

SAVING LIVES AND REDUCING HEALTH CARE COSTS: HOW CLEAN AIR ACT RULES BENEFIT THE NATION

A report from



November 2011

Prepared by



ABOUT THE GROUPS

Trust for America's Health is a non-profit, non-partisan organization dedicated to saving lives by protecting the health of every community and working to make disease prevention a national priority. www.healthyamericans.org.

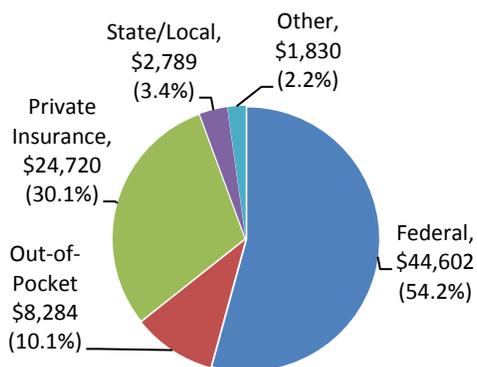
Environmental Defense Fund, a leading national nonprofit organization, creates transformational solutions to the most serious environmental problems. EDF links science, economics, law and innovative private-sector partnerships. www.edf.org.

David Gardiner & Associates, a strategic advisor to organizations seeking a sustainable future, delivers innovative and practical solutions for businesses and non-profits. www.dgardiner.com.

EXECUTIVE SUMMARY

The U.S. Environmental Protection Agency (EPA), under the authority of the Clean Air Act, has issued many rules over the past 40 years to protect human health and the environment by limiting air pollution. EPA estimates that four recently proposed or finalized Clean Air Act rules (listed below) will deliver roughly \$500 billion in annual economic benefits, and that the economic benefits of the 1990 Clean Air Act Amendments will rise to roughly \$2 trillion annually in 2020. EPA's estimates of the economic value of its clean air rules include the value of avoided premature mortality, negative health impacts, lost worker productivity due to illness, and environmental improvements such as increased visibility and agricultural productivity.

Savings from Four Clean Air Rules (in millions)



This report examines some of the health benefits of Clean Air Act rules and estimates the air pollution-related health care savings that result from reduced rates of illness that come from breathing cleaner air. There are two parts to the analysis. The first part of the analysis examines four recently proposed or finalized EPA rules to limit air pollution: the Cross-State Air Pollution Rule, the Utility Mercury and Air Toxics Rule, the Industrial Boiler Rule, and the Cement Kiln Rule.

The analysis presented here shows that, because of the reduced rates of serious health problems such as non-fatal heart attacks, chronic bronchitis, and premature mortality, **over the next decade these four Clean**

Air Act rules will yield pollution-related health care savings of over \$82 billion dollars, including:

- **\$44.6 billion** in Medicare, federal Medicaid, and other federal-level health care savings;
- **\$2.8 billion** in state-level Medicaid and other state and local health care savings;
- **\$8.3 billion** in out-of-pocket savings by individuals and families; and
- **\$24.7 billion** in private insurance savings, which ultimately benefits employers and individuals in the form of lower health insurance premiums.

The second part of the analysis examines the broader cumulative air pollution-related health care savings from programs implemented pursuant to the 1990 Clean Air Act Amendments. **From 2000 to 2020, by reducing pollution, the 1990 Clean Air Act Amendments will yield more than \$612 billion in pollution-related health care savings, including:**

- **\$313.5 billion** in Medicare, federal Medicaid, and other federal-level health care savings;
- **\$19.0 billion** in state-level Medicaid and other state and local health care savings;
- **\$54.6 billion** in out-of-pocket spending by individuals and families; and
- **\$212.7 billion** in private insurance spending, which ultimately benefits employers and individuals in the form of lower health insurance premiums.

The Clean Air Act and its rules not only significantly reduce the negative health effects from air pollution, but also save billions of dollars in associated health care spending.

INTRODUCTION

Air pollution has significant negative impacts on human health, posing a threat to all segments of the population, but especially vulnerable populations including the very young and the elderly. The effects can be short-term, such as triggering asthma attacks or causing respiratory infections (e.g., acute bronchitis), or they can be long-term, such as causing chronic respiratory or heart disease or, in the case of mercury, harming the developing brains of children.

The U.S. Environmental Protection Agency uses peer-reviewed scientific, medical, and economic studies to analyze its clean air rules and to quantify the specific health benefits that result, as well as the estimated economic value of the societal health and environmental benefits of clean air. EPA's valuations of the total economic benefits of clean air rules include both health benefits (such as direct medical costs, the value of avoided pain and suffering, and the opportunity costs and increased productivity associated with not being sick) and environmental benefits (such as increased agricultural crop yields and improved visibility). The combined annual economic value of the health and environmental benefits of the four recent clean air rules once in effect is estimated to be roughly \$500 billion, and for the 1990 Clean Air Act Amendments to be nearly \$2 trillion in 2020.

But given reductions in air pollution resulting from proposed or finalized EPA rules, how much will governments, private insurers, and individuals save on health care spending for the treatment of air pollution-related illnesses?

This study seeks to answer this question in two different contexts. First, this report estimates some of the pollution-related health care savings that can be expected from four specific clean air rules recently proposed or finalized under the Clean Air Act.¹ These four EPA rules limiting air pollution are: the Cross-State Air Pollution Rule (CSAPR), the Utility Mercury and Air Toxics Rule (also known as Utility MACT), the Industrial Boiler Rule (also known as Boiler MACT), and the Cement Kiln Rule (also known as Cement MACT). Using publicly available data for health benefits, cost-of-illness, and health care payer shares for medical expenditures, **this analysis estimates that over the next ten years, these four rules will save over \$82 billion in direct pollution-related health care expenditures, including over \$44.6 billion from Medicare, Medicaid, and other federal health programs and \$8.3 billion in out-of-pocket medical expenses for American families.**

Second, in addition to examining the four rules listed above, this report examines the pollution-related health care savings that result from a combination of rules issued under the 1990 Clean Air Act Amendments. When Congress amended the Clean Air Act in 1990, it mandated that EPA study the cumulative health and societal benefits resulting from reductions in air pollution. EPA recently released its Second Prospective Study on the current and projected benefits from the Clean Air Act Amendments of 1990.² Based on the health benefits estimated in that study, the analysis here estimates that **between 2000 and 2020, the Clean Air Act Amendment rules combined will save over \$612 billion in direct pollution-related health care expenditures, including \$313.5 billion from Medicare, Medicaid, and other federal health programs and \$54.6 billion in out-of-pocket medical expenses for American families.**

The Clean Air Act and its rules provide cleaner air and vital public health protection for all Americans. This translates to pollution-related health care savings by governments, private insurers, individuals, and families. In other words, the Clean Air Act not only protects Americans' health, but also their

¹ This study focuses solely on savings from pollution-related health care spending. It is not a comprehensive budget analysis, and does not attempt to assess all possible changes in revenue and spending that might result from the implementation of various Clean Air Act rules.

