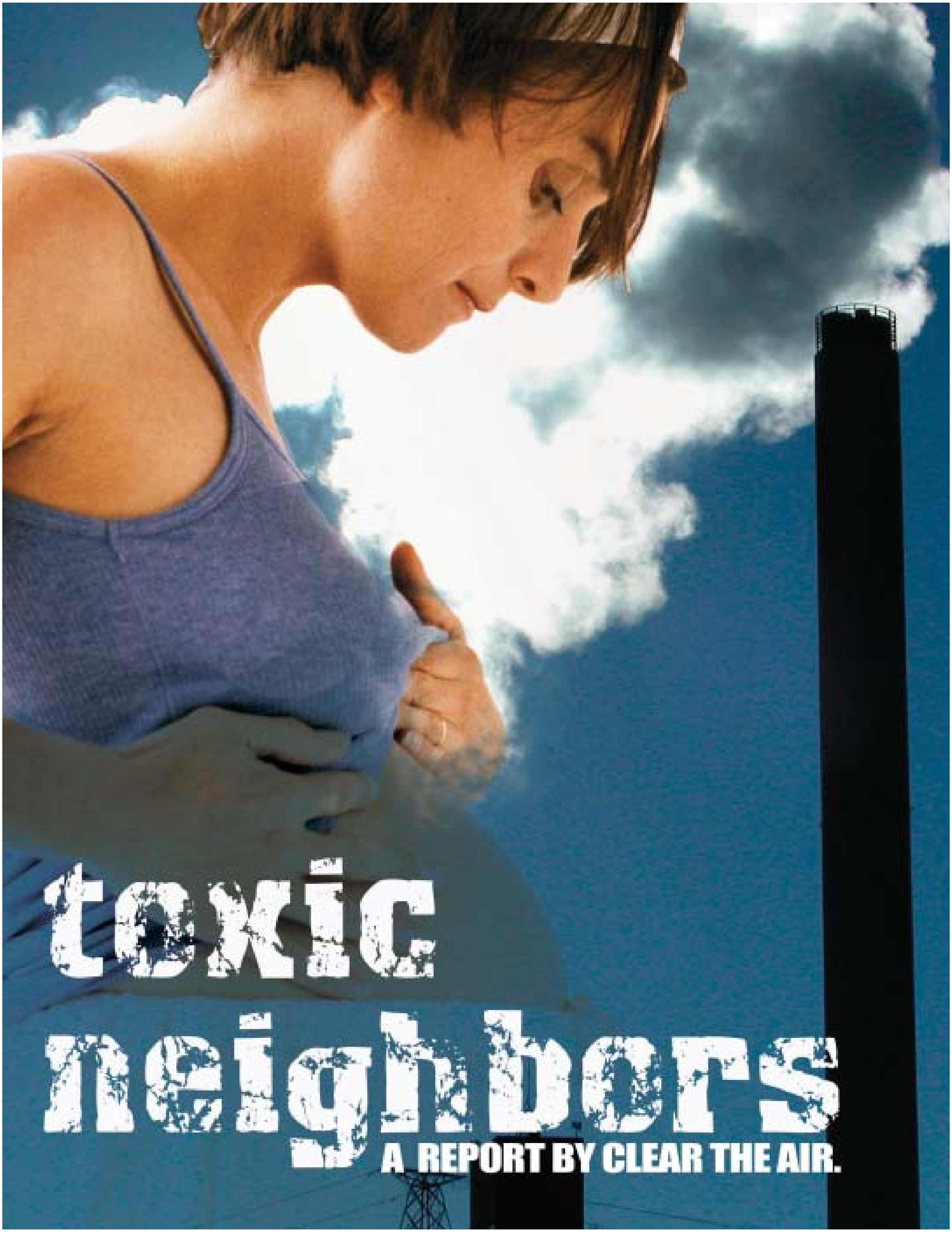
toxic neighbors
A REPORT BY CLEAR THE AIR.

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Executive Summary

Newly released U.S. Environmental Protection Agency (EPA) information on toxic air emissions shows that electric utilities were once again the biggest air polluters in the U.S. in 2001. The 2001 Toxics Release Inventory (TRI) data constitute our nation's premier database of information on how much toxic air, water, and land pollution is released each year by various industries. Coal-fired electric power plants first reported to TRI for the 1998 reporting year, and this year's inventory provides more usable information on persistent, bioaccumulative toxic chemicals (PBTs).

