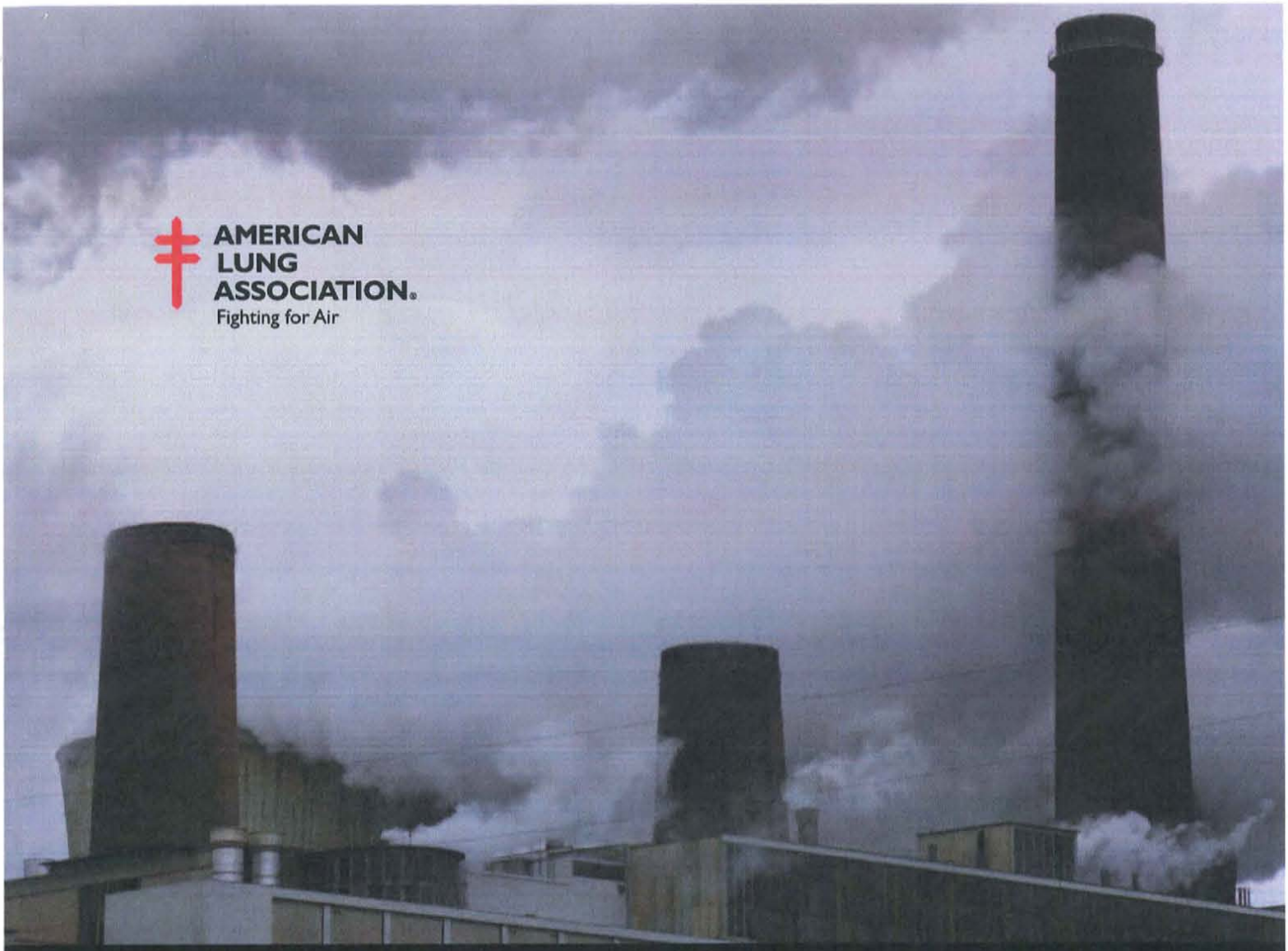

AMERICAN LUNG ASSOCIATION.
Fighting for Air

Toxic Air

The Case for Cleaning Up Coal-fired Power Plants

March 2011

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Toxic Air

The Case for Cleaning Up Coal-fired Power Plants

Overview

Coal-fired power plants produce electricity for the nation's power grid, but they also produce more hazardous air emissions than any other industrial pollution sources. The quantity is staggering. Over 386,000 tons of 84 separate hazardous air pollutants spew from over 400 plants in 46 states.[1] Their emissions threaten the health of people who live near these plants, as well as those who live hundreds of miles away. Despite the concentration of these plants largely in the Midwest and Southeast, their toxic emissions threaten the air in communities nationwide.

In 1990, Congress took action to protect Americans from these airborne hazards. Congress added special requirements in the Clean Air Act to require the U.S. Environmental Protection Agency to clean up toxic substances. Now, at last, over twenty years later, EPA is poised to announce steps on March 16, 2011 to finally require the electric utility companies to clean up these dangerous emissions.

Toxic Air: The Case for Cleaning Up Coal-fired Power Plants highlights the threats from the hazardous air pollutants from electricity generators and explains why cleaning up these plants is essential. More details are in a longer white paper, *Emissions of Hazardous Air Pollutants from Coal-fired Power Plants*, available at www.lungusa.org/ToxicAirReport. The