² Environmental Protection Agency, "The Benefits and Costs of the Clean Air Act from 1990 to 2020", April 2011, available at: <http://www.epa.gov/oar/sect812/prospective2.html>

wallets, saving billions of dollars in health care spending by families and federal and state/local governments.

SAVINGS FROM FOUR CLEAN AIR ACT RULES OVER THE NEXT TEN YEARS

Fossil-fueled power plants, industrial facilities like chemical plants and manufacturing facilities, and cement plants are all major sources of a host of dangerous air pollutants, including mercury, arsenic, dioxins, volatile organic compounds, acid gases, heavy metals, smog, and soot. Many of these heavy metals and organic chemicals are known carcinogens and can attack and disrupt the functioning of organs such as the kidneys, liver, lungs, or brain.³

Mercury emissions from power plants and other industrial sources make their way into aquatic systems where mercury concentrations build up over time in fish. Humans are exposed to mercury when they eat contaminated fish. Mercury is a potent neurotoxin, and mercury exposure can cause brain damage and mental retardation, especially in unborn babies and infants whose brains are still developing.⁴

In addition, these facilities are also all major source categories for soot pollution (also known as particulate matter), a mixture of dust, ash, and other particles formed through atmospheric reactions of fossil fuel combustion products. These particles, especially smaller-sized particles less than 2.5 microns, can penetrate deep into the lungs, trigger asthma attacks, and cause bronchitis, heart attacks, strokes, and even death.⁵

The EPA has recently finalized or is close to finalizing four major rules to address pollution from these sources, through its authority under the Clean Air Act. The Clean Air Act was first adopted in 1970, amended in 1977, and amended again in 1990. These four recently proposed or finalized rules have their origins in provisions adopted during the Clean Air Act Amendments of 1990.

- The *Cross-State Air Pollution Rule*, finalized in July 2011, requires 27 states in the eastern half of the country to significantly improve air quality by reducing power plant emissions that cross state lines and contribute to ground-level ozone and fine particle pollution in other states. Annually, this rule is expected to save up to 34,000 lives, avoid 15,000 non-fatal heart attacks, avert 19,000 hospital and emergency room visits, and prevent 1.8 million lost school and work days, delivering estimated total economic benefits of up to \$280 billion dollars.⁶
- The proposed *Utility Mercury and Air Toxics Rule*, scheduled to be finalized in December 2011, would reduce emissions of toxic air pollutants such as mercury, dioxin, acid gases, and arsenic from new and existing coal- and oil-fired power plants. Coal-fired power plants are the nation's largest manmade source of mercury emissions. Cleaning up mercury and other toxic air pollutants will also significantly reduce the amount of particulate pollution emitted by these power plants. Annually, this rule is expected to save up to 17,000 lives, avoid 11,000 non-fatal heart attacks, avert 12,000 hospital and emergency room visits, and prevent 850,000 missed work days, delivering total economic benefits of up to \$140 billion dollars.

³ For more on the health effects of hazardous air pollutants, see Environmental Protection Agency, *Health Effects Notebook for Hazardous Air Pollutants* website, <http://www.epa.gov/ttn/atw/hlthef/hapindex.html>.

⁴ For more on the health effects of human exposure to mercury, see Environmental Protection Agency, *Mercury: Human Exposure* website, <http://www.epa.gov/mercury/exposure.htm>.

⁵ American Lung Association, "Toxic Air: The Case for Cleaning Up Coal-Fired Power Plants", March 2011, available at: <http://www.lungusa.org/assets/documents/healthy-air/toxic-air-report.pdf>.

⁶ See the Methodology section for links to the EPA's Regulatory Impact Analyses for each of the four rules.

- The *Industrial Boiler Rule*,⁷ expected to be finalized in April 2012, would reduce emissions of toxic air pollutants such as mercury, dioxin, carbon monoxide, and acid gases from new and existing industrial, commercial, and institutional boilers and process heaters at major source facilities and incinerators. Industrial boilers are the nation’s second largest manmade source of mercury emissions. Annually, cleaning up mercury and other toxic air pollutants from these facilities will save up to 6,500 lives, avoid 4,000 non-fatal heart attacks and 41,000 asthma attacks, and prevent over 300,000 missed work and school days, delivering total economic benefits of up \$54 billion dollars.
- The *Cement Kiln Rule*, finalized in August 2010, will reduce mercury emissions by 92 percent and significantly reduce other air toxics, smog, and soot pollution from cement plants across the United States. Annually, this rule is expected to save up to 2,500 lives, avoid 1,500 non-fatal heart attacks and 1,000 asthma related ER visits, and prevent 130,000 missed work days, delivering total economic benefits of up to \$18 billion dollars.

Reducing air pollution leads to substantial reductions of both serious and mild illnesses. This report focuses on a subset of the health benefits that result from these four Clean Air Act rules, namely premature deaths, heart attacks, chronic bronchitis, hospitalizations for other cardiovascular and respiratory diseases, and emergency room visits for asthma. Reductions in these illnesses are responsible for the overwhelming share of total air pollution-related health care savings. Excluding other health benefits, such as asthma exacerbations, acute bronchitis, and other respiratory symptoms (for which less precise cost-of-illness data is available), means that the health care savings presented in this study are a conservative lower estimate of actual savings.

In general, all health benefits for each rule begin accruing after the compliance date for each rule, which is generally several years after the rule is finalized. The cumulative lives saved by these four rules as they phase in over the next ten years are shown in Figure 1, and the accumulated health benefits analyzed in this study for these four clean air rules over this same time frame are summarized in Table 1.⁸ Multiplying the specific health benefits by each illness’s average health care costs yields estimates of the associated health care savings.