This report is an in-depth analysis of the quantity and nature of toxic pollution from coal-burning power plants. It demonstrates that discharges and emissions from electric utilities occur at levels that raise serious public health concerns. It also shows the role of special pollution exemptions that allow the electric power industry to continue to release much higher levels of toxics each year than would be permitted if controls were installed.

Although mercury and mercury compounds have historically been reported in TRI, the threshold – the weight metric triggering the reporting requirement – was too high to capture electric utility mercury air emissions. For 2000, this threshold was lowered, and a plant-by-plant accounting of mercury emissions from power plants became available. The 2001 data confirm that coal-fired power plants continue to be the largest industrial source of mercury air emissions in the United States and show that electric utilities are the largest industrial source of airborne dioxin and dioxin-like compounds. Mercury is known to affect the development of a child's brain and nervous system, and dioxin is known to cause cancer in humans at very low doses. Both mercury and dioxin are also endocrine disruptors, chemicals that mimic human hormones and can cause trans-generational effects in extremely small doses.

In 2000, EPA determined that power plant mercury emissions threaten public health and began the process of regulating mercury air emissions from power plants. At the same time, EPA announced that it would also review other toxic chemical emissions from power plants to determine if they require regulation. Given EPA's determinations, reducing toxic threats from power plants should be easy. Analysis of the 2001 TRI data shows that using currently available control technologies coal-fired electric power plants could reduce their air emissions of mercury, non-mercury metals, acid gases, and organics, such as dioxins by over 90 percent. Many power plants are already using these control technologies. A court-approved settlement requires EPA to propose its regulations by December 15, 2003.

Utilities claim that their toxic releases – while large in the aggregate – pose no threat to human health or the environment. However, neither the electric utility industry nor EPA has examined either the potential long-term risk to mothers, their children, the elderly, or to people with respiratory illnesses, or the effect of short-term high exposures. In addition, the effects of exposure to multiple pollutants at the same time have not been evaluated. Both EPA and the electric utility industry have also failed to analyze how power plant toxic chemical emissions contribute to the formation of fine particle pollution, an enormous public health concern.

Key Findings

• Electric utilities released nearly one billion pounds of toxic pollution[1] in 2001, more than any other industry in the U.S., except for metal mining, which releases most of its toxics to land. Electric utilities emit more toxic air pollution than the chemical, paper, and primary metals industries combined.

• Electric utilities accounted for approximately 43 percent of all TRI air emissions in 2001, releasing nearly three-quarters of a billion pounds in air pollutants.

• Analysis of the TRI data shows that currently available technology could reduce total air toxics emissions by over 620 million pounds, and the best performing power plants are already using this technology. If applied to the universe of U.S. coal-fired power plants, installation and optimization of fabric filters (baghouses), electrostatic precipitators, and sulfur dioxide scrubbers could result in a 91 percent reduction in mercury air emissions. Non-mercury metals could be reduced by 94 percent, acid gases by 96 percent, and organic compounds by 99 percent. These controls would also significantly reduce emissions of particulates and acid rain forming sulfur dioxide.

Additional Findings

• Southern Company, American Electric Power (AEP), Progress Energy (holding company for Florida Power and CP&L), and Tennessee Valley Authority (TVA) ranked highest for toxic air emissions in 2001. Southern Company was responsible for more than 10 percent of reported TRI air emissions from the entire electric utility industry. Southern, AEP, and TVA also ranked first, second, and third for total toxic releases to air, water, and land.

• North Carolina, Ohio, Pennsylvania, Florida and West Virginia were the top five states for electric utility toxic air emissions in 2001. Together, power plants in these five states were responsible for approximately 45 percent of U.S. electric utility toxic air emissions.

• Coal-fired power plants released over 309,000 pounds of persistent, bioaccumulative, toxic (PBT) chemicals to the air in 2001. EPA lowered the reporting thresholds for some of these chemicals for the first time in the 2000 reporting year because PBTs remain in the environment for long periods of time and accumulate in body tissue, greatly increasing the likelihood and amount of exposure. The 2000 TRI data represented the first full accounting of releases of chemicals, such as mercury and PCBs. While most of these substances were on the TRI reporting list prior to 2000, the quantities of these materials generated on site were too low to meet the previous TRI threshold. The threshold for lead and lead compounds was lowered in 2001, and data show electric utilities released more than 200,000 pounds of these chemicals to the air in 2001.

