1.1 Reduce Human Exposure to Transportation-Related Emissions

1.1.1 Background: Reduce Human Exposure to Transportation-Related Emissions

Prevalence of and Human Exposure to Transportation-Related Emissions

Transportation-related emissions with the most direct effect on human health include carbon monoxide, nitrogen dioxide, ozone, (the primary ingredient in smog), particulate matter (especially the "fine" particulates, known as $PM_{2.5}$), sulfur dioxide, and toxics such as lead.[20]

Fifty-eight percent of people in the U.S. live in areas with unhealthful levels of ozone. Looking at the two most vulnerable age groups, more than 20.4 million adults over age 65 and almost 44 million children under age 18 live in counties with unhealthy ozone levels. Approximately one in three Americans is at elevated risk for $PM_{2.5}$-related health impacts.[21]

Impact of Transportation-Related Emissions on Disease

Exposure to traffic-related pollutants is associated with asthma, non-asthma respiratory symptoms, impaired lung function, and cardiovascular mortality and morbidity.[22,23] Populations that are exposed over longer terms—people living near high-traffic roadways, for example—experience increased levels of cardiopulmonary mortality,[24,25] as well as adverse pregnancy outcomes such as pre-term birth and low birth weight.[26,27] Particulate exposure has been directly associated with decreases in lung function in older adults already suffering from chronic

---

20 U.S. Environmental Protection Agency. 2011. *National Ambient Air Quality Standards.* Available at: http://www.epa.gov/air/criteria.html [accessed May 22, 2011].

21 U.S. Environmental Protection Agency. 2010. *Fine Particle Designations. Particulate Matter FAQs.* Available at: http://www.epa.gov/pmdesignations/faq.htm#0 [accessed November 18, 2010].

22 Health Effects Institute. 2010. Traffic-Related Air Pollution: A Critical Review of the Literature on Emissions, Exposure, and Health Effects. HEI Panel on the Health Effects of Traffic-Related Air Pollution. Available at: http://pubs.healtheffects.org/view.php?id=334 [accessed on June 21, 2011].

23 Brunekreef, B. and S.T. Holgate. 2002. Air pollution and Health. *The Lancet*, 360 (9341): 1233-1242.

24 Gan, W., Q.L. Tamburic, et al. 2010. Changes in Residential Proximity to Road Traffic and the Risk of Death from Coronary Heart Disease. *Epidemiology*, 21 (5): 642-649.

25 Ostro, B., M. Lipsett, et al. 2010. Long-Term Exposure to Constituents of Fine Particulate Air Pollution and Mortality: Results from the California Teachers Study. *Environmental Health Perspectives*, 118: 363-369.

26 Wu, J., M. Wilhelm, J. Chung and B. Ritz. 2011. Comparing Exposure Assessment Methods for Traffic-Related Air Pollution in an Adverse Pregnancy Outcome Study. *Environmental Research*, 111 (5): 685-92.

27 Brauer, M., C. Lencar, et al. 2008. A Cohort Study of Traffic-Related Air Pollution Impacts on Birth Outcomes. *Environmental Health Perspectives*, 116 (5).

obstructive pulmonary disease and in children with asthma.[28] Long-term exposure to $PM_{2.5}$ is associated with increased risk of cardiopulmonary mortality.[29]

Generally, children and infants are the most susceptible to air pollutants because of their increased levels of physical activity and the fact that their lungs are still developing.[30] Financially disadvantaged populations and minorities are disproportionately impacted by air pollution because they are more likely to live in areas with worse air quality.[31]

Potential for Reducing Exposure to Transportation-Related Emissions

Evidence of the negative health impacts of traffic-related air pollutants has led to increasingly strict controls, resulting in reductions in motor vehicle emissions and subsequent improvements in air quality. However, many of these gains have been offset by an increase in vehicle-miles traveled (rising rapidly until the economic downturn) and the increasing urbanization of the population, which puts homes, workplaces, and schools near highways.[32,33,34]

National strategies for reducing exposure to transportation-related emissions have included an extensive system for monitoring pollution, policies to separate high-pollution sources from vulnerable populations, and encouraging adoption of technologies to reduce emissions.

We examine four policies that have contributed or could contribute further to these strategies.