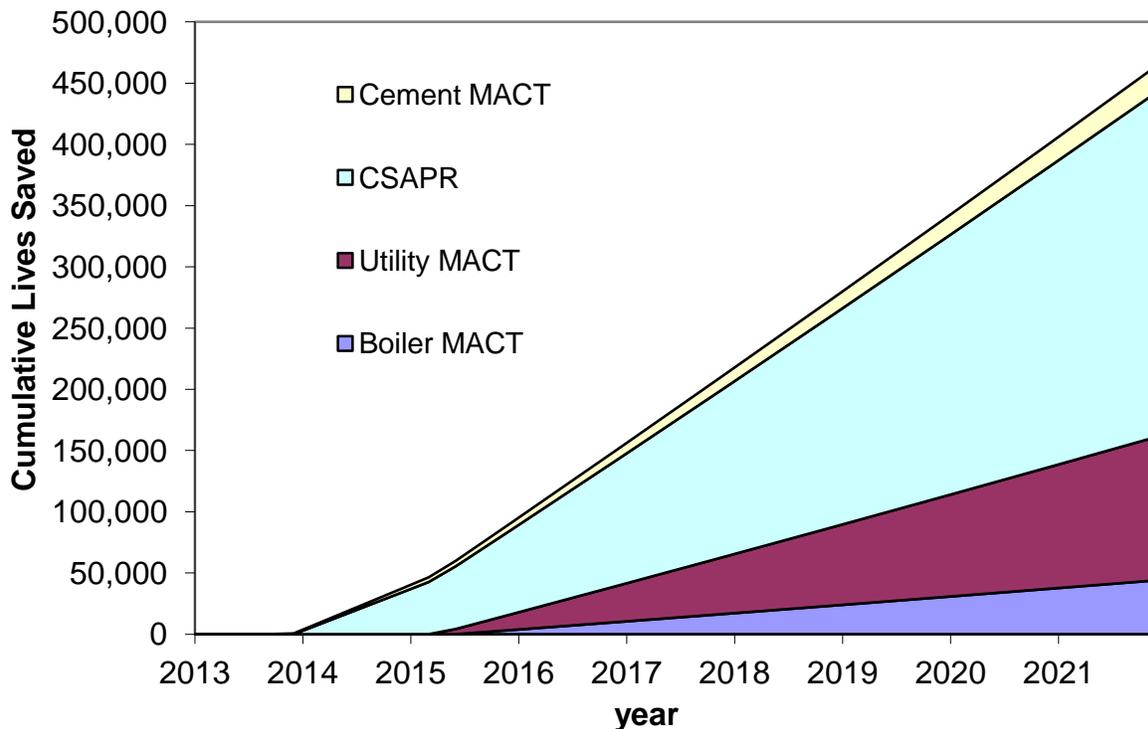
Table 1: Cumulative Health Benefits Over Ten Years (Through 2021) for Four Clean Air Act Rules

Adverse Health Effects	Total Reduction in Cases
Premature mortality (including infant mortality)	464,703
Chronic bronchitis	119,399
Non-fatal heart attacks (age over 18)	239,853
Hospital admissions, cardiovascular	85,885
Hospital admissions, respiratory	40,242
ER visits, asthma (age less than 18)	120,362

⁷ EPA finalized emissions standards for commercial and industrial boilers in February 2011, and the health incidence and economic benefits listed here are from those standards. EPA has since announced that it would be reconsidering the February rules and expects to finalize these new standards by April 2012. The new proposed rule was not available at the time this report was completed.

⁸ The health benefits for each of these rules is additive. See Methodology section for details on calculation of projected benefits, including exact compliance dates for each rule.

Figure 1: Cumulative Lives Saved Over Ten Years (Through 2021) for Four Clean Air Act Rules*



*Health benefits begin accruing after the compliance date for each rule.

Federal Savings

The federal government bears a significant portion of the costs of medical conditions caused by air pollution, particularly through its Medicare and Medicaid programs which provide health insurance coverage primarily to those over the age of 65 and those with limited income, respectively. For instance, the analysis in this study indicates that Medicare covers more than 45 percent of the costs of hospital admissions for respiratory disease, while Medicaid’s total share (split between state and federal governments) is more than 20 percent (see Table A5 in the Appendix). The federal government also bears costs through its coverage for veterans and military personnel (VA and TRICARE), as well as through other programs.

Using information from the U.S. Department of Health and Human Services that tracks health care spending for specific illnesses by payer, this analysis estimates that the combined health benefits resulting from the Cross-State Air Pollution Rule, the Utility Mercury and Air Toxics Rule, the Industrial Boiler Rule, and the Cement Kiln Rule will cut federal pollution-related health care spending by **\$44.6 billion** over the next ten years – with the vast majority of those savings attributable to savings in Medicare spending. Cumulative federal savings by illness is listed below in Table 2.⁹ A more detailed breakdown by federal payer, rule, and year can be found in Table A1 in the Appendix.

⁹ See the Methodology section for information on how health care savings for avoided premature mortality were estimated.

Table 2: Pollution-Related Health Care Savings Over Ten Years (Through 2021) from Four Clean Air Act Rules, by Adverse Health Effect and Payer (in millions)

Adverse Health Effect	Total Federal Savings	Total State/Local Savings	Total Out-of-Pocket Savings	Total Private Insurer Savings
Premature mortality (including infant mortality)	\$27,335	\$1,965	\$5,853	\$2,576
Chronic bronchitis	\$1,952	\$155	\$759	\$1,873
Non-fatal heart attacks (age over 18)	\$14,037	\$567	\$1,617	\$19,312
Hospital admissions, cardiovascular	\$931	\$42	\$41	\$767
Hospital admissions, respiratory	\$332	\$48	\$10	\$153
ER visits, asthma (age less than 18)	\$15	\$11	\$5	\$39
TOTAL*	\$44,602	\$2,789	\$8,284	\$24,720

*Totals may not exactly match sums due to rounding.

State and Local Savings

Like the federal government, significant portions of state and local governments’ budgets are spent on health care. As such, state and local governments also bear a share of the costs of pollution-related health effects, particularly through the state share of Medicaid. There are also a host of other state and local health programs affected by pollution-related health care spending.

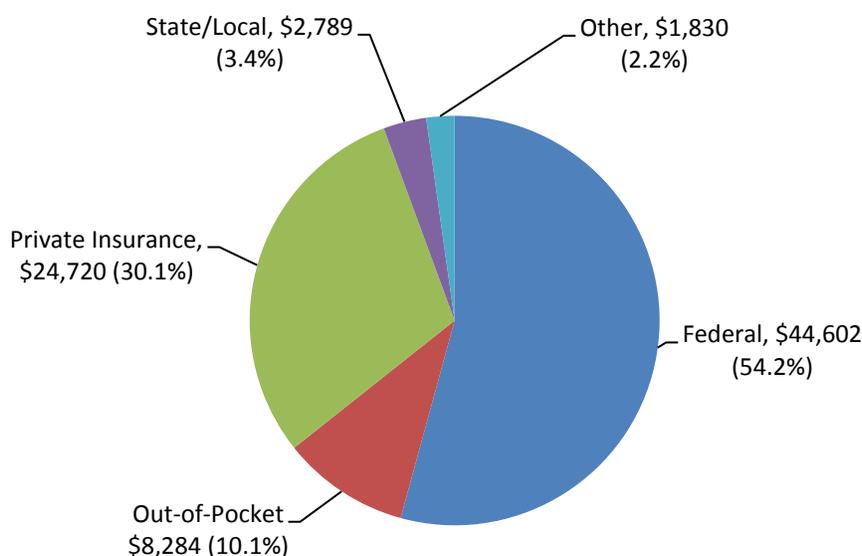
This analysis estimates that the four Clean Air Act rules will result in savings of approximately **\$2.8 billion** in state and local pollution-related health care spending over the next ten years. Cumulative state- and local-level savings by illness is summarized above in Table 2. A more detailed breakdown by rule and by year can be found in Table A2 in the Appendix.