American Lung Association commissioned the analysis from Environmental Health and Engineering, Inc. in Boston. That paper describes the risks and the cleanup equipment in greater detail. Also, on the website is a separate summary table that lists the power plants in each state, provides information on the coal that they burn and any equipment they have in place to reduce hazardous air pollutants.

Burning coal creates harmful pollution

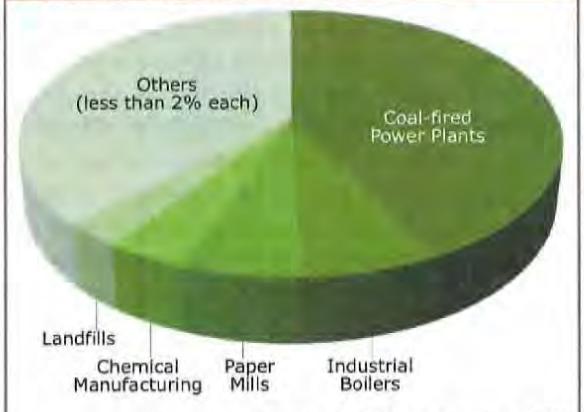
The process of burning coal releases chemicals into the atmosphere that threaten not only the air Americans breathe, but the water they drink, the soil they live on and the food they eat. EPA classifies many of these chemicals as "hazardous air pollutants" or "air toxics," a category that means they are known or reasonably expected to harm human health or the environment or both.

Hazardous air pollutants from coal-fired power plants include:

- Acid gases, such as hydrogen chloride and hydrogen fluoride;
- Benzene, toluene and other compounds;
- Dioxins and furans;
- Formaldehyde;
- Lead, arsenic, and other metals;
- Mercury;
- Polycyclic Aromatic Hydrocarbons (PAH); and
- Radioactive materials, like radium and uranium.[2,3]

Researchers have found these toxic emissions cause a dangerous array of harm to human health as shown in Table 1.[3] These emissions can make breathing difficult and can worsen asthma, chronic obstructive pulmonary disease, bronchitis and other lung diseases. These pollutants can cause heart attacks and strokes, lung cancer and other cancers, birth defects and premature death.

