HOW ENERGY POLICIES AFFECT PUBLIC HEALTH

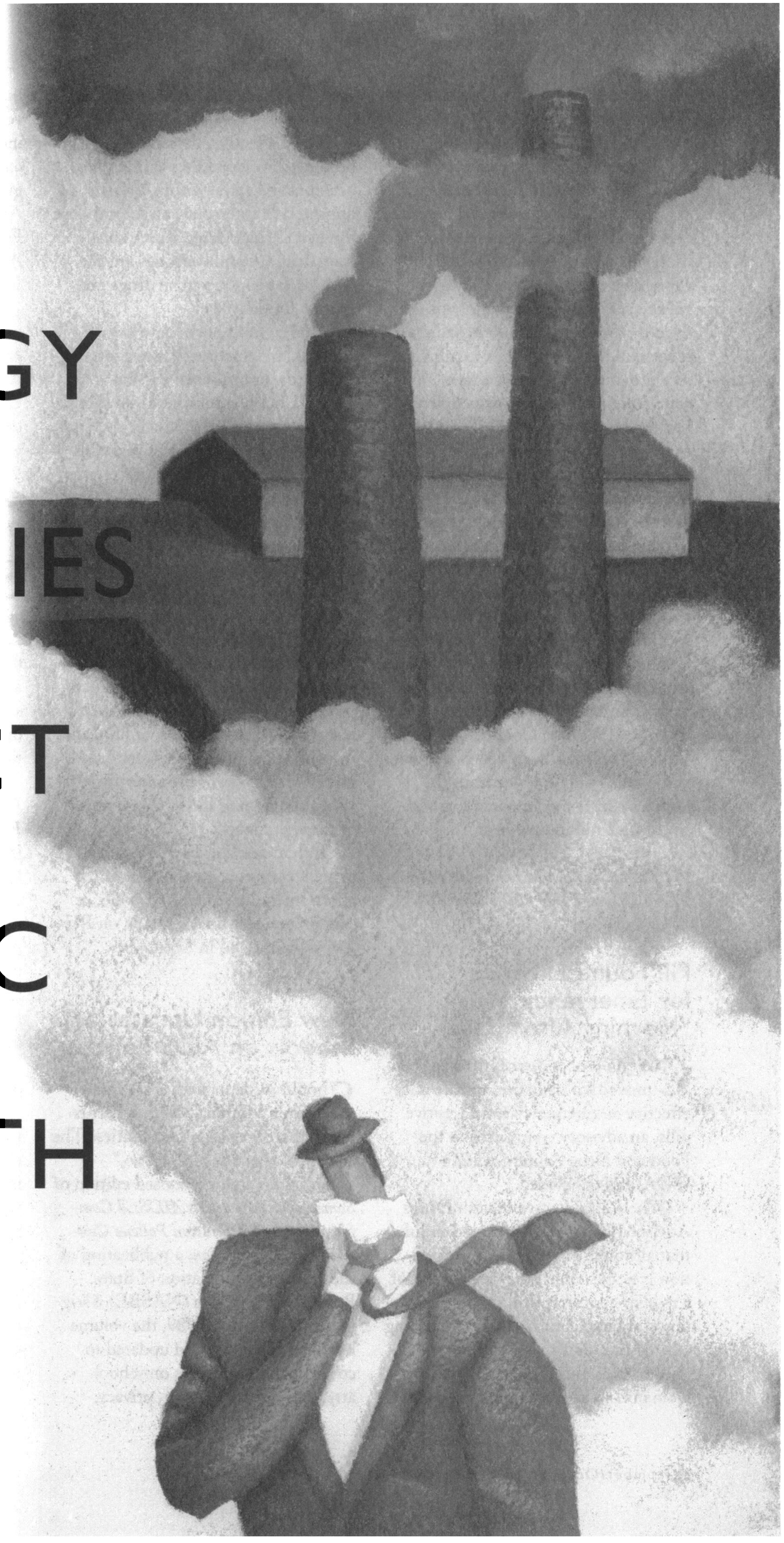
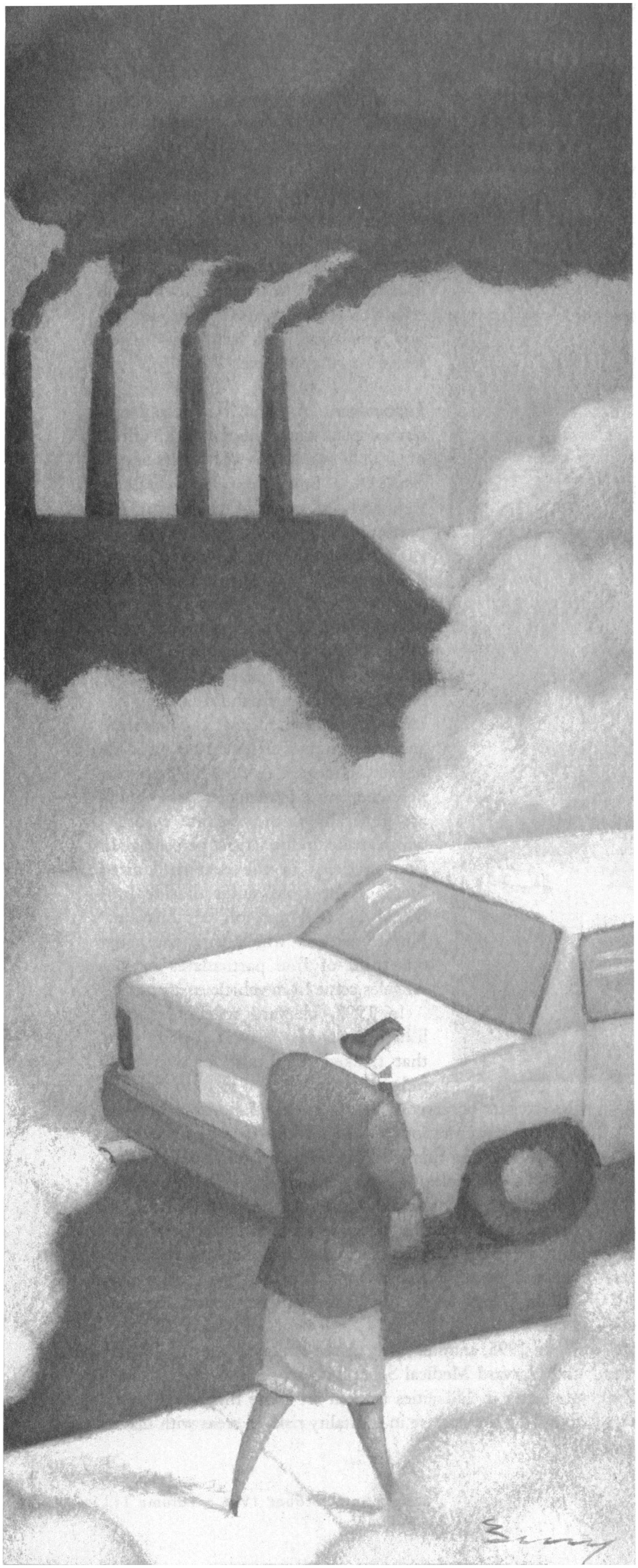


