Executive Summary

Diesel soot, or particulate matter (PM), is a dangerous pollutant that can penetrate deep into the lungs. People exposed to diesel soot can suffer from severe respiratory and cardiovascular illnesses, chronic bronchitis, cancer, and premature death. In 2000, the California Air Resources Board (CARB) estimated that diesel PM was responsible for 70 percent of the state's risk of cancer from airborne toxics (CARB, 2000c). Diesel engines often remain in operation for decades, with the older engines releasing the greatest amount of pollution.

California has made some progress in reducing diesel emissions, but state retrofit regulations designed to equip existing diesel vehicles with better pollution controls have yet to address 85 percent of diesel pollution sources. In addition, California's successful voluntary incentive programs to clean up diesel pollution are chronically underfunded.

This study evaluates the human health impacts of diesel exhaust in California and estimates the number of people that will suffer serious health problems from exposure to diesel PM.[1] Using financial data from the U.S. Environmental Protection Agency (U.S. EPA, 2003), the Union of Concerned Scientists (UCS) evaluates the economic impact of these diesel-related health problems and compares the costs to the benefits of reducing diesel pollution. UCS finds that the relatively modest costs of pollution cleanup can pay off in reduced hospitalizations, fewer asthma cases, and saved lives. This analysis represents a conservative estimate because many potential health and welfare impacts—such as smog-related respiratory problems, increasing asthma rates (especially for children), and damage to agricultural crops and forest habitats—are not quantified.

[1] Our analysis includes both PM directly emitted from diesel engines and formed secondarily from nitrogen oxides (NOx). We base our health impacts analysis on epidemiological studies that use real-world data to estimate the human health consequences of pollution. These studies provide mathematical formulas (called concentration-response, or C-R, functions) that provide a range of results within a 90 percent confidence interval. In the Executive Summary, we present the "mean" or middle value of these results, while the body of the report includes the 90 percent confidence range. Because of the uncertainties associated with epidemiological studies, the number of health effects presented should be viewed as estimates within a range, and not the actual number of incidences.

Statewide results

Today's impacts: More diesel-related deaths than homicides

In 2004 alone, diesel pollution will cause an estimated 3,000 premature deaths in California—greater than the estimated 2,300 annual homicides in the state.[2] In addition, diesel exhaust will cause an estimated 2,700 cases of chronic bronchitis and about 4,400 hospital admissions (including emergency room, or ER, visits) for cardiovascular and respiratory illnesses every year. **The cost of these health impacts is $21.5 billion per year.**

Future impacts: More than 38,000 diesel-related deaths by 2020

By 2020, stricter emission standards for new engines should reduce the number of annual diesel-related health problems about 50 percent.[3] But tens of thousands of premature deaths will occur while we wait for old, polluting engines to be replaced by new, cleaner engines. Implementing the state's plan to reduce diesel pollution, which calls for reducing emissions from engines on the road today, would prevent an estimated 11,000 premature deaths and 16,000 hospital admissions (including ER visits) by 2020. **Cutting pollution from existing diesel engines would result in a cumulative savings of $48 billion to $70 billion between 2004 and 2020.**

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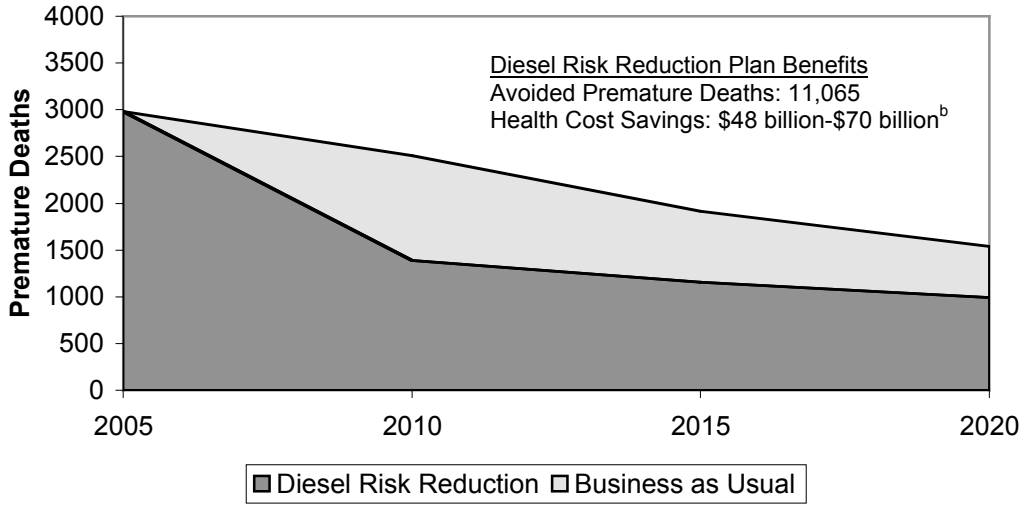
[2] Number of homicides is for 2001, based on data from the California Department of Health Services.