Coal-fired Power Plants are a Major Source of Hazardous Air Pollutant Emissions



Source: U.S. EPA, National Emissions Inventory, 2007[2]

Facts about Hazardous Air Pollutants from Coal-fired Power Plants

386,000
tons per year produced

84
different hazardous air pollutants

Over 40%
of U.S. mercury emissions

76%
of U.S. acid gas emissions

Source: U.S. EPA, National Emissions Inventory, 2007[2]

These pollutants threaten essential life systems. Acid gases are corrosive and can irritate and burn the eyes, skin, and breathing passages. Long term exposures to metals have the potential to harm the kidneys, lungs, and nervous system. Exposures to a handful of the metals and dioxins in coal-fired power plant emissions increase the risk of cancer. Specific forms of arsenic, beryllium, chromium, and nickel have been shown to cause cancer in both human and animal studies. Table 1 also identifies those pollutants that have long-term impacts on the environment because they accumulate in soil, water and fish.[3]

Coal-fired power plants supplying electricity to the grid are the biggest emitters of airborne mercury among all industrial sources. The pair of maps on page 4 shows the locations of coal-fired power plants and how they can lead to high mercury levels in the local and regional areas.[4,5] Mercury is associated with damage to the kidneys, liver, brain, nervous system and can cause birth defects.[3]

Table 1 Health and Environmental Issues Associated With Hazardous Air Pollutants (HAP) Emitted By Electric Generating Stations Fueled By Coal

Class of HAP	Notable HAPs	Human Health Hazards	Environmental Hazards
Acid Gases	Hydrogen Chloride, Hydrogen Fluoride	Irritation to skin, eyes, nose, throat, breathing passages	Acid precipitation, damage to crops and forests.
Dioxins and Furans	2,3,7,8-tetrachlorodioxin (TCDD)	Probable Carcinogen: Stomach and immune system. Affects reproductive endocrine and immune system.	Deposits into rivers, lakes and oceans and is taken up by fish and wildlife. Accumulates in the food chain.
Mercury	Methylmercury	Damage to brain, nervous system, kidneys and liver. Causes neurological and developmental birth defects.	Taken up by fish and wildlife. Accumulates in the food chain.
Non-Mercury Metals and Metalloids (excluding radioisotopes)	Antimony, Arsenic, Beryllium, Cadmium, Chromium Nickel, Selenium, Manganese	Carcinogens: lung, bladder, kidney, skin. May adversely affect nervous, cardiovascular, dermal, respiratory and immune systems	Accumulates in soil and sediments. Soluble forms may contaminate water systems.
	Lead	Damages developing nervous system. May adversely affect learning, memory and behavior. May cause cardiovascular and kidney effects, anemia, weakness of ankles, wrists and fingers.	Harms plants and wildlife; accumulates in soils and sediments. May adversely affect land and water ecosystems.
Polycyclic Aromatic Hydrocarbons (PAH)	Benzo-a-anthracene, Benzo-a-pyrene, Fluoranthene, Chrysene, Dibenzo-a-anthracene	Probable Carcinogens. May attach to small particulate matter and deposit in the lungs. May have adverse affects to the liver, kidney, and testes. May damage sperm cells and cause impairment of reproduction.	Exists in vapor or particulate phase. Accumulates in soil and sediments
Radioisotopes	Radium	Carcinogen: lung and bone. Bronchopneumonia, anemia, brain abscess.	Deposits into rivers, lakes and oceans and is taken up by fish and wildlife. Accumulates in soils and sediments and in the food chain.
	Uranium	Carcinogen: lung and lymphatic system. Kidney disease	
Volatile Organic Compounds	Aromatic hydrocarbons including benzene, xylene, ethylbenzene and toluene.	Irritation of the skin, eyes, nose, throat; difficulty in breathing; impaired function of the lungs; delayed response to visual stimulus; impaired memory; stomach discomfort; and effects to the liver and kidneys. May also cause adverse effects to the nervous system. Benzene is a carcinogen.	Accumulates in soil and sediments.
	Aldehydes including formaldehyde	Probable Carcinogen: lung and nasopharyngeal cancer. Eye, nose, throat irritation, respiratory symptoms	

Particulate matter pollution is another deadly air pollutant from these plants.