Illustration by John Berry



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SYNOPSIS

THE CONNECTION BETWEEN energy policy and increased levels of respiratory and cardiopulmonary disease has become clearer in the past few years. People living in cities with high levels of pollution have a higher risk of mortality than those living in less polluted cities. The pollutants most directly linked to increased morbidity and mortality include ozone, particulates, carbon monoxide, sulfur dioxide, volatile organic compounds, and oxides of nitrogen.

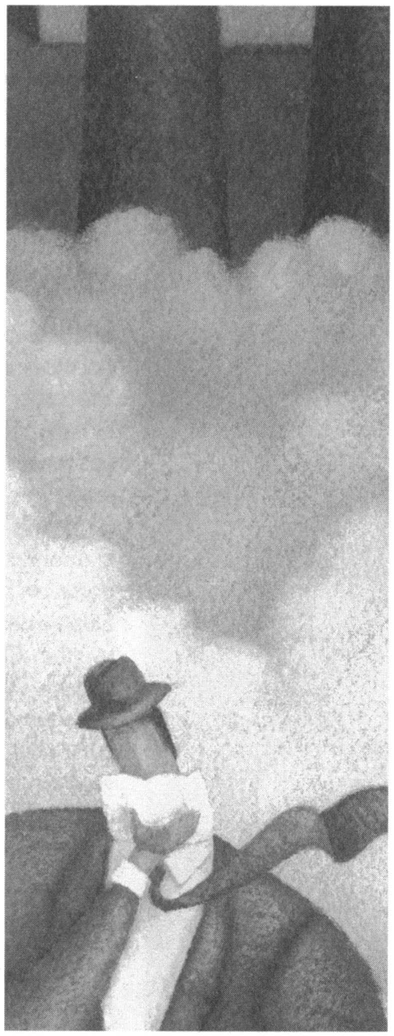
Energy-related emissions generate the vast majority of these polluting chemicals. Technologies to prevent pollution in the transportation, manufacturing, building, and utility sectors can significantly reduce these emissions while reducing the energy bills of consumers and businesses. In short, clean energy technologies represent a very cost-effective investment in public health.

Some 72% of the Federal government's investment in the research, development, and demonstration of pollution prevention technologies is made by the Department of Energy, with the largest share provided by the Office of Energy Efficiency and Renewable Energy. This article will examine the connections between air pollution and health problems and will discuss what the Department of Energy is doing to prevent air pollution now and in the future.

One of the largest and most cost-effective set of investments aimed at improving public health through a prevention-based approach is being made by neither the Department of Health and Human Services nor the Environmental Protection Agency (EPA). The Department of Energy's (DOE) Office of Energy Efficiency and Renewable Energy each year invests more than half a billion dollars in the development and deployment of technologies to prevent pollution. Energy choices made in the United States over the last several decades in manufacturing, transportation, and construction are having a significant effect on today's air quality. Likewise, the energy choices and investments that we make today will have profound consequences for future environmental quality, which should be of great concern to public health professionals.