Policy 1: Improve monitoring of locations where pollution sources are concentrated

Policy 2: Locate residential and community facilities away from transportation-related emissions

Policy 3: Minimize exposure to $PM_{2.5}$

Policy 4: Encourage adoption of technologies to reduce vehicle emissions

---

28 Tranga, C. et al. 2006. Effect of Particulate Air Pollution on Lung Function in Adult and Pediatric Subjects in a Seattle Panel Study. *Chest*, 129 (6): 1614-1622.

29 Ostro B., M. Lipsett, P. Reynolds, D. Goldberg, A. Hertz, C. Garcia, et al. 2010. Long-Term Exposure to Constituents of Fine Particulate Air Pollution and Mortality: Results from the California Teachers Study. *Environmental Health Perspectives* 118: 363-369.

30 Schwartz, J. 2004. Air Pollution and Children's Health. *Pediatrics*. American Academy of Pediatrics. 113 (S3): 1037-1043.

31 Houston, D., J. Wu, P. Ong, A. Winer. 2004. Structural Disparities of Urban Traffic in Southern California: Implications for Vehicle-Related Air Pollution Exposure in Minority and High-Poverty Neighborhoods. University of California, Los Angeles. Journal of Urban Affairs 26 (5): 565-592.

32 U.S. Environmental Protection Agency. 2011. 2011 *U.S. Greenhouse Gas Inventory Report*. *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2009*. Chapter 3. Available at: http://www.epa.gov/climatechange/emissions/downloads11/US-GHG-Inventory-2011-Chapter-3-Energy.pdf [accessed May 17, 2011].

33 Balbus, J.M. and D.Y. Triola. 2005. Transportation and Health. In H. Frumkin ed. *Environment Health: from global to local*. San Francisco, Jossey-Bass: 414-453.

34 Health Effects Institute. 2010. Traffic-Related Air Pollution: A Critical Review of the Literature on Emissions, Exposure, and Health Effects. HEI Panel on the Health Effects of Traffic-Related Air Pollution. Available at: http://pubs.healtheffects.org/view.php?id=334 [accessed on June 21, 2011].

1.1.2 Impact of Policies: Reduce Human Exposure to Transportation-Related Emissions

Policy 1—Improve monitoring of locations where pollution sources are concentrated

Definition

The U.S. Environmental Protection Agency (EPA) maintains the nation's chief repository of ambient air quality data, which is obtained from more than 10,000 monitors operated by state, tribal, and local agencies.[35,36]

History of Deployment

The 1970 Clean Air Act provides the legislative basis for the EPA's program of air pollution monitoring and regulation by establishing the EPA's enforcement authority, setting national standards and state performance standards for ambient air quality, and establishing regulations for stationary sources (e.g., factories, power plants, and the like) and motor vehicle emissions. Major amendments were made in 1977 and 1990, expanding the Clean Air Act's scope.[37]

Effectiveness and Impact

The EPA's network of monitors tracks ambient air quality in most parts of the country where there are significant transportation-related emissions. Without this system, the implementation of current regulation and documentation of exposure and subsequent disease would not be possible. A geographically more comprehensive monitoring network and further development of statistical models would enhance the system's effectiveness.

Economic Factors

According to the EPA, the benefits of Clean Air Act programs in 2010 totaled about $110 billion in prevented illnesses and premature deaths versus a cost of $27 billion.[38] While economic factors associated with monitoring air quality are not broken out separately, Clean Air Act programs would not be possible without an extensive system for monitoring exposure and related disease outcomes.

---

35 U.S. Environmental Protection Agency. *Technology Transfer Network (TTN) Air Quality System (AQS)* Available at: http://www.epa.gov/ttn/airs/airsaqs/index.htm [accessed May 16, 2011].

36 U.S. Environmental Protection Agency. *Monitoring Pollutant Concentration in the Ambient Air.* Available at: http://www.epa.gov/apti/course422/ce3.html [accessed November 17, 2010].

37 U.S. Environmental Protection Agency. *History of the Clean Air Act.* Available at: http://epa.gov/oar/caa/caa_history.html [accessed May 22, 2011].