Burning coal in these plants also produces fine particles, or particulate matter. These particles come directly from the ash and soot, but smaller particles come from chemical reactions that emitted gases undergo in the atmosphere. The smaller particles, those produced by fossil fuel combustion such as coal-fired power plants, (otherwise known as fine particles or $PM_{2.5}$) worsen asthma and bronchitis, cause heart attacks and strokes, and increase the risk of premature death. This is in part because these fine particles can travel far deeper into the lungs than larger ones that are filtered out by the nose and larger airways. Health problems from power plant emissions can occur when levels are high over a short period or at lower levels over longer time periods.[6]

Lethal Combinations

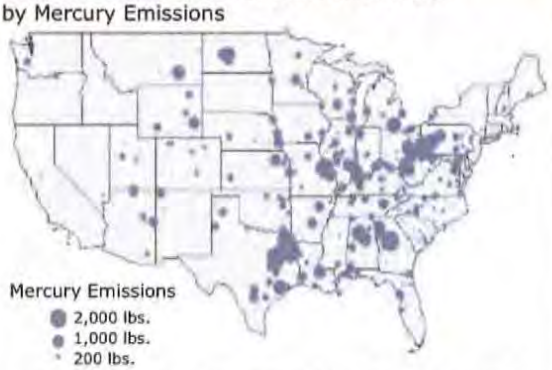
It can sometimes be difficult to link a health problem to a single air pollutant because of the complexity of the pollution mixtures. Different mixtures of pollutants can be much more dangerous than any one on its own.

The environment is also affected by these emissions. This includes such environmental degradation as the buildup of toxic metals; contamination of rivers, lakes and oceans; degradation of culturally important monuments, such as the Statue of Liberty and the Lincoln Memorial by acid rain. Acid rain reaching soil and water bodies can change their acidity or pH and alter the chemistry and nutrient balance in those environments. This can lead to changes in the types of plants, animals and microorganisms that inhabit those areas. Hazardous air pollutants also add to pollution in rivers and streams and can cause damage to crops, forests and, ultimately, to humans.[6,7]

Not all power plants are the same. There are over 400 coal-fired power plants, each with on average 2 to 3 individual boilers, supplying the electricity to the grid. Emissions vary depending on the types of coal used, the types of controls in place, and the length of time operated. Effects of the plant emissions will vary depending on the height of the stacks and their location relative to population centers, topography, and weather patterns.

Coal-fired Power Plants Contribute to Local and Regional Fall-Out of Mercury to Soil and Water

Local and Relative Size of U.S. Power Plants by Mercury Emissions



Source: M. J. Bradley & Associates. (2010). Benchmarking Air Emissions of the 100 Largest Electric Power Producers in the United States.