Out-of-Pocket and Private Insurer Savings

In addition to the impacts on federal, state, and local health care programs, this analysis estimates that these four clean air rules will reduce direct out-of-pocket health care expenses for American families by almost **\$8.3 billion** over the next ten years. It is also estimated that these rules will reduce pollution-related health care spending by private insurers by over **\$24.7 billion** over that time – costs that are ultimately borne by employers, individuals, and families in the form of insurance premiums. Cumulative out-of-pocket and private insurer savings by illness is summarized in Table 2. A more detailed breakdown by payer, rule, and year can be found in Table A3 in the Appendix.

In total, these four rules will save over \$82.2 billion dollars in direct health care costs for these six conditions over the next ten years. The breakdown by payer (including other sources not shown in Table 2) is shown in Figure 2. Because the most expensive pollution-related illnesses primarily affect seniors, over half of all savings from these clean air rules occurs at the federal level (see Table A1 in the Appendix for detailed breakdowns of savings by payer, rule, and year).

Figure 2: Pollution-Related Health Care Savings from Four Clean Air Act Rules Over Ten Years (Through 2021), by Payer (in millions)



SAVINGS FROM THE 1990 CLEAN AIR ACT AMENDMENTS, 2000-2020

The health and economic benefits of the Clean Air Act go well beyond the four rules examined above. To assess some of the positive cumulative impacts of the Clean Air Act, this report also estimates the pollution-related health care savings that result from the health benefits that have and are expected to occur between 2000 and 2020 because of programs implemented pursuant to the 1990 Clean Air Act Amendments. The 1990 Clean Air Act Amendments, signed into law by President George H. W. Bush, were the last major updates to the statute and included new programs to address acid rain, urban air pollution, and toxic air emissions. Congress also mandated that EPA provide more information about the economic, health, and environmental effects of air pollution, as well as the societal impacts that come from limiting pollution.

In 2011, EPA issued its Second Prospective Report on the benefits and costs of the 1990 Clean Air Act Amendments, which examined the impacts from 1990 to 2020.¹⁰ EPA’s study looks at the combined impact of rules in place as of 2005 and computes snapshot estimates of the health benefits of the rules for the years 2000, 2010, and 2020. The health benefits from the 1990 Clean Air Act Amendments are dramatic; in 2010, over 160,000 lives were saved by reductions in particulate matter and ozone, and in 2020, it is estimated that roughly 200,000 heart attacks and 17 million lost work days will be avoided. The EPA estimates that the total economic value of the health and environmental benefits in 2020 delivered by the 1990 Clean Air Act Amendments will be roughly \$2 trillion. These benefits include the value of avoided premature mortality, direct medical expenses, pain and suffering, increased worker productivity attributed to avoided illnesses, and a host of environmental benefits such as improved visibility and increased agricultural yields.

¹⁰ Environmental Protection Agency, “The Benefits and Costs of the Clean Air Act from 1990 to 2020”, April 2011, available at: <http://www.epa.gov/oar/sect812/feb11/fullreport.pdf>.

Using the benefits “snapshots” in the Second Prospective Report as a starting point, the analysis in this study calculates the cumulative health benefits for the period 2000-2020 for the same six categories of adverse health effects studied in the previous section (see Methodology section for details). The results are summarized in Table 3.

Table 3: Cumulative Health Benefits from 2000 to 2020 from the 1990 Clean Air Act Amendments

Adverse Health Effect	Total Reduction in Cases
Premature mortality (including infant mortality)	3,565,420
Chronic bronchitis	1,136,665
Non-fatal heart attacks (age over 18)	2,835,346
Hospital admissions, cardiovascular	971,795
Hospital admissions, respiratory	881,471
ER visits, asthma (age less than 18)	1,837,289

As was the case with the four Clean Air Act rules considered earlier, preventing air pollution-related illnesses will both substantially improve Americans’ health and quality of life and also yield significant savings in associated health care spending. The analysis in this study shows that the reduced rate of pollution-related illness from the 1990 Clean Air Act Amendments results in cumulative pollution-related health care savings from 2000 to 2020 of:

- **\$313.5 billion** from Medicare, federal Medicaid, and other federal-level programs;
- **\$19.0 billion** in state-level Medicaid and other state and local health care savings;
- **\$54.6 billion** in out-of-pocket savings by individuals and families; and
- **\$212.7 billion** in private insurance savings, which is ultimately passed through to employers and individuals in the form of lower health insurance premiums.

Total savings for each payer category by health effect are summarized in Table 4, and more detailed information listing savings by year can be found in the Appendix in Table A4.

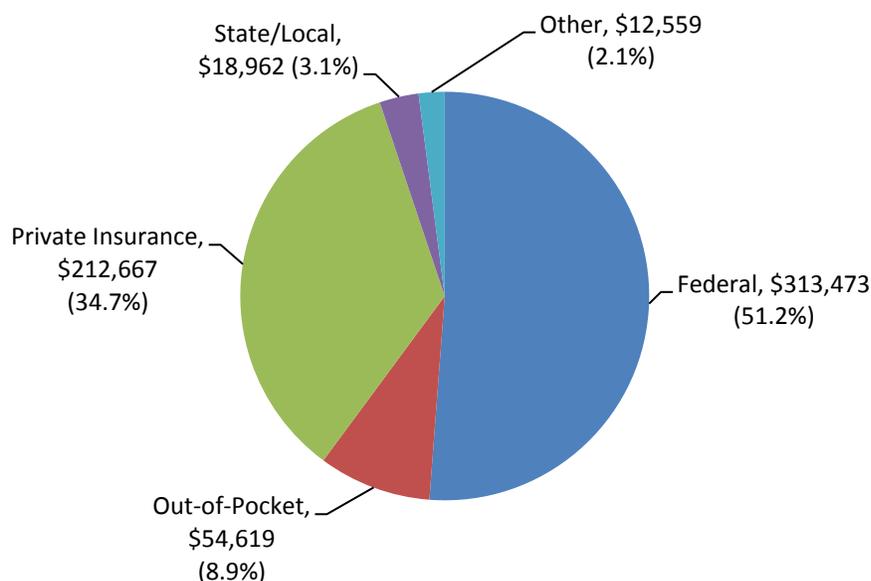
Table 4: Pollution-Related Health Care Savings from 2000 to 2020 from the 1990 Clean Air Act Amendments, by Adverse Health Effect (in millions)

Adverse Health Effect	Total Federal Savings	Total State / Local Savings	Total Out-of-Pocket Savings	Total Private Insurer Savings
Premature mortality (including infant mortality)	\$158,680	\$11,402	\$33,978	\$14,937
Chronic bronchitis	\$14,064	\$1,122	\$5,466	\$13,544
Non-fatal heart attacks (age over 18)	\$126,825	\$5,124	\$14,606	\$174,487
Hospital admissions, cardiovascular	\$8,078	\$363	\$354	\$6,655
Hospital admissions, respiratory	\$5,656	\$821	\$163	\$2,604
ER visits, asthma (age less than 18)	\$170	\$128	\$52	\$441
TOTAL*	\$313,473	\$18,962	\$54,619	\$212,667

*Totals may not exactly match sums due to rounding.