In the past few years, a number of major studies and survey reports have documented the growing body of evidence establishing the link between air pollution and public health. What is less well known is that the vast majority of the pollutants most clearly linked to increased morbidity and mortality are energy related. In 1994, energy-related emissions—such as those from power plants, vehicles, and industry—accounted for more than 90% of emissions of sulfur dioxide, carbon monoxide, nitrogen oxides and volatile organic compounds, and for most of the smallest particulates (under 2.5 microns in diameter).[1,2]

The production and use of energy does more environmental damage than any other economic activity. In a world of ever-increasing population seeking an ever-increasing standard of living, reconciling environmental, public health, and economic goals will require that we use our resources much more efficiently. Instead of controlling the effects of pollution after it is already generated, we must take a new approach to pollution, one that is familiar to the public health community but has not been the traditional approach in the environmental field: prevent it from occurring in the first place.



DOE has the single largest set of resource efficiency and pollution prevention investments in the world. These investments not only help the environment by preventing the emission of millions of tons of pollution, they lower the cost of using energy, thereby saving consumers and businesses billions of dollars a year. In other words, these technologies achieve net economic savings for society, and we get emission reductions and improved public health as a free benefit.

The first half of this article will examine the connections between air pollution and respiratory health problems, and the second half will discuss what DOE is doing to prevent air pollution now and for the future.

The Relationship between Air Pollution and Respiratory Health Problems

Lung disease, which affects more than 10% of the population, is the third leading cause of death in the United States and among the fastest growing.[3] Annual deaths from lung cancer increased nearly 20% from 1979 to 1992.[3] Studies have confirmed the link between air pollution, and increases in respiratory-related hospitalizations and visits to doctors.[4,5]

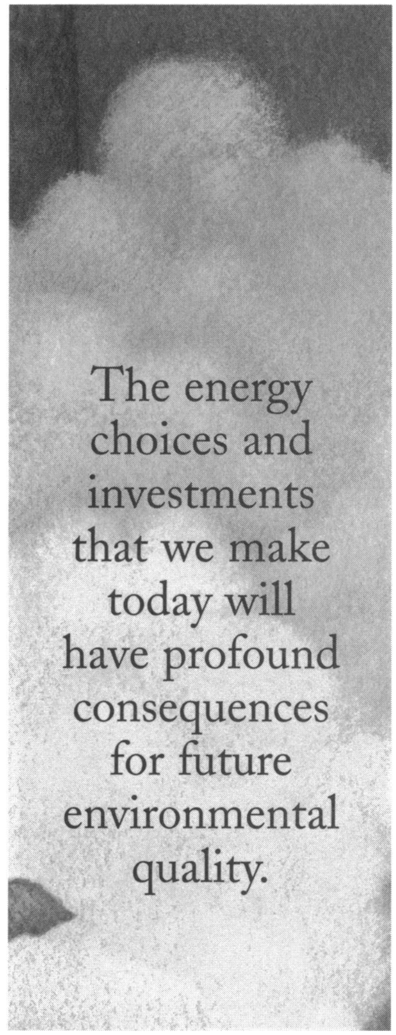
The direct health care costs of respiratory disease combined with the indirect costs (such as lost productivity) are staggering. The total annual cost for lung disease has been estimated to exceed $60 billion.[3] Urban areas are especially hard hit. In Los Angeles alone, the cost of air pollution is estimated at $9.8 billion per year in medical expenditures and lost time from work.[6] And the costs are rising. Total estimated costs of asthma-related illnesses have more than doubled since 1985, from $4.5 billion to $9.5 billion.[3,7]

The 1970 Clean Air Act and its amendments establish a set of health-related national ambient air quality standards for six air pollutants (sometimes called criteria pollutants) that are persistent and widespread: particulate matter, sulfur dioxide (SO_2), nitrogen dioxide and related compounds (NO_x), ozone, carbon monoxide, and lead. This article focuses on the first five.

Particulates. A number of recent epidemiological studies on the health effects of air pollution involve the effects of particulates, a broad term encompassing thousands of types of chemicals. The particulates most widely studied are those particles with an aerodynamic diameter of 10 microns or less (PM10) and those with a diameter of 2.5 microns or less (PM2.5). Also known as fine particles, PM2.5 includes sulfate and nitrate aerosols. Fine particles are capable of getting through the natural filtering system of the nose and throat and can penetrate deep into the human lung and do serious damage.[2] Although chemically heterogeneous, particulates as a group are generally acidic. Sulfate aerosols, which make up the largest percentage of fine particles in the eastern United States, come from sulfur dioxide produced by coal and oil combustion.[8] Nitrate aerosols which comprise about one-third of fine particulates in Los Angeles come from vehicle emissions.[9]

In 1993, Harvard researchers published results of a 16-year, six-city study that tracked the health of over 8000 individuals for a period of 14 to 16 years. Researchers observed a nearly linear relationship between particle concentrations in the air and increased mortality rates, indicating that even relatively low levels of air pollution (fine particles) contributed to adverse health effects. The risk of early death in high-level areas was 26% higher than in areas with the lowest levels of pollution, even after controlling for other risk factors such as smoking and occupation. The study found that the risk of cardiopulmonary disease in high level areas was 37% higher than in low level areas.[10]