Source: National Atmospheric Deposition Program/Mercury Deposition Network

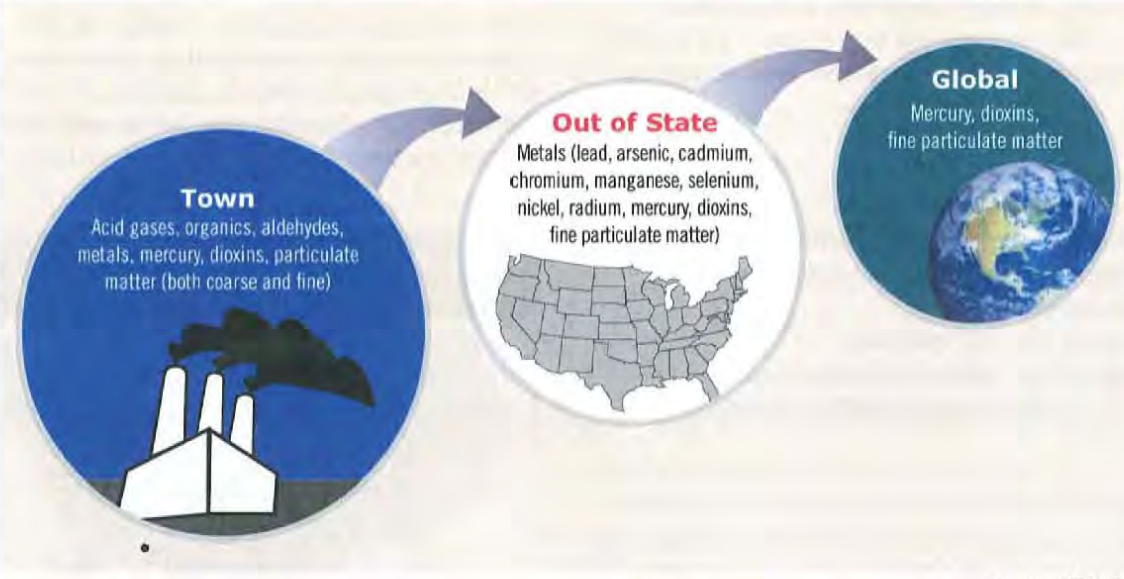
Hazardous emissions threaten health locally and at great distances. People who live nearest the smokestacks have historically borne the brunt of these hazardous pollutants. For example, acid gases, such as hydrochloric acid and hydrofluoric acid tend to settle out within a day or two, posing high risk to neighborhoods and towns nearby. Mercury and sulfur dioxide emissions from power plants also have immediate impact in the local area. Many pollutants also travel much farther and can be carried hundreds or even thousands of miles from their original source. Health effects may be experienced so far from the actual power plants that cause-and-effect relationships can only be determined through detailed analyses of relationships between emissions, transport, concentrations, exposure, and effect.[3]

Many metals, dioxins and other pollutants adhere themselves to the fine particles. They may travel with airborne particles to distant locations. These particles can remain in the air for up to a week or more, travelling long distances, being carried by winds to areas far away from the original source. Even areas which seem remote and pristine such as national parks can be affected by toxic pollutants emitted many miles away. These emissions put the quality of the air at risk both locally and across the country. They can be inhaled deep into the body as well.[6]

Some hazardous pollutants adhere to particles and travel widely.

As=Arsenic Cd=Cadmium Se=Selenium OC=Organic Compounds

Spatial Range of Impact



Source: ATSDR 2011

Who is at risk?

Everyone faces increased risk of harm from exposure to these hazardous air pollutants. However, many people face greater risk because of their age, health conditions, or exposure to the pollutants. They include:

- Children and teenagers;
- Older adults;
- Pregnant women;
- People with asthma and other lung diseases;
- People with cardiovascular diseases;
- Diabetics;
- People with low incomes;
- People who work or exercise outdoors; and
- Others with existing health problems.[6,7]

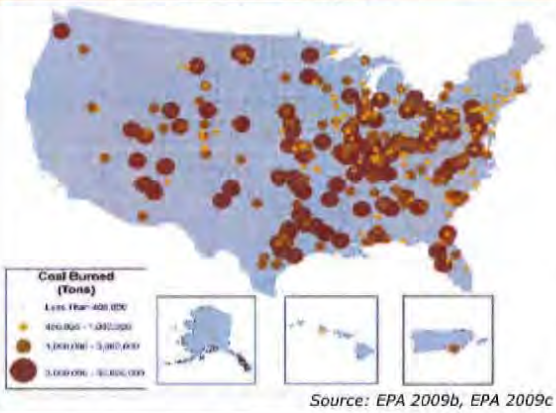
All too often those who have low incomes or who are members of ethnic or racial minorities bear a disproportionate share of the effects of air pollution because they live closer to industrial facilities, including power plants, and to high traffic areas.[8,9]