• Coal-fired power plants released more than 91,000 pounds of mercury and mercury compounds into the air in 2001 and were the largest industrial source of mercury emissions. About sixty percent of industrial mercury air emissions came from power plants in 2001. The chemical industry and metal mining ranked second and third for mercury air emissions in 2001.[2]

• American Electric Power, Reliant Energy, Southern Company, Tennessee Valley Authority and Dominion Resources were the five electric utility parent companies with the greatest air emissions of mercury in 2001. These five companies accounted for nearly one-third of all U.S. electric utility mercury air emissions, and AEP alone released nearly 10 percent of U.S. power plant mercury air emissions.

• Texas, Ohio, Pennsylvania, Indiana, and West Virginia were the five states with the greatest electric utility mercury air emissions in 2001, accounting for 39 percent of power plant mercury air emissions. Power plants in Texas alone accounted for nearly 10 percent of nationwide power plant mercury air emissions.

• Electric utilities released over 700 grams of extremely toxic dioxin and dioxin-like compounds into the air in 2001. The industry reported the largest amount of air emissions of dioxin and dioxin-like compounds in 2001, accounting for 27 percent of dioxin air emissions from industrial sources reporting to TRI.

• El Paso Merchant was the single largest source of dioxin air emissions in the utility sector. Other companies in the top five category for dioxin air emissions in 2001 were Cogentrix Energy (with power plants in 12 states, mostly on the east coast), PPL, XCEL Energy (with power plants in 12 states, mostly western), and Alliant Energy.

• Pennsylvania, Virginia, Florida, North Carolina, and Wisconsin were the top five states for air emissions of dioxin and dioxin-like compounds in 2001. Pennsylvania accounted for nearly 23 percent of the electric utility industry's air emissions of dioxin and dioxin-like compounds.

• Coal-fired power plants released nearly seven million pounds of toxic metals and metal compounds other than mercury to the air in 2001, many of which are known or suspected carcinogens and neurotoxins. Power plants have no required controls specifically for toxic metals, even though they are among the largest sources of such pollution, releasing metals to both air and land.

• Coal-fired power plants released over six hundred million pounds of dangerous acid gases to the environment in 2001, constituting the bulk of the industry's toxic pollution. Acid gases can cause acute respiratory problems, and aggravate asthma and emphysema. They also contribute to the formation of fine particle pollution. As many as 30,000 premature deaths each year from fine particles are linked to the power sector.[3]

• While, on average, other industries reporting to TRI release about 15 percent of their toxic chemical waste to the environment, coal-burning power plants release approximately two-thirds of their waste to the environment, because most power plants are not required to control their releases to air, land and water.

• Coal-fired power plants are the most widespread, large scale, long-lived industrial generator of toxic releases in the U.S. Over the past 50 years, coal-fired power plants have released an estimated one million tons (two trillion pounds) of eight toxic metals (arsenic, mercury, beryllium, chromium, nickel, lead, manganese and selenium). In addition, until the current plants are fully retired in 2050, they will have released an additional 1.5 million tons for a total environmental loading of about 2.5 million tons (five trillion pounds).

Recommendations

The TRI data reveal that the electric power industry is by far the largest aggregate source of some of our most toxic air pollution, especially acid gases and mercury, and is the largest source of airborne dioxin. Reducing this enormous source of toxic pollution can be done, but it will require a combination of closing special loopholes that exempt electric utilities from the same pollution controls that apply to other industries, modernizing our current fleet of power plants, and investing in cleaner power sources. Some measures that should be taken immediately are:

• EPA is in the midst of setting toxic emission standards for coal-fired power plants. According to a court approved deadline, the Agency must propose standards by December 15, 2003. Final rules are due one year later with a statutory compliance deadline of 2007. EPA is under industry pressure to ignore the court deadline and only regulate mercury, while ignoring other toxic emissions like dioxin. This analysis confirms that good control of all air toxics is achievable with current technology. EPA needs to adhere to the court schedule and strictly regulate all electric utility toxic air emissions – especially dioxin, acid gases, and metals – so that, at a minimum, power plants meet the same standards other industries meet for toxic air pollution.

• EPA will soon propose Best Available Retrofit Technology (BART) standards for "grandfathered" power plants that were built between 1962 and 1977 and are exempt from meeting modern emissions standards. Stringent new BART rules would dramatically reduce fine particle regional haze by requiring power plants to install electrostatic precipitators (ESP), sulfur scrubbers, selective catalytic reduction (SCR) equipment and other cost-effective cleanup technologies. The combined effect of these controls would be dramatic reductions in power plant toxic air emissions as well as the pollutants that cause acid rain and premature mortality. EPA has committed to propose BART rules in April 2004 with final rules due in April 2005.