In 1995, another study by the American Cancer Society and Harvard Medical School, involving over 550,000 people living in 151 cities tracked for more than seven years, found a 17% increase in mortality risks in areas with higher concentrations of fine particles relative to those in areas with lower concentrations. Researchers also found a 15% increase in mortality risks in areas with higher concentrations of sulfate aerosols. The risk of death from cardiopulmonary disease was 31% higher in the most polluted cities. For subjects who had never smoked, the increased risk of premature death from cardiopulmonary disease was 43%. For women who resided in the more polluted cities and had never smoked the risk of cardiopulmonary disease increased 57%.[11]



A 1996 meta-analysis by the Natural Resources Defense Counsel (NRDC) extrapolated the results of the earlier epidemiological studies to estimate the extent of premature death due to particulate air pollution in 239 U.S. cities. The NRDC study estimated that 64,000 people may die prematurely from heart and lung disease attributable to particulate air pollution, with lives being shortened an average of one to two years in the most polluted cities.[11]

In their gaseous state, SO_2 and NO_x also have adverse health impacts.[9] Oxides of sulfur can cause injury to the respiratory system.[12] It is well documented that asthmatics are especially sensitive to even relatively low SO_2 exposure, as measured by increased airway resistance and reduced lung function.[9] Nitrogen dioxide can irritate the lungs and lower resistance to respiratory infections.[1,13] Children exposed to high levels of nitrogen dioxide may be more susceptible than other children to respiratory tract infections.[13,14] Nitrogen oxides are also an important precursor to both ozone and acid rain.[15]

Ozone. Ozone was first identified as a key component of urban air pollution (smog) in Southern California in the 1950s. Today, ozone (O_3) is one of our most prevalent air pollution problems. Ozone is an example of a class of pollutants called photochemical oxidants that result from chemical reactions driven by heat and sunlight. Ozone concentrations tend to peak daily in the afternoon, and seasonally during the late spring and summer. The primary precursor pollutants are NO_x and volatile organic hydrocarbons. Combined with summertime stagnation of air masses, the pollutants cook into a chemical atmospheric "soup" and form dangerous levels of ozone.

Ozone is capable of destroying organic matter, including lung and airway tissue. Ozone acts as a powerful respiratory irritant at the levels frequently found in most of the nation's urban areas during the summer months.[9] More than 50 million Americans live in 82 ozone nonattainment areas according to the latest EPA data.[1,16] Nonattainment areas are geographic areas that do not meet the health-related primary national ambient air quality standards set by the EPA under the Clean Air Act and its amendments. According to an American Lung Association committee,[8] "During years with particularly hot summers (e.g., 1988) rates of ozone generation increase and violations of the ozone national ambient air quality standard occurred in counties with a population totalling 135 million."[14,17]

The adverse impact of ozone on health has been understood for more than a quarter of a century. In 1970, the Council on Environmental Quality reported that an increased frequency of asthma attacks occurs in some patients even on those days when hourly concentrations of ozone are well within air quality standards.[18] A growing number of studies have linked short-term ozone exposure to hospital admissions and doctor visits for asthma and other respiratory problems.[21] A June 1996 study by the Harvard School of Public Health for the American Lung Association found that exosure to ozone was linked to 10,000 to 15,000 hospital admissions and between 30,000 to 50,000 emergency room visits in 13 U.S. cities during 1993 and 1994.[4]

Other recent findings warn of increased health effects from ozone air pollution:

- Asthma attacks increase substantially with ozone levels.[19]
- Above average ozone levels increase death rates.[20]
- Ozone exacerbates allergies.[21]
- Long-term exposure to ozone may affect the severity of asthma.[22]

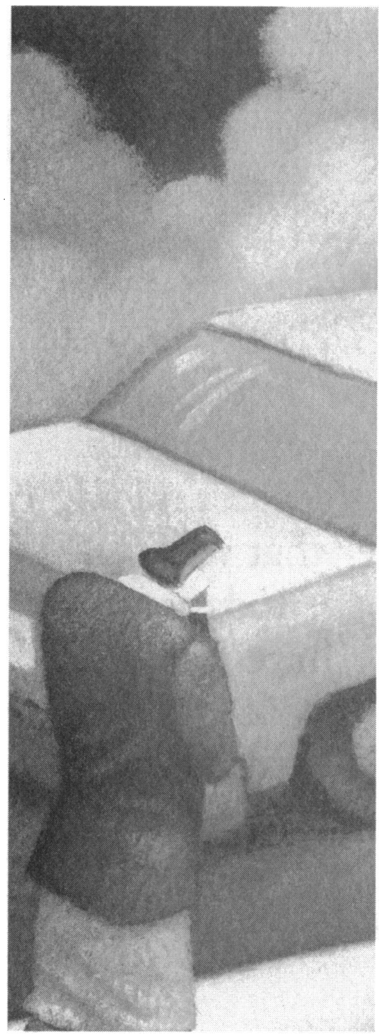
A 1993 study by the American Lung Association estimated that more than six million adults and children with asthma and more than eight million people with chronic obstructive pulmonary disease lived in areas that exceeded the Federal health standard for ozone. As many as 27 million children under the age of 13 and nearly two million children with asthma are exposed to potentially unhealthful levels of ozone.[14]

While exposure to ozone air pollution causes adverse health effects in most people, children are especially susceptible to these effects. The rate of asthma in children under 18 jumped 79% between 1982 and 1993.[23] Inner-city children suffer from asthma at twice the national average, and minorities suffer a disproportionate amount as well (see sidebar: "Groups at Special Risk").[16]