Living closer to these plants likely puts them at higher risk of exposure to the pollutants. For instance, a study of mercury pollution in eastern Ohio, found that most of the mercury pollution there came from the power plants that ring Steubenville, Ohio.[10] An analysis of the data from the 2000 Census found that 68 percent of the African Americans lived within 30 miles of a coal-fired power plant.[11] One study of five power plants in the Washington, DC, area found that African Americans and people with less than a high school education were among the groups hardest hit by pollution from these plants. Nearly 50 percent of the risks for premature mortality of power plant-related exposures were borne by the 25 percent of the population with less than high school education.[8]

Cleaning up is possible and required by law

The most effective way to reduce these emissions is to install cleanup technology that provides the "maximum achievable" clean up of the coal-fired power plants. In 1990, Congress amended the Clean Air Act to require the EPA to start work requiring sources to clean up 187 different pollutants recognized as "hazardous." EPA is finally putting these requirements in place for the electric utility industry after two decades and as a result of a court decision requiring them to act.[12]

Power Plants in 46 States Burn Coal to Supply Electricity



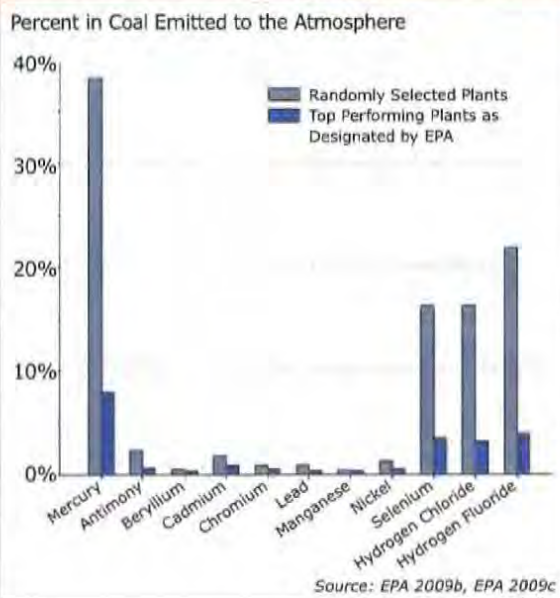
Source: EPA 2009b, EPA 2009c

What the rule will do

Coal-fired plants and oil-fired plants that produce 25 megawatts or more of electricity for sale to the grid will be required to install "maximum achievable control technology" under the new rule. New plants will be required to have the same level of technology as the best-controlled similar plants. Existing plants will be required to install controls that are at least as stringent as the top 12 percent of plants in that category. The graph below shows emission levels reported to EPA from the "top performing" plants (top 12 percent) compared to a random sampling of plants in 2010. It provides clear evidence that better controls can cut the emission of the toxic pollutants in the air.

The EPA will propose these new requirements on or before March 16, 2011. The courts have required the EPA to issue the final rules by November 16, 2011. All coal and oil-fired power plants that produce 25 megawatts of power for sale will be required to comply with this ruling, as required by the Clean Air Act. The new regulations are expected to take effect three years from the date EPA makes them final.

Top Performing Coal-fired Plants Emit Substantially Smaller Amounts of Hazardous Air Pollutants



Source: EPA 2009b, EPA 2009c

Control Technologies Are Currently Available

Control technologies to meet the requirements to clean up these pollutants currently exist. In fact, many power plants use them already. Because the pollutants are so diverse, separate equipment is needed to target the major groups. For example, scrubbers cut acid gases, sulfur dioxide and particulate matter; additional technologies work to reduce other particles; activated carbon injection curbs mercury emissions. Under this approach, the coal-fired power plants will be able to select the most cost-effective, facility-specific strategies to reduce pollutants in their emissions. Table 2 describes the technologies widely in use now that can be used to comply with this rule.[1]