• EPA should abandon its efforts to administratively repeal the Clean Air Act's New Source Review (NSR) program. The Clean Air Act provisions on NSR require electric utilities to install emission controls if they make major modifications to power plants that significantly increase emissions. Full enforcement of NSR could lead to dramatic reductions in power plant pollution. Despite this, since taking office the Bush Administration has been doing everything in its power to weaken the program. These efforts have included repeal of NSR cleanup requirements and dramatic reductions in NSR enforcement activity. In a manner similar to the BART rules, faithful NSR enforcement would result in the installation of modern pollution control technology that substantially reduces air toxic emissions, since sulfur and nitrogen control technologies remove other power plant toxic emissions as a co-benefit.

• Congress is currently considering proposals that would take a comprehensive approach to cleaning up power plants (rather than regulating pollutant by pollutant), enabling the industry to make more coordinated decisions on how best to meet their environmental obligations.[4] These proposals include provisions to close an existing loophole that allows older power plants to escape emissions controls for sulfur dioxide and nitrogen oxides. Reducing emissions of pollutants such as sulfur dioxide, nitrogen oxides, carbon dioxide, and mercury will also help reduce other toxic air pollution. For example, sulfur dioxide controls are extremely effective at reducing emissions of acid gases, the largest releases from electric power plants.

• The vast majority of electric power plants operating today are more than 30 years old. They burn coal and oil to produce electricity, both of which contain relatively high levels of impurities that result in toxic air pollution. Modernizing this fleet of plants by converting or replacing them with cleaner alternatives, such as integrated gasification combined cycle (IGCC) units or natural gas-fired power plants will help reduce toxic air pollution from electric utilities.

• Finally, a great deal of toxic air pollution can be avoided by shifting some of our electricity needs to renewable power sources such as wind, geothermal, solar, and biomass. Energy efficiency measures will also reduce toxic air pollution by reducing the amount of fossil fuel burned to generate electricity.

The time has come for electric utilities to do their fair share to reduce the threats that toxic pollutants pose to our families, our future, and our environment. The time is long past due for power plants to stop emitting more toxic air pollution than the chemical, paper, and primary metals industries combined.

Introduction

In the United States, the electric power industry is our biggest toxic air polluter, and coal, which generates 60 percent of our electricity, is the dirtiest fuel. When coal is burned, metals and other compounds in the coal (e.g., sulfur and mercury) are released. More than 900 million tons of coal is burned in the U.S. each year by the approximately 426 power plants[5] that submit reporting data to the U.S. EPA's Toxics Release Inventory[6] (TRI), resulting in the release of over 700 million pounds of chemicals into our air and nearly one billion pounds of chemicals to our air, land and water combined.

Once the approximately 900 million tons of coal are burned, nearly 130 million tons of power plant combustion waste remains. Receiving the wastes from these power plants are roughly 600 landfills, waste lagoon, and/or mine shafts[7] where this waste – contaminated with metals and other toxic compounds – is being dumped. Thousands of tons of toxic pollutants are discharged onto our lands and into our waters every year under minimal regulatory oversight. Given that the typical coal-fired plant operates for about 50 years, the cumulative impact of these emissions makes coal-fired power plants one of the most widespread, large-scale, and long-lived generators of toxic releases in the U.S. More than half of all Americans – over 156 million people – live within 30 miles of a coal-fired power plant.

Figure 1: Coal-Fired Power Plants Larger than 25 MW.

Illustration by MSB Associates.

1998 marked the first year that electric utilities were required to report to TRI. Since 1987 industrial facilities engaged in manufacturing have been required to report to TRI their annual releases to the environment and off-site transfers of waste on a chemical-specific basis. Since the first reports, TRI has been expanded to include more activities, industries, and substances. In 1991, TRI was expanded to require data on pounds of on-site recycling, energy recovery, and treatment activities at facilities. In 1995, the number of substances reportable to TRI nearly doubled. In 1997, EPA expanded the types of facilities required to report to TRI to include electric utilities burning coal or fuel oil, along with other new sources such as mining. Finally, in 1999, EPA set lower reporting thresholds for persistent, bioaccumulative, toxic (PBT) chemicals, greatly expanding data collected on substances of concern. For example, the reporting threshold for mercury was reduced from 25,000 pounds to 10 pounds in recognition of its toxicity, persistence, and high degree of bioaccumulation. PBT reporting was expanded to include lead and lead compounds for the 2001 reporting year.