This analysis estimates that for the years 2000-2020, the 1990 Clean Air Act Amendment rules modeled in the Second Prospective Report will save about \$612.3 billion dollars in direct health care spending for pollution-related illnesses for these six conditions. Because the EPA’s Second Prospective Report did not include the four rules analyzed in the first part of this study, the total savings of the Clean Air Act Amendments of 1990 are actually even higher.¹¹ The breakdown by payer (including other sources not listed in Table 4) is shown in Figure 3.

Figure 3: Pollution-Related Health Care Savings from the 1990 Clean Air Act Amendments, from 2000-2020, by Payer (in millions)



CONCLUSION

The Clean Air Act has provided critical public health protection for over 40 years. The pollution reductions resulting from its rules have prevented millions of premature deaths, significantly reduced illnesses such as chronic bronchitis and asthma attacks, and made our children healthier. This has not only dramatically improved the quality of life for millions of Americans, but yielded tremendous economic benefits as well. This study has attempted to quantify some of those benefits in the form of direct pollution-related health care savings, as well as determine who receives those benefits.

It should be noted that not all air pollution-related health benefits or associated savings have been captured here. There are many milder pollution-related health benefits that have been quantified by EPA but were not included in this analysis, primarily due to a lack of reliable cost-of-illness data for these illnesses (e.g., acute bronchitis, asthma exacerbations, and upper and lower respiratory symptoms). While the treatments for these illnesses are relatively inexpensive over-the-counter or prescription medications, families still feel the impact of these costs because they are largely paid for out-of-pocket. In addition, EPA’s analyses do not quantify many of the other health benefits from reduced pollution, such as reductions in cancer risk from reduced environmental exposure to carcinogens. In that sense, both the analysis presented here and the EPA’s health benefits analyses should be viewed as conservative.

¹¹ Because the Second Prospective Report includes health benefits estimated to result from the Clean Air Interstate Rule (a predecessor to the Cross State Air Pollution Rule that was significantly less protective of public health), the health benefits projected in the Report and those from the four recent Clean Air Act rules are not strictly additive.

There are additional economic benefits to these rules that are not captured in this analysis. For example, a 2001 analysis estimated that by 2010, due to the 1970 Clean Air Act, the nation's gross domestic product would be 1.5 percent higher than without the Clean Air Act, primarily due to increased worker productivity in adults who benefited from reduced exposure to neurotoxins as children.¹² Overall, the total economic benefits of the 1970 Clean Air Act as well as the 1990 Clean Air Act Amendments have exceeded costs by a factor of over 30 to 1, with estimated net benefits of approximately \$22 trillion over the 1970-1990 period and \$12 trillion over the 1990-2020 period.¹³ The Clean Air Act has been one of the nation's most successful efforts to improve the health and welfare of its citizens.

¹² Dale W. Jorgenson Associates, "An Economic Analysis of the Benefits and Costs of the Clean Air Act, 1970 to 1990: Revised Report of Results and Findings", August 2001, available at: [http://yosemite.epa.gov/ee/epa/eeerm.nsf/vwAN/EE-0565-01.pdf/\\$file/EE-0565-01.pdf](http://yosemite.epa.gov/ee/epa/eeerm.nsf/vwAN/EE-0565-01.pdf/$file/EE-0565-01.pdf).

¹³ Environmental Protection Agency, "The Benefits and Costs of the Clean Air Act, 1970 to 1990", October 1997, available at: <http://www.epa.gov/oar/sect812/copy.html>; Environmental Protection Agency, "The Benefits and Costs of the Clean Air Act from 1990 to 2020", April 2011, available at: <http://www.epa.gov/air/sect812/feb11/fullreport.pdf>.

METHODOLOGY

Calculating direct pollution-related health care savings by payer due to the Clean Air Act requires three pieces of information: (1) quantitative information on the reduction of specific health incidence endpoints, (2) information about average health care Cost-of-Illness (COI) for each health endpoint, and (3) information on the relative share of medical expenditures covered by various possible payers. Once these three types of data are available, estimates of the health care savings for each rule can be derived by multiplying the COI for each ailment by the amounts paid by each payer for each ailment each year. The methodologies for obtaining and utilizing data on health benefit incidence, COI, and payer splits are each described below.

Health Benefit Incidence

Health Benefits for Four Clean Air Act Rules:

The EPA's Regulatory Impact Analyses (RIAs) for each of the Clean Air Act rules¹⁴ form the basis of the figures on reduced incidence of adverse health effects (using the Laden et al.(2006) estimates for premature mortality). The EPA derives its incidence figures from peer-reviewed literature, air quality modeling, and health impact functions.

Because of the way EPA computes its health benefits from each of the four clean air rules in this study, all health benefits from each of these rules are additive. In general, all health benefits are computed as the result of the difference in a pollutant's emissions trajectory under a clean air rule relative to a baseline policy scenario where no rule is in place. As a result, the benefits from pollution rules that cover different source categories (i.e. the Cement MACT, CSAPR for power plants, and Boiler MACT) are additive. In the case of Utility MACT, which also applies to power plants, EPA assumed that CSAPR was in effect when creating its baseline emissions trajectory. Therefore, the emissions reductions that result from the Utility MACT rule are in addition to those from CSAPR, as are its calculated health benefits.

Each final Clean Air Act rule provides for a period of time specified in the rule to allow for regulated pollution sources to come into compliance. In this study, all health benefits from any particular rule are assumed to begin only after the compliance date. EPA's RIAs for each rule provide a "snapshot" estimate of the annual health benefits, specified for a particular year. In general, annual health incidence benefits in this analysis are derived from these estimates. For any rule whose compliance date occurs in the middle of the year, benefits are assumed to accrue on a monthly basis equal to 1/12 of the annual rate for the portion of the year after the compliance date. Specifically, the compliance dates used in the analysis in this report for each of the four rules is as follows:¹⁵ (1) the Cement Kiln Rule – October 2013, (2) the Cross-State Air Pollution Rule – January 2014,¹⁶ (3) the Boiler Rule – July 2015, based on the EPA's announced April 2012 schedule completing its reconsideration of that rule, and (4) Utility MACT – April 2015. Benefits incidence in future years are expected to increase as the U.S. population increases. In order to project reduced incidence into the future through 2021, the

¹⁴ Links to the RIAs for each rule are as follows: CSAPR: <http://www.epa.gov/airtransport/pdfs/FinalRIA.pdf>; Utility MACT: <http://www.epa.gov/ttnecas1/regdata/RIAs/ToxicsRuleRIA.pdf>; Boiler MACT: http://www.epa.gov/ttnecas1/regdata/RIAs/boilersriafinal110221_psg.pdf and http://www.epa.gov/ttnecas1/regdata/RIAs/CISWIRIAfinal110221_psg2.pdf; Cement Kiln MACT: <http://www.epa.gov/ttnecas1/regdata/RIAs/portlandcementfinalria.pdf>.

¹⁵ The Utility MACT and Boiler MACT have not yet been finalized, and accordingly, the compliance dates used in this report for these two rules are tentative. Any differences between these tentative compliance dates and the actual compliances dates published when the rules are finalized will affect the health benefits and associated savings listed here.