More benefits from cleaning up these hazards

More good news for cleaning up these pollutants: Reducing emissions of these hazardous air pollutants will also cut emissions of other harmful pollutants. The same equipment needed to clean up the 84 hazardous emissions also lowers other harmful air pollutants, including sulfur dioxide, fine particulate matter ($PM_{2.5}$), and nitrogen oxides. Each of these three makes breathing difficult, causes asthma attacks and increases the risk of emergency room and hospital visits. But particulate matter is an even more threatening pollutant, as these microscopic particles can cause cardiovascular disease, including heart attacks and strokes, and can cause premature death.[6] Reductions in nitrogen oxides may also help reduce ozone smog, another widespread and harmful pollutant, because they are one of the key "ingredients" in producing ozone in the atmosphere.[15]

Table 2 Currently Available Control Technologies in Use for Reduction of Emissions of Air Toxics from Coal-fired Power Plants

Control Technology	Which Pollutants Are Controlled?	How Does This Technology Work?	Number (Percentage) of Plants Using This Technology
	Acid Gas Control Technologies		
Wet or Dry Flue Gas Desulfurization (Scrubbers)	HAPs: Hydrogen chloride, Hydrogen fluoride, Hydrogen cyanide, Mercury, Collateral Pollutants: Sulfur dioxide, Particulate matter	Liquid mixed with limestone is sprayed into the emission or emissions are passed through a stream of liquid mixed with lime or a bed of basic material such as limestone; reactions between sulfur and base compounds produce salts which are removed from the exhaust air stream.	**208 (46%)**
Dry Sorbent Injection (DSI)	HAPs: Hydrogen chloride, Hydrogen fluoride, Hydrogen cyanide, Collateral pollutant: Sulfur dioxide	Dry sorbent consisting of sodium bicarbonate, lime, or a similar material is blown into duct, reacts with acid gases and is captured in downstream PM controls.	**19 (4%)**
	Non-Mercury Metal Control Technologies		
Electrostatic Precipitators (ESP)	HAPs: Antimony, Beryllium, Cadmium, Cobalt, Lead, Manganese, Nickel, Particle phase organics Collateral Pollutants: Other forms of primary particulate matter	Particles are charged with electricity and collected on oppositely charged plates, particles are collected for disposal/further treatment.	**333 (74%)**
Baghouse	HAPs: Antimony, Beryllium, Cadmium, Cobalt, Lead, Manganese, Nickel, Particle phase organics Collateral Pollutants: Other forms of primary particulate matter	Emissions are passed through fabric filters and collected.	**157 (35%)**
Cyclones	HAPs: Antimony, Beryllium, Cadmium, Cobalt, Lead, Manganese, Nickel, Particle phase organics Collateral Pollutants: Other forms of primary particulate matter	Use centrifugal force to separate particulate from gas streams.	**23 (5%)**
	Mercury Control Technology		
Activated Carbon Injection (ACI)	Mercury, Arsenic, Chromium, Selenium, Dioxin and other gas-phase organic carbon-based compounds	Powdered activated carbon (similar to charcoal) is blown into the flue gas after combustion, pollutants are adsorbed by carbon and removed by PM controls	**58 (13%)**

Source: The number of plants using a specific technology was obtained from information in the U.S. Environmental Protection Agency Clean Air Markets Database and the U.S. Department of Energy, Energy Information Administration.[1]

No more delays: obey the law now

After 20 years, these electric utilities will finally be required to follow the law. No longer will these power plants be allowed to emit pollutants that are so hazardous to human health and the environment. This rule will hold power plants accountable to the same standards that other industries have been held to nationwide. Even though the Clean Air Act Amendments of 1990 clearly set out the requirement for cleaning up these toxic pollutants, the electric power industry has used various loopholes and extensions to avoid having to clean up. They have long been one of the nation's top polluters. This will be the first time there will be federal limits on air toxics from power plants. This is a huge step towards cleaning up the air we depend on and giving us back the air we deserve.

For More Information

Find more information about power plants in your state and take action to support cleaning up power plants at www.LungUSA.org/ToxicAirReport.