[3] Our projections of the health impacts of diesel pollution in 2020 do not account for emission reductions that may be achieved through retrofit regulations recently adopted (but not yet finalized) by California. Since these rulemakings were not final as of May 2004, we did not have sufficient information to evaluate their emissions inventory impacts.

Figure ES-1. Premature Deaths from Diesel Pollution[a]

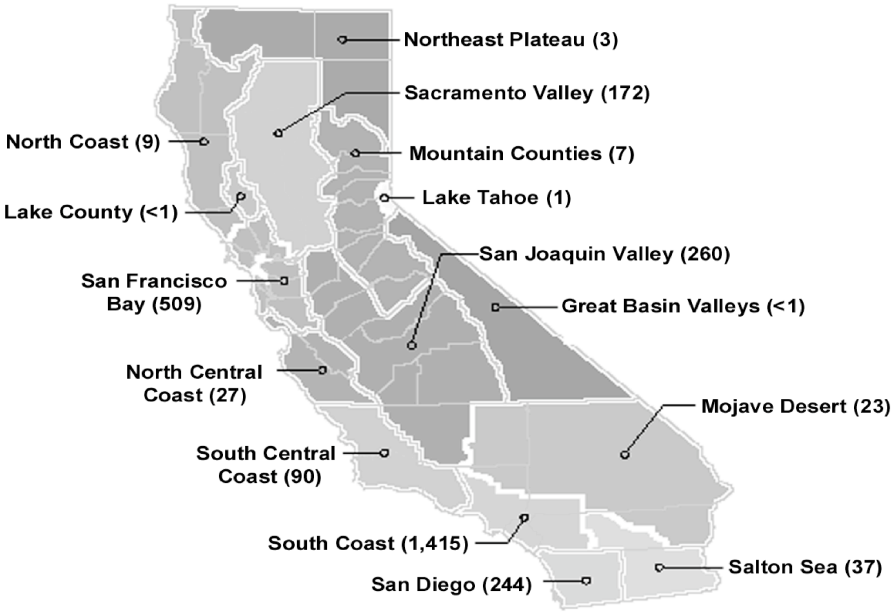


NOTES:
a. Our projections of the health impacts of diesel pollution through 2020 do not account for emission reductions that may be achieved through retrofit regulations recently adopted (but not yet finalized) by California. Since these rulemakings were not final as of May 2004, we did not have sufficient information to evaluate their emissions inventory impacts.
b. Health cost savings are based on all health endpoints evaluated in this study and are presented in year 2004 dollars. Both a three percent and seven percent social discount rate are applied to health incidences occuring from 2005 through 2020, resulting in a range of cost savings.

Air basin results

While Californians in every corner of the state are exposed to diesel pollution, the most densely populated and polluted air basins have the highest number of health problems (Figure ES-2). Roughly 90 percent of California's population, and 80 percent of the state's diesel pollution sources, are found in 5 of the 15 air basins: Sacramento Valley, San Diego, San Francisco Bay Area, San Joaquin Valley, and South Coast (Table ES-1).

Figure ES-2. 2004 Estimated Premature Deaths by Diesel Exposure by Air Basin



NOTE: Premature deaths are a result of exposure to diesel particulate matter, both direct from the tailpipe and from the conversion of NOx emissions to particulates in the atmosphere. Estimates for indirect particulate exposure for each air basin are based on a conversion of NOx emissions to particulates.
SOURCE: Image courtesy of CARB.

Table ES-1. Health Incidences from Diesel Exhaust in 2004 by Air Basin

Health Endpoint	Estimated Mean No. of Incidences in 2004					
	Sacramento Valley	San Diego	San Francisco Bay Area	San Joaquin Valley	South Coast	Statewide
Premature Mortality	172	244	509	260	1,415	2,980
Chronic Bronchitis	154	219	459	234	1,273	2,682
Hospital Admissions						
COPD	34	49	102	52	282	595
Cardiovascular Illness	101	143	299	153	831	1,751
Asthma Admissions	18	26	54	27	149	314
Asthma ER Visits	100	142	296	151	822	1,731
Total Estimated Health Costs (millions of 2004$)	$1,242	$1,763	$3,688	$1,884	$10,241	$21,575

NOTE: Estimates include effects of both indirect PM formed from NOx emissions and direct PM emissions. COPD is chronic obstructive pulmonary disease.