¹⁶ The first phase of compliance for CSAPR begins in January 2012. However, EPA did not provide quantitative estimates for health incidence benefits during this phase (i.e. 2012-2013); therefore no health benefits are included for this time frame. The actual benefits for the CSAPR are therefore significantly larger than what is presented here.

analysis adjusts these annual estimates for population growth, as projected by the U.S. Census Bureau.¹⁷

Cumulative Health Benefits of the 1990 Clean Air Act Amendments

The EPA's 2011 analysis of the benefits and costs of the 1990 Clean Air Act Amendments includes reduced incidence figures for the years 2000, 2010, and 2020 (Second Prospective Study, Table 5-6),¹⁸ which form the basis of the figures on reduced incidence of the adverse health effects analyzed in this study. Again, the EPA derives its incidence figures from peer-reviewed literature, air quality modeling, and health impact functions.

Reduced incidences for the intervening years (2001-2009, 2011-2019) were derived by using the EPA's overall benefit-index trajectory (which reflects the year-to-year emissions changes that underpin the modeled benefits estimates), showing the percent contribution of each year to the 10-year interval. EPA based its series of benefits index values on summing up the year-to-year products of pollutant-specific emissions changes multiplied by estimates for the dollar per ton value for each pollutant, to derive intra-target year interpolations of total monetized benefits. This trajectory of index values is used as a proxy to estimate the trajectory of health benefits to interpolate intra-target year incidences of adverse health effects.

In order to test the sensitivity of these results to the choice of interpolation method, a linear interpolation between the years 2000, 2010, and 2020 was also computed. The differences in cumulative health incidence and health savings using the alternate interpolation method were both negligible, at less than 0.5 percent.

Costs-of-Illness

For the illnesses analyzed in this study, only the direct medical costs associated with each health incidence were computed. Cost-of-Illness values used in this study are summarized in Table A5 in the Appendix.

For ER visits for asthma (ICD-9 code 493), hospital admissions for cardiovascular illnesses (ICD-9 codes 390-429) and hospital admissions for respiratory illnesses (ICD-9 codes 460-519), the COI is calculated using the Medical Expenditure Panel Survey (MEPS) data files for 2008,¹⁹ including only cases where the relevant ICD-9 codes are the primary diagnosis. In this report, the category "ER visits respiratory" listed in some of the RIAs is treated the same as "ER visits asthma."

For non-fatal heart attacks, COI includes both expenditures associated with the immediate cardiac emergency, as well as any associated follow up care for a period of years following the event. This study takes the same approach as EPA does in its RIA for the Utility Mercury and Air Toxics Rule, which is to say that the COI is computed as an average of COIs reported in Wittels et al (1990)²⁰ and Russell et al (1998).²¹ These COIs are 5-year cost figures, which are accounted for in this analysis in the year the heart attack is avoided.

¹⁷ U.S. Census Bureau, National Population Projections, 2008, available at:

<http://www.census.gov/population/www/projections/summarytables.html>.

¹⁸ Environmental Protection Agency, "The Benefits and Costs of the Clean Air Act from 1990 to 2020", April 2011, available at: <http://www.epa.gov/air/sect812/feb11/fullreport.pdf>.

¹⁹ Department of Health and Human Services, Agency for Healthcare Research and Quality, *Medical Expenditure Panel Survey* website, <http://www.meps.ahrq.gov/mepsweb/index.jsp>.

²⁰ Wittels, E.H., J.W. Hay, and A.M. Gotto, Jr. 1990. "Medical Costs of Coronary Artery Disease in the United States", *American Journal of Cardiology* 65(7):432-440, available at:

<http://www.sciencedirect.com/science/article/pii/000291499090806C>.

²¹ Russell, M.W., D.M. Huse, S. Drowns, E.C. Hamel, and S.C. Hartz. 1998. "Direct Medical Costs of Coronary Artery Disease in the United States", *American Journal of Cardiology* 81(9):1110-1115, available at:

<http://www.ajconline.org/article/S0002-9149%2898%2900136-2/abstract>.

For chronic bronchitis, the COI is a reflection of a long stream of costs associated with the disease over the patient's lifetime. COI estimates therefore depend on the age of onset of the disease and the choice of discount rate when computing these costs. EPA's BenMAP²² includes COI estimates for chronic bronchitis for three different age-of-onset ranges and two discount rates in Table J-6. Due to limited data on the distribution function for the age of onset, for this study, the COIs from different ages of onset computed with a 3 percent discount rate were averaged with equal weight (implying a uniform distribution function for age of onset). To estimate the sensitivity of these results to the choice of this distribution function, overall health care savings were computed using two alternate scenarios. The first function is taken from a study on a Finnish rural male population²³ and increases the overall savings estimate by approximately 0.5 percent. A second scenario using the lowest COI of the three cohorts (implying that the age of onset for all cases of chronic bronchitis is over 65 years old) decreases the overall savings by approximately 1.8 percent. This conservative assumption sets a firm lower bound for choice of distribution function's impact on the overall savings estimate.

To estimate savings from avoided adult premature mortality, average health care expenditures in the last year of life are used as a proxy for COI. This analysis relies on the May 2003 estimates from the Centers for Medicare & Medicaid Services, based on the Medicare Current Beneficiary Survey, of the average annual health expenditures for the last year of life from 1992-1999.²⁴

Estimated medical costs for avoided infant mortality are based on an estimate in the May 2011 article in the *Journal of Law, Medicine & Ethics* by Lantos and Meadow of the approximate median NICU costs for non-survivors.²⁵

All costs are adjusted to 2011 dollars (using August 2011 CPI-U medical care as a base and using the annual average of CPI-U medical care for years prior to 2011, in the cases where the COI estimates are given in earlier-year dollars or where medical expenditures occur in those years). Medical costs for all health endpoints for each year from 2012 through 2021 are adjusted upwards for inflation using an annual health care cost rise of 5.8 percent (based on a July 2011 estimate from the Office of the Actuary of the Centers for Medicare and Medicaid Services of projected national health spending growth per year for the period 2010 through 2020).²⁶

Payer Split Information for Federal, State/Local, Private Insurer, and Out-of-Pocket Costs

The MEPS data files for 2008 provide figures for the amount of total expenditures paid by Medicare, Medicaid, VA, TRICARE, Other Federal, Self/Family, Private Insurers, Other State/Local, and several other sources. For ER visits for asthma and hospital admissions for cardiovascular and respiratory illness, the MEPS figures for mean expenditure per payer are used.

For chronic bronchitis (ICD-9 code 491) and non-fatal heart attacks (ICD-9 code 410), the MEPS data are used to identify the *share* paid by each payer, and these percentages are then applied to the relevant COI.

²² Abt Associates Inc., "BenMAP Environmental Benefits Mapping and Analysis Program", August 2010, available at: <http://www.epa.gov/air/benmap/models/BenMAPManualAppendicesAugust2010.pdf>.