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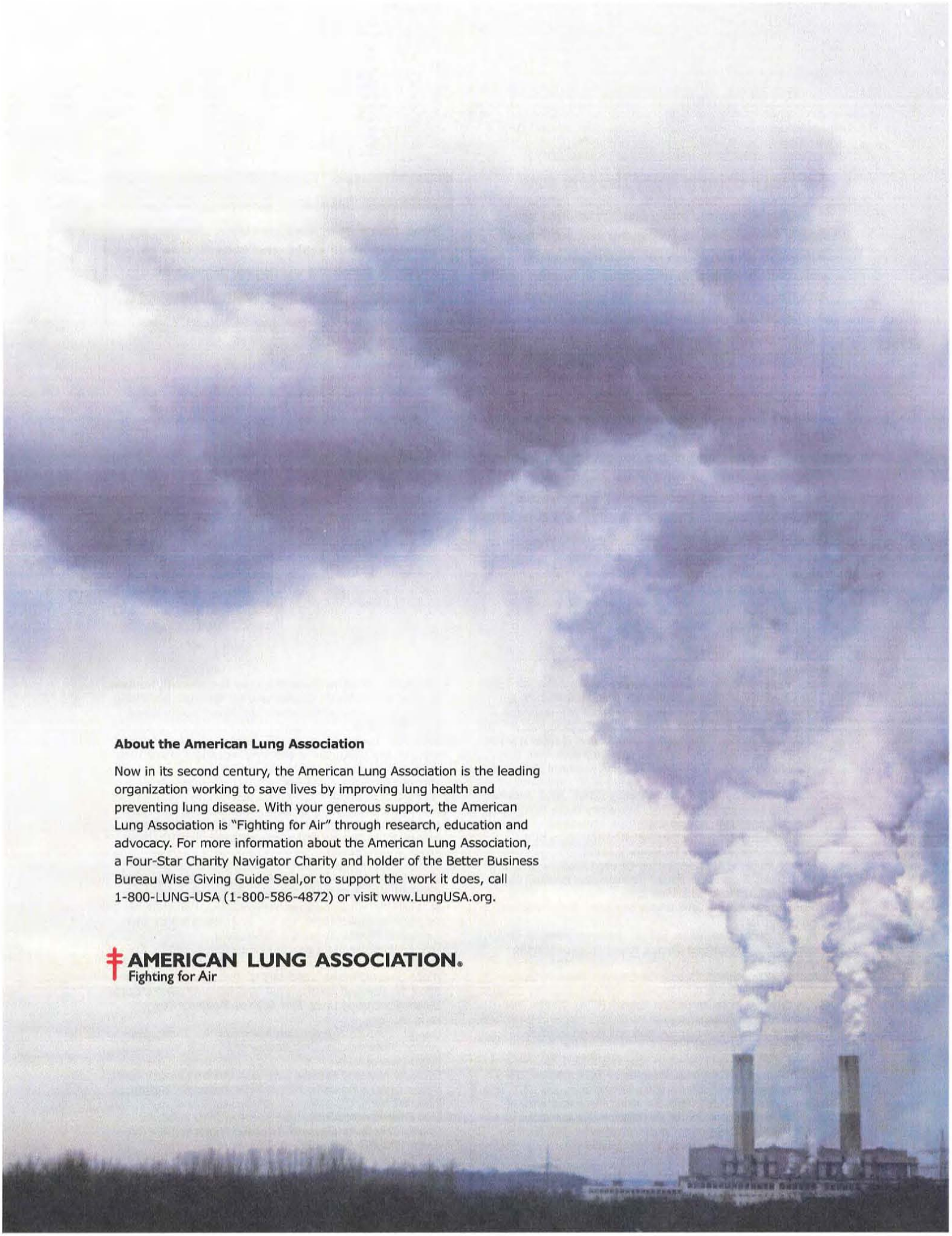

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