The cost to the nation is great, in terms of lives as well as economic costs. Deaths from asthma have increased more than 90% since 1979. The annual direct health care cost of asthma is approximately $6.9 billion.[3] Indirect costs, such as lost productivity, have been quantified at about $2.6 billion, with asthma accounting for an estimated three million lost work days annually.[7]

Carbon monoxide. When carbon monoxide is inhaled, it is absorbed by the blood more readily than oxygen and causes body tissues to be deprived of oxygen. Carbon monoxide (CO) combines chemically with hemoglobin, the oxygen-transporting element of human blood, at a rate far greater than that of oxygen itself.[24,25] At high levels, death is certain.[9] Studies show that exposure to 10 parts per million of CO for approximately eight hours may dull mental performance.[18] Such levels of CO are commonly found in cities throughout the world. In heavy traffic situations, levels of 70, 80, or 100 parts per million are not uncommon.

Nearly 20 million people are exposed to harmful, nonfatal levels of CO, causing a wide variety of ailments including headaches, nausea, fatigue, dizziness, and exacerbation of various heart conditions including the onset of heart attacks.[8] Moreover, it is believed to impose an extra burden on those already suffering from anemia and chronic lung disease.[8,9]



Multiple pollutants. While each of the above pollutants have been documented to cause adverse health impacts in isolation, most of the time people will be exposed to more than one of them at a time. Indeed, in urban settings in the summer, one might well be subjected to all of them simultaneously. One would expect that the negative health effects of multiple exposures would at the very least be additive, and it would certainly not be surprising if there were a more negative synergistic effect. Only a limited number of studies have been done in this area, but those results are ominous.[9] One clinical study exposed asthmatic young women to ozone, to sulfur dioxide, and to both sequentially. It was the third condition, in which ozone exposure was followed by sulfur dioxide exposure, that triggered bronchial reactions.[26]

The Energy Solution: Pollution Prevention

Our energy choices in a number of sectors of the economy have had a profound effect on air quality and public health. Consider transportation. An average car travels some 100,000 miles over its life, consuming over 3000 gallons of gasoline and discharging tons of air pollutants. Vehicles are responsible for a large fraction of the air pollution in urban areas around the world. That will only worsen as the world's fleet of 500 million cars doubles to one billion cars by 2030.

At the turn of the century, steam, electric, and internal combustion engines were all competing for the emerging automobile market. If large quantities of oil had not been discovered at the same time, it is quite possible that alternative kinds of fuels and propulsion would have emerged. Vehicle exhaust controls helped curb emissions, as did Federal fuel efficiency standards. But those gains have been outstripped by trends of more cars being owned per household and cars being driven longer. Clean fuels and technologies still struggle in a market dominated by cheap gasoline and a political environment that is ambivalent about the Federal government's role in encouraging technology innovation.

In the early 1980s the Reagan Administration cut funding for the renewable energy program by 90%, slowing down the development and introduction of nearly pollution-free power generation technologies immeasurably. Similarly deep cuts in Federal funding for energy-efficient transportation, industrial, and building technologies delayed or killed the introduction of hundreds of clean technologies into the marketplace. Federal funding for pollution prevention did not begin to increase again until the early 1990s.

Many other national decisions have had adverse consequences for the environment. For example, regulatory choices in the 1970s slowed the expansion of natural gas as a fuel for electric power generation. This delayed the more widespread use of the cleanest fossil fuel.

Given our past energy choices, we are faced today with a tremendous burden of energy-related pollution. Fine particles, 2.5 microns or less in size, are chiefly produced by coal-fired power plants and by combustion of fossil fuels in transportation and manufacturing. More than 90% of sulfur dioxide emissions are energy related, coming primarily from the burning of coal and oil in utility and industrial operations. Nearly 90% of carbon monoxide emissions are energy related, mostly from vehicular traffic. More than 95% of nitrogen dioxide emissions are derived from fossil fuel combustion, arising principally from motor vehicles, power plants, and industrial sources. Ozone is not emitted directly but is a byproduct, principally of emissions of volatile organic compounds (more than 90% of which are energy related, mostly from vehicles, and industrial processes) and of oxides of nitrogen.[1]

The conclusions are clear. Air pollution has numerous and severe adverse public health impacts. If we are to prevent those impacts, we must make our energy production and consumption more efficient and cleaner. Moreover, we must act soon. While energy use was flat in the 1980s, and some energy-related emissions (such as SO_2 emissions) have declined due to the Clean Air Act, U.S. energy consumption has risen 15% since 1990, fueled by population and economic growth, and some energy-related emissions (for example, NO_x) have begun to rise. The Energy Information Administration projects that U.S. energy consumption will rise by a third over the next two decades. Globally, population growth, urbanization, and industrialization, especially in the developing world, are combining to create an explosion in energy consumption and energy-related emissions. Worldwide energy use could double over the next three to four decades.

To prevent the severe public health impact of air pollution, we must make our energy production and consumption more efficient and cleaner.