38 U.S. Environmental Protection Agency. *Benefits and Costs of the Clean Air Act.* Available at: http://yosemite.epa.gov/EE/epa/eerm.nsf/vwRepNumLookup/EE-0295A?OpenDocument [accessed June 15, 2011].

Conclusion

The current monitoring system should be continued and enhanced. For example, areas with persistently high ozone levels, mostly large cities, warrant more extensive monitoring of ozone and its precursors.[39] Also, vulnerable populations—people with heart and lung diseases, older adults, children, and people with diabetes—should be protected from excessive pollution exposure. Simultaneously, additional information about the effectiveness and costs associated with air quality monitoring is needed.

Policy 2—Locate residential and community facilities away from transportation-related emissions

Definition

Proximity to sources of transportation-related emissions increases the probability of adverse health effects.[40]

History of Deployment

This is a developing area of research and regulatory policy. Policies are being developed for some facilities. For example, in November 2010, the Environmental Protection Agency (EPA) issued draft voluntary guidelines for selecting locations for schools, because they serve children, who are especially vulnerable to air pollution. Proximity to air pollution sources—including traffic—is one of the considerations.[41]

Effectiveness and Impact

The distance at which adverse health effects decline significantly varies by pollutant and is not well-documented for all of the major transportation-related emissions. However, living near high-traffic roadways is associated with adverse health effects.[42] The effects of transportation-related emissions on asthma are strongest among those who live within 150 meters (0.09 miles) of a main road.[43,44] One class of pollutant that has been extensively studied is fine particulates—those that

---

39 U.S. Environmental Protection Agency. *Air Pollution Monitoring*. Available at: http://epa.gov/airquality/montring.html [accessed November 17, 2010].

40 Health Effects Institute. 2010. Traffic-Related Air Pollution: A Critical Review of the Literature on Emissions, Exposure, and Health Effects. HEI Panel on the Health Effects of Traffic-Related Air Pollution. Available at: http://pubs.healtheffects.org/view.php?id=334 [accessed on June 21, 2011].

41 U.S. Environmental Protection Agency. 2010. *School Siting Guidelines.* Available at: http://www.epa.gov/schools/siting/criteria.html# [accessed March 28, 2011].

42 Boothe, V.L. and D.G. Shendell. 2008. Potential Health Effects Associated with Residential Proximity to Freeways and Primary Roads: Review of Scientific Literature, 1999-2006. *Journal of Environmental Health*, 70 (8): 33-41, 55-56.

43 Venn, A.J., S.A. Lewis, M. Cooper, R. Hubbard, J. Britton. 2001. Living Near A Main Road and the Risk of Wheezing Illness in Children. *American Journal of Respiratory and Critical Care Medicine*, 164: 2177-2180.

44 Environmental Defense Fund. 2006. Motor Vehicle Air Pollution and Public Health: Asthma and Other Respiratory Effects.

are 2.5 micrometers or less in diameter ($PM_{2.5}$). Exposure is greatest within the first 300 meters (0.18 miles) of a major source, with levels decreasing to ambient upwind concentrations at distances greater than that.[45]

Economic Factors

There is insufficient data to determine economic factors involved in locating key facilities away from major roadways.

Conclusion

Proximity to roadways with heavy traffic is associated with disease outcomes. Land use planning requirements for new facilities serving vulnerable populations and for road projects anticipated to carry high levels of traffic should take into consideration proximity of vulnerable populations to transportation-related emissions.

Policy 3—Minimize exposure to $PM_{2.5}$

Definition

"Fine" particulate matter is defined as $PM_{2.5}$, 2.5 micrometers or less in diameter. It poses a health threat because its small size means it can become deeply lodged in the lungs.[46] Sources of $PM_{2.5}$ include motor vehicle engines—especially older diesel engines—power plants, wood burning, and some industrial processes.[47,48]

History of Deployment

U.S. regulations setting limits for particulate emissions date back to 1971. In 1987, they were updated to include a standard for PM_{10}, targeting particles with a diameter of 10 micrometers or less.[49] In 1997, the EPA revised the PM standard to include $PM_{2.5}$. In September 2006, the agency lowered the acceptable levels of $PM_{2.5}$ emissions.[50]

---

45 California Air Resources Board. 2003. *Health Impacts of Research on Fine and Ultrafine PM Exposure.* Available at: http://www.arb.ca.gov/research/pmr/pmr-sum1.htm [accessed November 18, 2010].