South Coast: Highest amount of diesel-related illnesses and deaths in California

Nearly half of the state's health incidences from diesel pollution occur in the South Coast Air Basin, where 45 percent of the state's population breathes more than 30 percent of California's emissions of diesel PM and nitrogen oxides (NOx). In 2004, diesel pollution will cause an estimated 1,400 premature deaths, 1,300 cases of chronic bronchitis, and 2,100 hospitalizations for cardiovascular and respiratory illnesses. **The cost of these health impacts is $10.2 billion per year.**

San Francisco Bay Area: Second highest of 15 air basins

With 20 percent of the state's population breathing 17 percent of California's diesel PM and NOx pollution, the Bay Area has more diesel-related illnesses than 13 other air basins in California. Diesel pollution released in 2004 will cause an estimated 500 premature deaths, 460 cases of chronic bronchitis, and 750 hospitalizations. **The cost of these health impacts is $3.7 billion per year.**

San Joaquin Valley: Third in diesel-related illnesses and deaths

With 10 percent of the state's population and 17 percent of California's diesel PM and NOx pollution, the San Joaquin Valley has the third most diesel-related health problems in the state. In 2004, diesel exhaust will cause an estimated 260 premature deaths, 230 cases of chronic bronchitis, and 380 hospitalizations. **The cost of these health impacts is $1.9 billion per year.**

San Diego: Fourth of 15 air basins

Eight percent of the state's population live in the San Diego Air Basin and breathe six percent of California's diesel PM and NOx pollution. In 2004, diesel pollution will cause an estimated 240 premature deaths, 220 cases of chronic bronchitis, and 360 hospitalizations. **The cost of these health impacts is $1.8 billion per year.**

Sacramento Valley: Fifth of 15 air basins

The fifth highest number of diesel-related health problems occurs in the Sacramento Valley, which has about six percent of the state's population and nine percent of its diesel PM and NOx pollution. Diesel exhaust emitted in 2004 will cause an estimated 170 premature deaths and more than 150 cases of chronic bronchitis. Hospital admissions for cardiovascular and respiratory illnesses exceed 250. **The cost of these health impacts is $1.2 billion per year.**

Federal new engine standards

New engine standards do not clean up the biggest polluters: existing diesel engines.

Thousands of premature deaths can be avoided by accelerating the replacement of diesel engines and retrofitting existing diesel equipment with the latest emission controls.

Until recently, the EPA focused primarily on cleaning up gasoline-powered vehicles. Now, new highway trucks and buses, as well as off-highway (also called "nonroad") heavy equipment, will be required to cut soot and smog-forming pollution by a factor of approximately 10. These regulations only apply to new engines and do not address two major categories of diesel engines: trains and ships.

Due to the longevity and durability of the diesel engine, as well as the toxicity of particulate emissions, new engine standards alone are not enough to protect Californians today from the health consequences of diesel pollution. The bulk of diesel pollution now and for the next decade or more will come from engines already in use. Thousands of premature deaths can be avoided by accelerating the replacement of diesel engines and retrofitting existing diesel equipment with the latest emission controls.

California's Diesel Risk Reduction Plan

The plan sets aggressive goals, but is in jeopardy.

California has been on the forefront of state efforts to reduce diesel pollution. In 2000, CARB developed the Diesel Risk Reduction Plan, which calls for reducing diesel PM 75 percent by 2010 and 85 percent by 2020 (from the base year 2000 level). UCS finds that implementing the Risk Reduction Plan could cut diesel-related health incidences and health costs by more than half from 2004 levels, and reduce cancer risk from exposure to diesel exhaust by 80 percent (Figure ES-1, p.x).

To meet these goals, the plan calls for stronger emission standards, retrofit regulations, and voluntary incentives. But the plan is in jeopardy of falling short of its goals due to regulatory gridlock and a lack of funding. This report finds that unless additional action is taken, diesel PM will only be cut about 30 percent by 2010, rather than the 75 percent target.[4]

State retrofit regulations

Regulatory development is on the slow track.

In the last few years, CARB approved new regulations for certain diesel fleets that together account for about 15 percent of California's diesel PM pollution.[5] As a result of these regulations, CARB estimates that PM emissions from these fleets will be halved by 2010, and about 1,200 premature deaths will be avoided. CARB has faced considerable industry opposition to these rules, many of which took years to be developed and finalized.

[4] UCS's evaluation included the impact of recent diesel cleanup regulations passed by CARB but not yet finalized, federal highway tailpipe standards, and the federal highway nonroad rule passed in May.

[5] Based on 2010 emission estimates (see Table 2-1, p.18).