In the face of such growth in energy demand, we can no longer pursue only the traditional approach to the environment: cleaning up pollution after the fact or safely disposing of it in the land, water, or atmosphere. We need to dramatically reduce or prevent pollution from occurring in the first place, in the generation of electricity and in the use of energy in transportation, industry, and buildings. The DOE is responsible for 72% of the Federal investment in the research, development, and demonstration of pollution prevention technologies.[27]

The largest set of these programs are in the Office of Energy Efficiency and Renewable Energy. Over the next decade and a half, these programs hold the prospect of preventing a significant amount of pollution while dramatically lowering the nation's energy bill (see Table). The full spectrum of DOE programs aimed at reducing air pollution cover a broad range of supply and demand technologies.

Clean energy supply. Clearly fossil fuel use is going to increase globally for decades under even the most optimistic scenarios for the use of alternative energy sources. Therefore we need to develop and deploy technologies for burning fossil fuels more cleanly and expand the use of the cleanest burning fossil fuel, natural gas. Natural gas is the premier hydrocarbon in our country's fossil-based energy portfolio, in part because of the efficiency and economic and environmental benefits of natural gas, but also as part of our effort to reduce our rising national dependence on imported oil. For these reasons, the Department has been a leader in supporting increased natural gas use in electric generation, in industrial cogeneration and process systems, in residential and commercial heating and cooling technologies, and in transportation. Particularly promising are fuel cells, which are compact modular devices that generate electricity and heat with high efficiency and virtually no pollution. Fuel cells run on hydrogen converted primarily from natural gas. Together with small gas-fired turbines, they will help lead the expanded use of natural gas and are essential for the growth of a more distributed and cleaner global electricity system.

At the same time, the prospects for renewable energy resources—such as solar, wind, and geothermal—are very promising. They, too, have the potential to reduce the generation of polluting byproducts. In one of two planning scenarios recently developed by Royal Dutch/Shell, the most profitable oil company in the world, renewable energy provides nearly half the world's energy in four to five decades.[28] In a quiet energy revolution that has received little attention in the press, the costs of renewable power have come down dramatically.[29]

For example, since 1980, research funded by DOE has brought down the cost of photovoltaic (PV) electricity from sunlight by a factor of five to under 20 cents per kilowatt-hour. This price is already competitive for developing countries that haven't yet built an extensive and expensive electricity grid. The sales of PVs have been rising steadily, and reached $300 million last year. With continued research, development, and economies of scale from increased market share, PV electricity will continue to decline in price for decades. PVs may have a market of $300 billion per year in the middle of the next century, if Shell's scenario proves true.

What is exciting about the emergence of renewable energy and fuel cells as major providers of energy is the possibility of realizing the dream of nearly pollution-free energy in the coming decades, at prices competitive with traditional power plants. As is the case with most longer-term research and development efforts, we cannot know for sure today which specific energy technologies will be successful, which is why the Department pursues a variety of paths simultaneously. We can only be sure that there will be a multitrillion-dollar market for advanced power generation technologies in the coming decades and that environmental and public health concerns will increasingly be factored into decisions about what kind of power to use.

Even with increased use of electricity from natural gas and renewable energy technologies in the coming decades, the nation and the world will be faced with significant environmental problems. Each sector of our economy will be challenged to operate more efficiently and cleanly as economic growth fuels increases in the demands for energy.

Cleaner manufacturing. The industrial sector will continue to be the major source of hazardous and toxic waste, and the vast majority of that pollution will come from a handful of very energy-intensive industries, most of which have historically spent far less than the rest of the manufacturing sector in research and development. The half dozen most energy-intensive industries in the country—pulp and paper, chemicals, steel, aluminum, petroleum refining, glass, and metal casting—account for 80% of the energy consumed in U.S. manufacturing, 80% of the toxic waste, and 95% of U.S. hazardous waste. They represent the biggest opportunities to increase energy and resource efficiency while reducing pollution. The public health benefits of reducing toxic and hazardous waste emissions are an added bonus.

Beginning in the early 1980s, deep cuts in Federal funding delayed or killed the introduction of hundreds of clean technologies into the marketplace.

That's why DOE began partnering with these industries two years ago to create industry visions and technology road maps: the former lays out the industry's vision for a low-polluting, highly energy-efficient, and very economically competitive factory or industry of the future, and the latter is a research timeline for developing the technologies needed to achieve this vision. This Industries of the Future program has already had startling success.

According to a trade magazine of the pulp and paper industry, the industry's vision, Agenda 2020, is helping to demonstrate to EPA that a prevention-based strategy can be a better way to meet environmental standards.[30] This may result in a final set of EPA standards with substantially reduced compliance costs, from $11.5 billion down to $3–$4 billion. This from a DOE program costing just a few millions of dollars a year.

One government-supported project has helped reduce glassmaking emissions of nitrogen oxides by 90% while cutting furnace energy use 25%; it is now used in manufacturing 15% of all glass made in the United States. Another technology, a process for de-zincing scrap steel, provided the breakthrough that industry needed in order to recycle 10 million tons of scrap metal annual. By the year 2005, electrochemical de-zincing could reduce the cost of raw materials $160 million per year, save 50 trillion BTUs of energy, and provide 75,000 tons of inexpensive zinc.

The nation with the first businesses to make the shift to pollution prevention will acquire several unique benefits. Its businesses will become more competitive since their costs for purchasing resources and disposing of waste will be lower.[31] That nation will capture the lion's share of an enormous global market for clean technology and environmental services. But most important, it will reap the benefits of improved public health at home.