46 U.S. Environmental Protection Agency. 2010. *Fine Particle Designations. Particulate Matter FAQs.* Available at: http://www.epa.gov/pmdesignations/faq.htm#0 [accessed November 18, 2010].

47 Ibid.

48 U.S. Environmental Protection Agency. *Particulate Matter (PM-10).* Available at: http://www.epa.gov/airtrends/aqtrnd95/pm10.html [accessed June 16, 2011].

49 Ibid.

50 U.S. Environmental Protection Agency. 2006. *PM Standards Revision.* Available at: http://www.epa.gov/PM/naaqsrev2006.html [accessed November 17, 2010].

Effectiveness and Impact

$PM_{2.5}$ exposure is greatest within the first 300 meters (0.18 miles) of a major source, with levels decreasing to ambient upwind concentrations at distances greater than 300 meters.[51] Long-term exposure to $PM_{2.5}$ is associated with increased risk of cardiopulmonary mortality.[52] Limiting $PM_{2.5}$ emissions within 300 meters of residential areas would greatly reduce exposure.

Economic Factors

The monetized value of the public health impacts of $PM_{2.5}$ exposure is estimated to be in the tens of billions of dollars annually, which is significant enough to make its reduction a consideration in setting transportation policy.[53]

Conclusion

To reduce the negative impacts of $PM_{2.5}$ exposure on vulnerable populations, the distance from high-traffic locations should be used as a consideration in development of facilities used by vulnerable populations or facilities where long-term exposure will result.

Policy 4—Encourage adoption of technologies to reduce vehicle emissions

Definition

Advanced motor vehicle emission control technologies for gasoline engines include catalytic converters, advanced ignition and fuel injection systems, on-board computers, and electronic controls, which are all standard components of today's new cars.[54] For diesel engines, there are numerous retrofit technologies for existing engines. They include: catalyst mufflers, diesel particulate filters, crankcase filtration systems, diesel oxidant catalysts conversions, and cetane enhancers.[55]

---

51 California Air Resources Board. 2003. Health Impacts of Research on Fine and Ultrafine PM Exposure. Available at: http://www.arb.ca.gov/research/pmr/pmr-sum1.htm [accessed November 18, 2010].

52 Ostro B., M. Lipsett, P. Reynolds, D. Goldberg, A. Hertz, C. Garcia, et al. 2010. Long-Term Exposure to Constituents of Fine Particulate Air Pollution and Mortality: Results from the California Teachers Study. *Environmental Health Perspectives*, 118: 363-369.

53 Levy J.I., J.J. Buonocore and K. von Stackelberg. 2010. Evaluation of the Public Health Impacts of Traffic Congestion: A Health Risk Assessment. *Environmental Health*, 9: 65.

54 Manufacturers of Emission Controls Association News. 2000. *Advanced Motor Vehicle Emission Control Technology Celebrates 25th Anniversary.* Available at: http://www.meca.org/galleries/default-file/25thannivpr.pdf [accessed May 22, 2011].

55 U.S. Environmental Protection Agency. *Verified Technologies.* Available at: http://epa.gov/cleandiesel/verification/verif-list.htm [accessed May 22, 2011].

History of Deployment

Starting in 1970, automobiles sold in the United States were required to meet emissions standards for six criteria pollutants.[56] In the 1975 model year, the first automobiles with catalytic converters were sold on the U.S. market,[57] simultaneously with the broader rollout of unleaded gasoline that the converters required. The following decades saw changes in fuel formulas, combined with engine technologies.[58]

As of 2008, overall national air quality has improved significantly compared with 1990: ozone is down 14 percent, lead is down 78 percent, nitrogen dioxide has fallen 35 percent, carbon monoxide has been cut 68 percent, and sulfur dioxide has been reduced by 59 percent. Annual $PM_{2.5}$ concentrations dropped by 17 percent between 2001 and 2008.[59]

In October 2010, the EPA and the National Highway Traffic Safety Administration announced a joint fuel standards program to regulate greenhouse gas emissions and fuel economy as part of a package that included the first-ever greenhouse gas emissions standards for heavy-duty vehicles.[60]

Effectiveness and Impact

The development and enforcement of greenhouse gas emission standards will create significant reductions in fuel consumption and emissions for gasoline- and diesel-powered heavy trucks and commercial vehicles.[61]

Economic Factors

The EPA estimates that the joint fuel standards program will provide $41 billion in net benefits over the lifetime of model year 2014 to 2018 vehicles.[62,63]

---

56 U.S. Environmental Protection Agency. *National Ambient Air Quality Standards.* Available at: http://www.epa.gov/air/criteria.html [accessed May 22, 2011].