Now the state needs to develop cleanup regulations to address the remaining 85 percent of California's diesel soot. But regulatory development is hampered by the diverse array of engines and ownership patterns. Furthermore, small businesses, individual owners and operators, and public agencies may not be able to afford the costs of pollution controls or early engine retirement. For example, an already financially strapped school district can ill afford the costs of cleaner buses. While regulations are the cornerstone to achieving the goals of the Risk Reduction Plan, incentive programs can fill the gap where regulations fall short.

To put these figures into perspective, the total cost to each Californian over 10 years would be about two cents for each premature death avoided.

Costs and benefits of diesel cleanup: Evaluating the Moyer Program

This program saves lives at a low cost, but is running out of funding.

In 1999, California created the Carl Moyer Memorial Air Standards Attainment Program (often simply referred to as the "Moyer Program"), which provides funding for diesel equipment owners to replace or rebuild high-polluting diesel engines. Though the focus of the program is reducing NOx, significant PM benefits have been achieved as well. The Moyer Program has had to struggle every year for funding, with state investment plummeting from a high of $50 million in 2001 to $18 million in 2004.

Investing in the Moyer Program pays off in public health benefits (Table ES-2):

- UCS estimates that for every dollar invested, the Moyer Program has reduced public health costs by $9 to $16.
- If the Moyer Program were funded for the next 10 years at $100 million per year, the resulting health benefits would include an estimated 1,200 avoided premature deaths, 1,100 avoided cases of chronic bronchitis, and the reduction of more than 1,800 hospitalizations and ER visits. Even as the cost of achieving pollution control rises over time, benefits outweigh costs by about 10 to 1.
- To put these figures into perspective, the total cost to each Californian over 10 years would be about two cents for each premature death avoided.

Table ES-2. Estimated Health Benefits from Future Moyer Program (2005 through 2014)[a]

Health Endpoint	Estimated Cumulative Mean No. of Incidences Avoided 2005 through 2020[b,c]					
	Sacramento Valley	San Diego	San Francisco Bay Area	San Joaquin Valley	South Coast	Statewide
Premature Mortality	152	56	153	208	498	1,223
Chronic Bronchitis	137	51	137	187	448	1,101
Hospital Admissions						
COPD[d]	30	11	30	42	99	244
Cardiovascular Illness	89	33	90	122	293	718
Asthma Admissions	16	6	16	22	52	129
Asthma ER Visits	88	33	89	121	289	710
Total Cumulative Benefits at 3% discount rate (millions of 2004$)	$996	$371	$1,003	$1,363	$3,273	$8,031
Total Cumulative Benefits at 7% discount rate (millions of 2004$)	$701	$261	$709	$958	$2,309	$5,661

NOTES:
a. Estimates are based on Moyer Program funding of $100 million per year from 2005 through 2014.
b. Emission reductions and health benefits accrue for seven years after the final year of funding due to an average estimated project life of seven years.
c. Emission reductions in each air basin are based on the percentage of total statewide Moyer reductions achieved in the past (CARB, 2002b).
d. COPD is chronic obstructive pulmonary disease.

School Bus Program

This program protects California's most vulnerable population, but is facing the budget axe.

California's other diesel cleanup incentive program, the Lower Emission School Bus Program, is suffering from budget cuts, with state funds reduced to less than $5 million in 2004 from a high of $50 million in 2000. The program provides funds for cash-strapped school districts to replace their oldest, dirtiest, and least safe buses with new, cleaner buses, and to retrofit existing buses with pollution controls.

The third largest fleet in the country, California's school buses are among the oldest and most polluting in the nation, exposing the most vulnerable population to the toxic impact of diesel emissions. In a study of tailpipe pollution, California's school buses received the poorest score in the country for smog-forming emissions, toxic soot, and global warming pollution (UCS, 2002). Without additional funds for the School Bus Program, California's schoolchildren will continue to ride on the dirtiest buses in the country.

Policy Recommendations

California

The state should fully implement its Diesel Risk Reduction Plan by requiring early retirement of the worst polluting vehicles and advanced pollution control retrofits where possible. Key sectors including ports, ships, trains, construction equipment, agricultural engines, and most highway trucks and buses need to be cleaned up. California's successful incentive programs should receive sufficient and sustainable funding, rather than struggling every year with reduced budgets. In addition, the Moyer Program should be strengthened by allowing state funds to be used for projects that reduce PM only and by targeting funding to high-risk areas and populations.

EPA and Congress

For new engines, the EPA should develop regulations that hold trains and ships accountable to the same standards that other diesel engines face. To clean up the existing fleet, the EPA should develop retrofit regulations that require pollution controls or early engine retirement, and should work with Congress to develop a well-funded voluntary incentive program. To ensure emission controls are functioning at their full potential and to prevent tampering with exhaust controls, the EPA should develop an inspection and maintenance program. And finally, there needs to be more research into the real-world emissions from diesel engines and the health impacts of ultrafine particles.