Cleaner transportation. As much as 80% of urban air pollution is caused by transportation energy use. Energy-efficient transportation and alternative fuel technologies can substantially cut these emissions, improving local environmental quality and cutting health care costs as well.

The DOE's research efforts include advanced transportation technologies to use fuel much more efficiently with far fewer emissions, such as hybrid vehicles that combine an advanced internal combustion engine with an energy storage device. The Department recently developed an advanced natural gas vehicle with a 300-mile range, twice the range of existing natural gas vehicles, and we are working on even more advanced ones, including a gas turbine engine. The Department is developing advanced batteries as well as zero-emission fuel cells for use in transportation. At the same time, the Department is working to advance the infrastructure for alternative fuel vehicles to run on natural gas, electricity, and renewable biofuels.

These technologies will have another benefit, reducing dependence on imported oil. The United States currently imports about half its oil, which adds $50 billion to our trade deficit annually. Without more efficient transportation and alternative fuels, domestic oil consumption is projected to rise steadily, yielding an annual trade deficit in oil in excess of $100 billion a year by 2010.

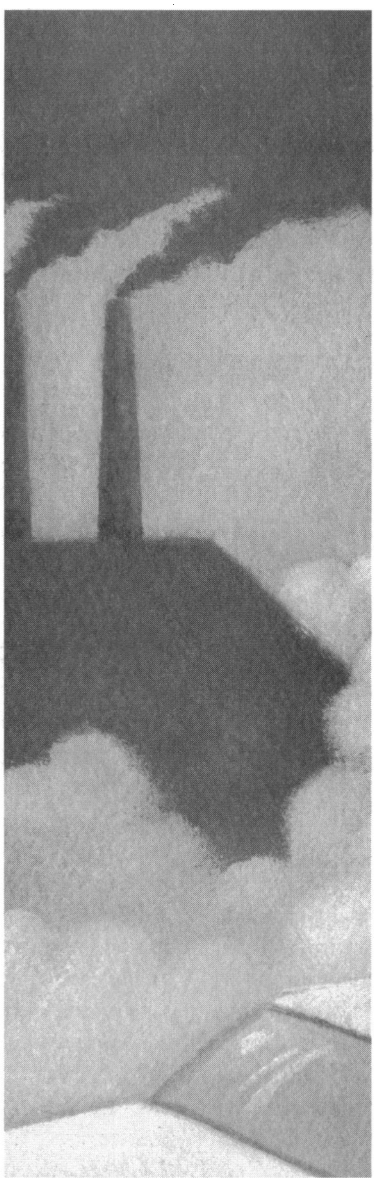
Cleaner buildings. Buildings account for one-third of all energy use and two-thirds of all electricity use, contributing $200 billion to the nation's energy bill. Developing and deploying energy-efficient technologies could dramatically reduce emissions and improve public health while cutting energy bills by one-third.

Table. Estimated pollution prevented with technologies sponsored by the Office of Energy Efficiency and Renewable Energy, Department of Energy

Pollutant	Annual reductions (U.S. tons) 2000	Annual reductions (U.S. tons) 2010	Cumulative reductions (U.S. tons) 1997–2010
SO_2	70,000	370,000	2.1 million
NO_x	270,000	1,290,000	7.4 million
CO	1,100,000	5,400,000	31 million

SOURCE: Office of Energy Efficiency and Renewable Energy, U.S. Department of Energy.

The Department's research efforts include developing advanced lighting, window, heating, and cooling technologies as well as integrated design techniques for new building construction that can reduce energy consumption and associated emissions 25% or more with a lower first cost and dramatically reduced construction waste. At the same time, we are working to deploy existing energy-efficient technologies through partnerships with the states, the U.S. Conference of Mayors, and Federal energy managers, among others.



Research has shown that these technologies not only reduce energy bills but can also increase worker productivity.[32] For example, one post office that underwent an energy efficiency upgrade found that its productivity in sorting mail jumped 7%, which resulted in additional savings six to eight times greater than the energy savings. In other instances, absenteeism dropped substantially with new energy-efficient building technologies or greater use of natural sunlight.[32]

Another key area of research is in the mitigation of urban heat islands. Most cities have dark surfaces and less vegetation than their surroundings, creating a "heat island" that affects climate, energy use, and habitability. For individual buildings, dark roofs and inadequate shading raise summertime air-conditioning demands, which increases the pollution caused by power generation. Heat islands raise the temperature of many cities by five degrees Fahrenheit, which has significant environmental and public health costs as ozone smog is typically created only in hot weather. Finally, the urban heat island exacerbates all heat waves, contributing to the dozens of summer fatalities that cities experience during the summer.

Cooling the city is straightforward. Buildings need shade trees for their southern exposure. Buildings, roads, and parking lots require light-colored surfaces. Cooler roads might have a slightly higher first cost, but probably will last 20% to 50% longer because of reduced thermal wear and reduced ultraviolet damage.