57 Manufacturers of Emission Controls Association News. 2000. *Advanced Motor Vehicle Emission Control Technology Celebrates 25th Anniversary.* Available at: http://www.meca.org/galleries/default-file/25thannivpr.pdf [accessed May 22, 2011].

58 U.S. Environmental Protection Agency. 1999. *Air Trends*. Available at: http://www.epa.gov/airtrends/aqtrnd99/pdfs/table2-2.pdf [accessed May 18, 2011].

59 U.S. Environmental Protection Agency. 2010. *Our Nation's Air.* Available at: http://www.epa.gov/airtrends/2010/report/highlights.pdf [accessed May 18, 2011.]

60 U.S. Environmental Protection Agency. 2010. EPA and NHTSA Announce a First Step in the Process for Setting Future Greenhouse Gas and Fuel Economy Standards for Passenger Cars and Light Trucks. EPA-420-F-10-051. Available at: http://yosemite.epa.gov/opei/rulegate.nsf/byRIN/2060-AP61 [accessed June 15, 2011].

61 U.S. Environmental Protection Agency. *Regulatory Initiatives.* Available at: http://www.epa.gov/climatechange/initiatives/index.html [accessed November 22, 2010].

62 Ibid.

63 U.S. Department of Transportation. 2010. *DOT, EPA Propose the Nation's First Greenhouse Gas and Fuel Efficiency Standards for Trucks and Buses.* EPA News Release. Available at: http://yosemite.epa.gov/opa/admpress.nsf/e77fdd4f5afd88a3852576b3005a604f/9b3706622f4ac560852577c7005ea140!OpenDocument [accessed June 15, 2011].

Conclusion

There are a variety of advanced motor vehicle emission control technologies that have already had enormous impacts in reducing emissions and associated disease. The joint fuel standards proposal will provide impetus for another significant gain in reducing emissions.

1.1.3 Conclusions: Reduce Human Exposure to Transportation-Related Emissions

Reducing human exposure to transportation-related emissions that most directly affect human health—carbon monoxide, nitrogen dioxide, ozone, (the primary ingredient in smog), particulate matter, sulfur dioxide, and toxins such as lead—can be accomplished through reducing emissions and reducing exposure.

A number of policies can achieve these goals: expanding current monitoring systems by focusing on, for example, urban areas with persistently high ozone levels; planning long-term facilities and those that serve vulnerable populations in a way that provides an adequate buffer, with special attention paid to $PM_{2.5}$ exposure; continue to build on the success of advanced motor vehicle emission control technologies and fuel efficiency efforts that have already had enormous impacts in reducing emissions and associated disease.

1.2 Reduce Transportation's Contribution to Climate Change

1.2.1 Background: Reduce Transportation's Contribution to Climate Change

Prevalence of and Threat from Greenhouse Gas Emissions

Greenhouse gases—primarily carbon dioxide or CO_2—trap heat and contribute to rising surface temperatures, which can trigger a multitude of mechanisms—including changing weather patterns and sea level rise—that can have adverse environmental health effects.[64] Some greenhouse gases occur and are emitted through natural processes. Others are created and emitted solely as a result of human activities.[65]

From 1990 to 2009, transportation's total greenhouse gas emissions (nearly all of which were CO_2) rose 17 percent. Put another way, in 2009, transportation was responsible for 33 percent of

64 Centers for Disease Control and Prevention. 2009. *Policy on Climate Change.* Available at: http://www.cdc.gov/climatechange/pubs/Climate_Change_Policy.pdf [accessed April 21, 2011].

65 U.S. Environmental Protection Agency. *Greenhouse Gas Emissions.* Available at: http://epa.gov/climatechange/emissions/index.html [accessed March 25, 2011].