each state meet a separate fleet-average standard.

Technical and Scientific Practices of States That Adopt California Standards

States that adopt California light-duty-vehicle emissions standards have supported the adoption by estimating the emissions reductions and in some cases the in-state economic impact of the regulations. The methods used to estimate emissions impacts in general rely on the same basic emissions models used by EPA and CARB.

Engineering-cost estimates of California emissions standards are typically adopted from CARB. States with larger populations, such as New York and Massachusetts, tend to perform their own analyses. Other states have relied on outside analyses, such as those conducted by the Northeast States for Coordinated Air Use Management.

Small-Engine Emissions Standards

An area of active interest for emissions control is in small gasoline-powered engines[6] used in an array of equipment and applications. Compared with light-duty-vehicle emissions control, small-engine emissions control poses special design, production, and distribution challenges. Small-engine manufacturers sell engines as well as equipment that use their engines, such as lawn mowers and chain saws. Small-engine equipment is often sold through a multistep distribution chain—from manufacturer to retail distributor to retail dealer. In addition, there is no state registration process for most small-engine products that can be used to ensure compliance with emissions standards. CARB has demonstrated some flexibility in setting emissions standards for small engines to deal with some of the difficulties inherent in the non-integrated industry. CARB has also worked with industry to reduce some of the burden in the compliance testing and certification process.

Recent federal legislation prohibits other states from adopting the California standards for small gasoline-powered engines and mandates that EPA issue new standards for small engines for the rest of the country. Thus, small engines form a new regulatory category different from other mobile sources. All other mobile sources fall into one of two categories: sources such as light-duty and heavy-duty vehicles for which California can set and other states can adopt emissions standards and sources such as airplanes and locomotives for which standards are entirely federally preempted.

Recommendations

California should continue its pioneering role when setting emissions standards for small engines to aid its efforts to improve air quality and be a proving ground for new emissions-control technologies. The committee encourages CARB to use the flexibility it has shown in revising standards based on new scientific and technical information for regulating small engines. The committee also recommends that the

[6] Here the committee refers to engines smaller than 25 horsepower that are used mainly in lawn and garden equipment.

suggested alternatives for improving the state adoption process be used if a decision is made in the future to allow states to adopt California small-engine standards.

Cost Analyses

CARB and EPA estimate the costs to meet emissions standards. Both agencies look at variable parts costs; fixed costs, such as research and development costs; and testing and certification costs. States that adopt California's standards typically rely on California's cost estimates. One element of relying on technology-forcing regulations and, in California's case, of serving as a laboratory for mobile-source emissions-control technologies is the considerable uncertainty in estimating the cost of complying with emissions standards. Future technologies assumed during standards development and thus included in the regulatory estimates are not always the ones used for compliance. Even when technological assumptions turn out to be correct, estimated cost might not be correct. Some costs, such as the costs to other states to implement and maintain a program, are excluded from California's economic impact analyses of their own standards. CARB and EPA have used cost estimates to calculate cost-effectiveness in units of dollars per mass of pollutant reduced to weigh mobile-source emissions control against other emissions-control strategies. In the past decade, EPA estimated the monetized benefits of its major rules to compare with costs.

The committee finds that it is difficult to determine what parties bear what fraction of the costs of emissions standards. Manufacturers closely guard cost and pricing data to avoid placing themselves at a competitive disadvantage. The majority of available estimates of the cost of emissions standards are for light-duty vehicles, but these estimates vary substantially and are uncertain. Vehicles are not priced to recoup directly the costs of meeting emissions standards because costs are difficult to allocate to a single model, especially research and design costs. Additional costs are also difficult to incorporate directly into the sticker price when two models that differ only in emissions equipment are being sold side by side or when a competitor does not include such a surcharge for its vehicles. Under such conditions, the cost of emissions controls must be absorbed in reduced profits, in reduced costs, or in distribution of costs throughout the whole product line.

Recommendations

To address the uncertainty inherent in prospectively estimating costs to comply with mobile-source emissions standards, the committee recommends that agencies and stakeholders attempt to improve communication about the uncertainty by providing a range of costs rather than a single point estimate, especially for new technologies. In addition, because costs are such an important element for understanding the impacts of state emissions standards, the committee finds a need for a comprehensive study of the costs of state standards. This study should include the difference in costs for the states that adopt California standards compared with costs for California, the distribution of those costs, and their cost-effectiveness. Costs should be viewed broadly and include the costs to manufacturers and distributors to develop and distribute products certified under two emissions standards and the costs to states to implement, enforce, and maintain the program.

Harmonization of Standards and Procedures

Recognizing the needs of some states to adopt more stringent mobile-source emissions standards to help meet air quality goals, a desirable objective is harmonization of CARB's and EPA's certification

procedures. Although meaningful differences in standards can be important in achieving clean air, superficial differences in areas such as certification procedures can be wasteful.

Harmonization of standards and testing procedures also has a global context. Since the beginning of emissions controls on mobile sources almost 50 years ago, there has been a profound shift in the manufacturing of mobile sources. Increased globalization means that foreign manufacturers are producing and selling their products within the United States, and domestic manufacturers are producing and selling globally. In addition, countries around the world have adopted mobile-source emissions standards, with those of the United States serving as one model.

Although harmonization is a worthy pursuit when the interests of the federal government and the states coincide, there are areas where their priorities diverge. A high-profile example is California's recent development of greenhouse gas emissions standards for light-duty vehicles. The California greenhouse gas standards, which have been promulgated by CARB and have been adopted or considered by several other states, reflect a difference in policy between the federal government and some states in addressing climate change with light-duty-vehicle emissions standards.

Recommendations

Regulators should make a determined effort to harmonize the procedures for testing and certification and look for opportunities to harmonize the emissions standards. Domestically, CARB and EPA should conduct a biennial assessment, either through a written report or public meeting, of where emissions testing and certification procedures can be harmonized and what emissions standards can be harmonized. The committee recognizes that EPA is leading the U.S. participation in international efforts to harmonize emissions standards and testing procedures. EPA should continue these efforts and encourage international participation in the biennial harmonization assessments. The committee recognizes that many countries will lag in the adoption of mobile-source emissions standards; therefore, global efforts to harmonize may need to focus initially on emissions testing and certification procedures.

Overview of Conclusions and Recommendations

Despite the substantial progress made over the past decades in reducing emissions from mobile sources, further progress is needed to attain air quality standards in many parts of the country. Separate California mobile-source emissions standards provide emissions control, air quality benefits, and innovation beyond federal standards. California should continue its pioneering role when setting mobile-source emissions standards. Although a second set of standards imposes additional costs and complexity to manufacturers, the committee concludes that the California program has been beneficial overall.

The committee recommends that CARB and EPA continue to review their scientific and technical practices in tandem to address areas for possible improvements and harmonization. The committee also recommends improvements to EPA's waiver process to provide timelier waiver decisions for California emissions standards.

State decisions to adopt California emissions standards have resulted in several disputes between states and industry, which typically led to extensive litigation. Although EPA is an appropriate entity to resolve or comment on some of these disputes, it has no authority over states' adoption decisions. The committee discussed two alternative roles that EPA could play to improve the state adoption process but did not reach a consensus to recommend either one.