Over a 20-year period, trees can be planted cheaply and roads, roofs, and parking lots replaced by cooler surfaces during the course of normal maintenance. This nominal additional cost would, by the year 2015, save the country $10 billion a year in energy and environmental costs. In Los Angeles alone, this would lower air conditioning bills by $360 million, eliminate as much pollution as is generated by three-quarters of the cars on the road, and reduce the creation of ozone smog by 10% or more.[33]

Clearly, urban heat island mitigation is an important effort. The Department is working to help develop and/or identify the best roofing and paving materials, to use computer models to determine the optimal approach to cooling a city, and to disseminate information around the nation.

Research and development of energy-efficient technologies are among the most cost-effective investments the Federal government makes. According to a GAO analysis, just two technologies developed by the DOE—software to help architects design more energy-efficient buildings and an energy-saving compressor for refrigerators—have saved consumers and businesses $8 billion.[34] Three other building technologies advanced by the Department, energy-efficient windows, lighting, and oil burners, have a net present value of more than $3 billion in energy savings. Yet the entire amount of Federal support for energy efficiency research and development from 1978 to 1996 came to only $7 billion. So just five successes among hundreds have paid for all that research. And these five technologies alone have prevented 1,000,000 tons of sulfur dioxide, 300,000 tons of oxides of nitrogen, and 25,000 tons of particulates from being generated and released into the atmosphere.

Conclusion

Air pollution causes severe public health problems, and the vast majority of air pollution is energy related. The nation and the world will be experiencing large increases in energy use in the coming decades. If this increase is achieved through traditional resource- and pollution-intensive methods, environment problems at an urban, regional, and global level will be seriously aggravated, at a terrible cost to human health and quality of life.

Pollution prevention and resource-efficient technologies improve the environment while lowering the energy bills of consumers and businesses. They are the key to sustainable development and offer the hope of minimizing or avoiding the risk of global climate change while saving money.

The choice of whether we move toward pollution prevention or stick with business as usual is being made today. Globally we are investing well over a trillion dollars a decade in new energy technology and infrastructure—and we will live with the consequences of these choices for decades to come. We have two paths. One is sustainable, profitable, and environmentally sound. The other is short term, costly, and potentially devastating from an environmental and human health perspective.

The DOE has the largest set of pollution prevention investments in the world, most in the energy efficiency and renewable energy program. While the Bush and Clinton Administrations supported steady increases in funding for these crucial technologies, Congress cut the budget by one-third last year and is proposing another comparable cut this year, which would undermine U.S. efforts to advance clean technologies at home and retain world leadership in this crucial area. These investments provide cost-effective alternatives to command and control regulation and form a vital part of our nation's environmental and public health strategy. They cannot be abandoned when our nation needs them most.

Both authors are with the U.S. Department of Energy. Dr. Romm, a physicist, is the Acting Principal Deputy Assistant Secretary for Energy Efficiency and Renewable Energy. Ms. Ervin is the Assistant Secretary.

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GROUPS AT SPECIAL RISK

Children are at risk. While exposure to air pollution causes adverse health effects in most people, children are especially susceptible. Children spend much more time outdoors (an average of 50% more than adults), particularly in the summertime when ozone levels are the highest. Children spend more time engaged in vigorous activity. Such activity results in more air, and therefore more pollution, being taken deep into the lungs.

Nearly 24 million children under age 13 in the United States live in areas with unhealthy exposure to particulate matter.[35] Researchers with the EPA and the Harvard School of Public Health studied nearly 1850 school children in six U.S. cities. When ozone (smog) went up, some children coughed more; when ozone and sulfur dioxide levels went up, some children suffered from wheezing, chest pain, coughing, and phlegm. When particulate pollution increased, all children suffered symptoms—even when the pollution was substantially lower than the current national danger standard.[36] Another study found that hospital admissions of children for asthma were consistently higher than average the day following elevated ozone levels.[37]

Air pollution has been linked to asthma, acute respiratory infections, allergies, and other ailments in children. Among chronic diseases, asthma ranks first in the number of children affected, first in making kids miss school, and first in sending them to the hospital. Scientists are concerned that children who experience more frequent lower respiratory infections may be at greater risk of lower-than-normal lung function later in life.[18] Inner city children have twice the national average rate of asthma (8.6% vs. 4.3%).[38]

Minorities are at risk. A disproportionate number of African Americans and Hispanics, because of their concentration in central city areas, are particularly hard hit by ambient air pollution. Thirty-one percent of Hispanics, 20% of African Americans, and only 12% of whites live in the 29 U.S. counties designated as nonattainment areas for three or more key pollutants.[39]

Thus it is not surprising that minorities are disproportionately affected by asthma. In 1993, the prevalence rate of asthma among African Americans was 22.3% higher than among whites. Although African Americans represent 12.4% of the U.S. population (one in eight), they account for 21% (one in five) of deaths due to asthma. And African Americans are four times as likely as whites to be hospitalized for asthma.[40]

The elderly are at risk. Older people often are frailer and weaker and significantly less resistant to infection than they were earlier in life. Some lung function decline appears to be part of the natural aging process. Air pollutants aggravate susceptibilities to influenza and pneumonia, of which older people are the primary victims. Many elders suffer chronic respiratory or heart conditions that may be markedly worsened by the effects of air pollution. A number of epidemiological studies have linked particulate matter with premature death and hospital admissions for cardiovascular and respiratory problems in the elderly.[41-44] Over 11 million elderly people in the United States live in areas with unhealthy exposure to particulate matter.[35]

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