²³ Pelkonen, M, I.-L. Notkola, A. Nissinen, et al., "Thirty-Year Cumulative Incidence of Chronic Bronchitis and COPD in Relation to 30-Year Pulmonary Function and 40-Year Mortality", *Chest* 130(4):1129-1137, October 2006, available at: <http://chestjournal.chestpubs.org/content/130/4/1129.full>.

²⁴ Centers for Medicare & Medicaid Services, MCBS Profiles, "Last Year of Life Expenditures", May 2003, Issue No. 10, available at: <https://www.cms.gov/mcbs/downloads/issue10.pdf>.

²⁵ Lantos, J.D. and W.L. Meadows, "Costs and End-of-Life Care in the NICU: Lessons for the MICU?", *The Journal of Law, Medicine & Ethics*, 39(2) : 194-200, Summer 2011, available at: <http://onlinelibrary.wiley.com/doi/10.1111/j.1748-720X.2011.00588.x/pdf>.

²⁶ Keehan, S.P., A.M. Sisko, C.J. Truffer et al., C.J. Truffer, et al., "National Health Spending Projections Through 2020: Economic Recovery And Reform Drive Faster Spending Growth", *Health Affairs*, July 2011, available at: <http://content.healthaffairs.org/content/early/2011/07/27/hlthaff.2011.0662.full>.

For infant mortality, the MEPS summary payer percentages for complications of pregnancy and birth²⁷ are used to approximate the percentages of costs covered by Medicare, Medicaid, private insurance, and out-of-pocket, which are then applied to the infant mortality COI.

For premature adult mortality, this analysis relies on the May 2003 estimates from the Centers for Medicare & Medicaid Services, based on the Medicare Current Beneficiary Survey, of annual health expenditures by payer for the last year of life from 1992-1999.²⁸

Payer split values used in this study are summarized in the Appendix in Table A5.

Federal spending includes Medicare, the federal part of Medicaid (using a pre-ARRA national average from CBO of about 57 percent²⁹), Veterans Affairs, TRICARE, and Other Federal. State/local spending includes the state part of Medicaid and Other State/Local.

The incidences each year are then multiplied by the amounts paid by each payer for each ailment each year to derive estimates of the health care spending savings for each rule, each ailment, and/or each year.

This analysis does not consider possible changes to Medicare and Medicaid coverage under the Patient Protection and Affordable Care Act of 2010; the Act is incorporated only in the July 2011 estimate from the Office of the Actuary of the Centers for Medicare and Medicaid Services of projected national health spending growth per year for the period 2010 through 2020.

Totals may not match the sum of all numbers shown in tables due to rounding.

²⁷ Department of Health and Human Services, Agency for Healthcare Research and Quality, Medical Expenditure Panel Survey, "Table 4: Total Expenses and Percent Distribution for Selected Conditions by Source of Payment: United States, 2008", available at: http://www.meps.ahrq.gov/mepsweb/data_stats/tables_compensia_hh_interactive.jsp?SERVICE=MEPSSocketo&PROGRAM=MEPSPGM.TC.SAS&File=HCFY2008&Table=HCFY2008_CNDXP_D&Debug=

²⁸ Centers for Medicare & Medicaid Services, MCBS Profiles, "Last Year of Life Expenditures", May 2003, Issue No. 10, available at: <https://www.cms.gov/mcbs/downloads/issue10.pdf>.

²⁹ Congressional Budget Office, "The Long-Term Outlook for Medicare, Medicaid, and Total Health Care Spending", *The Long-Term Budget Outlook*, June 2009, available at: <http://www.cbo.gov/ftpdocs/102xx/doc10297/Chapter2.5.1.shtml>

APPENDIX

Table A1: Federal Pollution-Related Health Care Savings Per Year from Four Clean Air Act Rules, by Rule and Payer (in millions)

		Savings Per Year									TOTAL
		2013	2014	2015	2016	2017	2018	2019	2020	2021	
Cross-State Air Pollution Rule	<i>Medicare</i>	x	\$2,256	\$2,410	\$2,574	\$2,749	\$2,937	\$3,137	\$3,350	\$3,577	\$22,990
	<i>Medicaid</i>	x	\$208	\$222	\$238	\$254	\$271	\$290	\$309	\$330	\$2,123
	<i>Other Fed</i>	x	\$30	\$32	\$34	\$36	\$39	\$42	\$44	\$47	\$305
Utility Mercury & Air Toxics Rule	<i>Medicare</i>	x	x	\$1,014	\$1,444	\$1,543	\$1,648	\$1,760	\$1,880	\$2,008	\$11,297
	<i>Medicaid</i>	x	x	\$90	\$128	\$136	\$146	\$155	\$166	\$177	\$997
	<i>Other Fed</i>	x	x	\$14	\$19	\$21	\$22	\$24	\$25	\$27	\$152
Industrial Boiler Rule	<i>Medicare</i>	x	x	\$258	\$550	\$588	\$628	\$671	\$716	\$765	\$4,176
	<i>Medicaid</i>	x	x	\$23	\$49	\$52	\$56	\$59	\$64	\$68	\$370
	<i>Other Fed</i>	x	x	\$3	\$7	\$8	\$8	\$9	\$9	\$10	\$54
Cement Kiln Rule	<i>Medicare</i>	\$44	\$186	\$199	\$212	\$227	\$242	\$259	\$276	\$295	\$1,939
	<i>Medicaid</i>	\$4	\$17	\$18	\$19	\$20	\$22	\$23	\$25	\$26	\$173
	<i>Other Fed</i>	\$1	\$2	\$3	\$3	\$3	\$3	\$3	\$4	\$4	\$26
TOTAL	<i>Medicare</i>	\$44	\$2,442	\$3,880	\$4,781	\$5,107	\$5,455	\$5,826	\$6,222	\$6,645	\$40,402
	<i>Medicaid</i>	\$4	\$225	\$353	\$433	\$462	\$494	\$528	\$563	\$602	\$3,663
	<i>Other Fed</i>	\$1	\$32	\$52	\$63	\$68	\$72	\$77	\$83	\$88	\$536

Table A1 shows the annual and cumulative federal pollution-related health care savings for each of the four Clean Air Act rules considered in this analysis. “Other Fed” includes Veterans Affairs, TRICARE, and other additional federal health savings. Health benefits begin accruing after the compliance deadline for each rule. See Methodology section for more details.

Table A2: State/Local Pollution-Related Health Care Savings Per Year from Four Clean Air Act Rules, by Rule (in millions)

	Savings Per Year									TOTAL
	2013	2014	2015	2016	2017	2018	2019	2020	2021	
Cross-State Air Pollution Rule	x	\$158	\$169	\$180	\$193	\$206	\$220	\$235	\$251	\$1,614
Utility Mercury & Air Toxics Rule	x	x	\$68	\$97	\$104	\$111	\$119	\$127	\$135	\$761
Industrial Boiler Rule	x	x	\$17	\$37	\$40	\$42	\$45	\$48	\$52	\$282
Cement Kiln Rule	\$3	\$13	\$14	\$14	\$15	\$16	\$18	\$19	\$20	\$132
TOTAL	\$3	\$171	\$268	\$329	\$352	\$376	\$402	\$429	\$458	\$2,789

Table A2 shows the annual and cumulative state and local pollution-related health care savings for each of the four Clean Air Act rules considered in this analysis, for each year from 2013 through 2021. Health benefits begin accruing after the compliance deadline for each rule. See Methodology section for more details.

Table A3: Out-of-Pocket and Private Insurer Pollution-Related Health Care Savings Per Year from Four Clean Air Act Rules, by Rule and Payer (in millions)

		Savings Per Year									TOTAL
		2013	2014	2015	2016	2017	2018	2019	2020	2021	
Cross-State Air Pollution Rule	<i>Out-of-Pocket</i>	x	\$473	\$505	\$539	\$576	\$615	\$657	\$702	\$749	\$4,816
	<i>Private Insurer</i>	x	\$1,280	\$1,367	\$1,453	\$1,560	\$1,666	\$1,779	\$1,900	\$2,029	\$13,035
Utility Mercury & Air Toxics Rule	<i>Out-of-Pocket</i>	x	x	\$202	\$287	\$307	\$327	\$350	\$374	\$399	\$2,245
	<i>Private Insurer</i>	x	x	\$687	\$979	\$1,046	\$1,117	\$1,193	\$1,274	\$1,360	\$7,655
Industrial Boiler Rule	<i>Out-of-Pocket</i>	x	x	\$51	\$110	\$117	\$125	\$134	\$143	\$153	\$833
	<i>Private Insurer</i>	x	x	\$170	\$364	\$389	\$415	\$443	\$473	\$506	\$2,760
Cement Kiln Rule	<i>Out-of-Pocket</i>	\$9	\$37	\$40	\$43	\$46	\$49	\$52	\$55	\$59	\$389
	<i>Private Insurer</i>	\$29	\$122	\$130	\$139	\$148	\$159	\$169	\$181	\$193	\$1,270
TOTAL	<i>Out-of-Pocket</i>	\$9	\$510	\$798	\$979	\$1,045	\$1,117	\$1,193	\$1,274	\$1,360	\$8,284
	<i>Private Insurer</i>	\$29	\$1,401	\$2,355	\$2,935	\$3,142	\$3,356	\$3,585	\$3,828	\$4,089	\$24,720

Table A3 shows the annual and cumulative federal pollution-related health care savings for each of the four Clean Air Act rules considered in this analysis. Health benefits begin accruing after the compliance deadline for each rule. See Methodology section for more details.

Table A4: Annual Pollution-Related Health Care Savings Per Year from 2000 to 2020 from the 1990 Clean Air Act Amendments, by Payer (in millions)

	Savings Per Year										
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Medicare	\$4,871	\$5,343	\$5,840	\$6,287	\$6,809	\$7,345	\$8,046	\$8,729	\$9,507	\$10,276	\$11,304
Medicaid (Fed)	\$430	\$471	\$515	\$554	\$599	\$646	\$707	\$767	\$834	\$901	\$991
Other Federal	\$72	\$79	\$87	\$94	\$103	\$111	\$122	\$133	\$146	\$159	\$175
Total Federal	\$5,373	\$5,894	\$6,442	\$6,935	\$7,511	\$8,103	\$8,876	\$9,629	\$10,487	\$11,336	\$12,470
State/Local	\$328	\$360	\$393	\$423	\$458	\$493	\$540	\$585	\$637	\$688	\$756
Out-of-Pocket	\$958	\$1,048	\$1,143	\$1,229	\$1,329	\$1,432	\$1,565	\$1,695	\$1,843	\$1,989	\$2,183
Private Insurance	\$3,450	\$3,808	\$4,185	\$4,524	\$4,921	\$5,329	\$5,869	\$6,392	\$6,995	\$7,593	\$8,397
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	TOTAL
Medicare	\$12,399	\$13,758	\$15,282	\$17,002	\$18,786	\$20,456	\$22,497	\$24,454	\$26,528	\$28,782	\$284,300
Medicaid (Fed)	\$1,085	\$1,202	\$1,334	\$1,483	\$1,637	\$1,781	\$1,958	\$2,127	\$2,306	\$2,501	\$24,830
Other Federal	\$192	\$212	\$235	\$261	\$288	\$313	\$344	\$373	\$404	\$438	\$4,343
Total Federal	\$13,675	\$15,172	\$16,852	\$18,745	\$20,711	\$22,551	\$24,798	\$26,954	\$29,238	\$31,721	\$313,473
State/Local	\$828	\$918	\$1,019	\$1,132	\$1,250	\$1,361	\$1,495	\$1,625	\$1,762	\$1,910	\$18,962
Out-of-Pocket	\$2,388	\$2,645	\$2,932	\$3,256	\$3,592	\$3,908	\$4,292	\$4,661	\$5,053	\$5,478	\$54,619
Private Insurance	\$9,252	\$10,299	\$11,477	\$12,809	\$14,190	\$15,476	\$17,056	\$18,567	\$20,168	\$21,909	\$212,667

Total Federal includes Medicare, Medicaid, and Other Federal. “Other Federal” includes Veterans Affairs, TRICARE, and other additional federal health savings.

Table A5: Cost-of-Illness and Payer Split Percentages

Adverse Health Effect	Cost of Illness	Payer Percentages								
		Medicare	Medicaid	VA	TRI-CARE	Other Fed'l	Other State/Local	Self / Family / Out-of-Pocket	Private Insurance	Other
Premature mortality	\$35,516 (1999)	63.6%	11.7%	-	-	-	-	15.0%	6.6%	3.0%
Infant mortality	\$20,000 (2011) (median)	0%	30.5%	-	-	-	-	6.0%	55.9%	7.7%
Chronic bronchitis	\$17,936 (2000)	29.12%	7.45%	5.23%	1.56%	0.03%	0.00%	15.62%	38.71%	2.27%
Non-fatal heart attacks (age over 18)	\$84,955 (2006)	36.68%	3.51%	0.20%	0.11%	0.08%	0.07%	4.50%	53.73%	1.14%
Hospital admissions, cardiovascular	\$13,602 (2008)	43.29%	5.12%	2.61%	0.14%	0.00%	0.00%	2.14%	40.34%	6.35%
Hospital admissions, respiratory	\$8,434 (2008)	45.77%	20.30%	2.45%	0.35%	0.00%	0.01%	1.74%	27.69%	1.71%
ER visits, asthma (age less than 18)	\$369 (2008)	0.00%	35.95%	0.00%	0.00%	0.00%	0.00%	6.30%	53.11%	4.64%

Cost-of-Illness figures are reported here, along with the year (shown in parentheses) prior to adjustments for inflation. Medicaid payer percentages include both federal and state contributions. Percentages may not total exactly to 100.0 percent due to rounding.