Although it is a reporting program and does not set emission limits, TRI has been responsible for huge reductions in emissions and discharges from industrial facilities. Simply having to report the amount of pollution being released and subsequently having that information made public has caused facilities to examine their processes and reduce releases to the environment.[8] From 1988, the year EPA uses as its TRI baseline, reported releases to air, water, and land, and injections into deep wells have decreased by over 50 percent among the manufacturing sector facilities that report to TRI.[9] For many companies, assembling their 1987 TRI numbers was a big surprise. They had never examined their emissions as a whole, and the totals were extremely high. And, of course, the numbers were an even bigger surprise to communities and citizens groups that had never previously had access to the information.

The numbers have turned out to be no less surprising for the more than 400 coal-burning electric power plants reporting to TRI for 2001. Nationwide, electric utilities ranked number one for air emissions in the TRI data and number two for total TRI releases (e.g. air, land and water) in 2001.

Even before the TRI toxic air pollution data became available, electric power plants were known to be the largest industrial source of air pollutants such as smog-forming nitrogen oxides, soot-forming sulfur dioxide, and carbon dioxide, a powerful greenhouse gas.[10] The vast majority of this pollution comes from older coal-fired power plants.[11] The TRI data confirm that these power plants are not only the largest industrial source of conventional air pollutants, but that they are also by far the largest source of our most toxic air pollutants, such as mercury, as well as acid gases and toxic metals and are the largest source of airborne dioxin.

This report examines nationwide and state TRI electric utility data for 2001. It shows the quantity of toxic pollutants reported by power plants for 2001 and estimates past and future emissions of several metals. The report also summarizes health effects and exposure pathways and suggests ways in which the massive amount of toxic power plant pollution can be reduced.

The numerous data tables at the end of the report reveal how much toxic pollution electric utilities emit compared to other industries, rank the top-polluting utility holding companies, and list, by amount, the more than 70 toxic chemicals released by power plants to the environment. The data tables also contain state-by-state information on electric utility toxic releases, including the quantity of toxic pollution released by each power plant in all 50 states.

National TRI Data on Electric Power Plants

How much toxic air pollution did electric utilities report for 2001?

Electric utilities reported releasing over 700 million pounds of chemicals to the air in 2001, and reported nearly one billion pounds of total releases to air, water, and land (see Table 1). Nationally, electric utilities ranked number one for industrial toxic air emissions in 2001, and number two for total TRI toxic releases, behind the metal mining industry.[12]

What are the top electric utilities or utility holding companies for TRI releases?

Southern Company, American Electric Power (AEP), Progress Energy (holding company for Florida Power and CP&L), and Tennessee Valley Authority (TVA) ranked highest for TRI air emissions in 2001 for the utility industry (see Table 2). Southern, AEP, and TVA also ranked first, second, and third for total TRI releases. Southern Company reported emissions of over 93 million pounds of TRI chemicals to the environment in 2001 and was responsible for more than 10 percent of TRI air emissions from the entire utility industry.[13]

What chemicals did electric utilities report to TRI?

The top three chemicals released reported by electric utilities – hydrochloric acid, sulfuric acid, and hydrofluoric acid (also known as hydrogen fluoride), accounted for nearly 98 percent of electric utility TRI air emissions in 2001 (see Table 3). Power plants also reported releasing nearly 7 million pounds of metals and metal compounds to the air. The reported metals with the greatest air emissions were compounds of barium, zinc, vanadium, and nickel.

Table 3 lists air emissions, total releases, and production-related waste for TRI chemicals reported by electric utilities. Production-related waste includes releases to land, air, or water, amounts of each chemical managed on site (by recycling, energy recovery, or treatment), plus amounts of each chemical shipped off site as waste. Sixty-three percent of production-related waste from power plants ended up as releases to the environment, indicating little waste management activity and few power plants with emission controls. By contrast, for non-utilities, only 15 percent of all TRI production-related waste was released to the environment.

The chemicals released when coal is burned comprise a large group of diverse pollutants with a number of health and environmental effects.[14] They are a public health concern because at sufficient exposure levels they adversely affect human health. Some are known to cause cancer, others impair reproduction and the normal development of children, and still others damage the nervous and immune systems. Many are respiratory irritants that can worsen already existing respiratory conditions such as asthma. Some of these pollutants are an environmental concern because they damage ecosystems and can harm the plants and animals that rely on these ecosystems. The health and environmental effects caused by power plant emissions may vary over time and space, from short-term episodes of dust from a nearby combustion waste landfill to the long-term global dispersion of mercury.

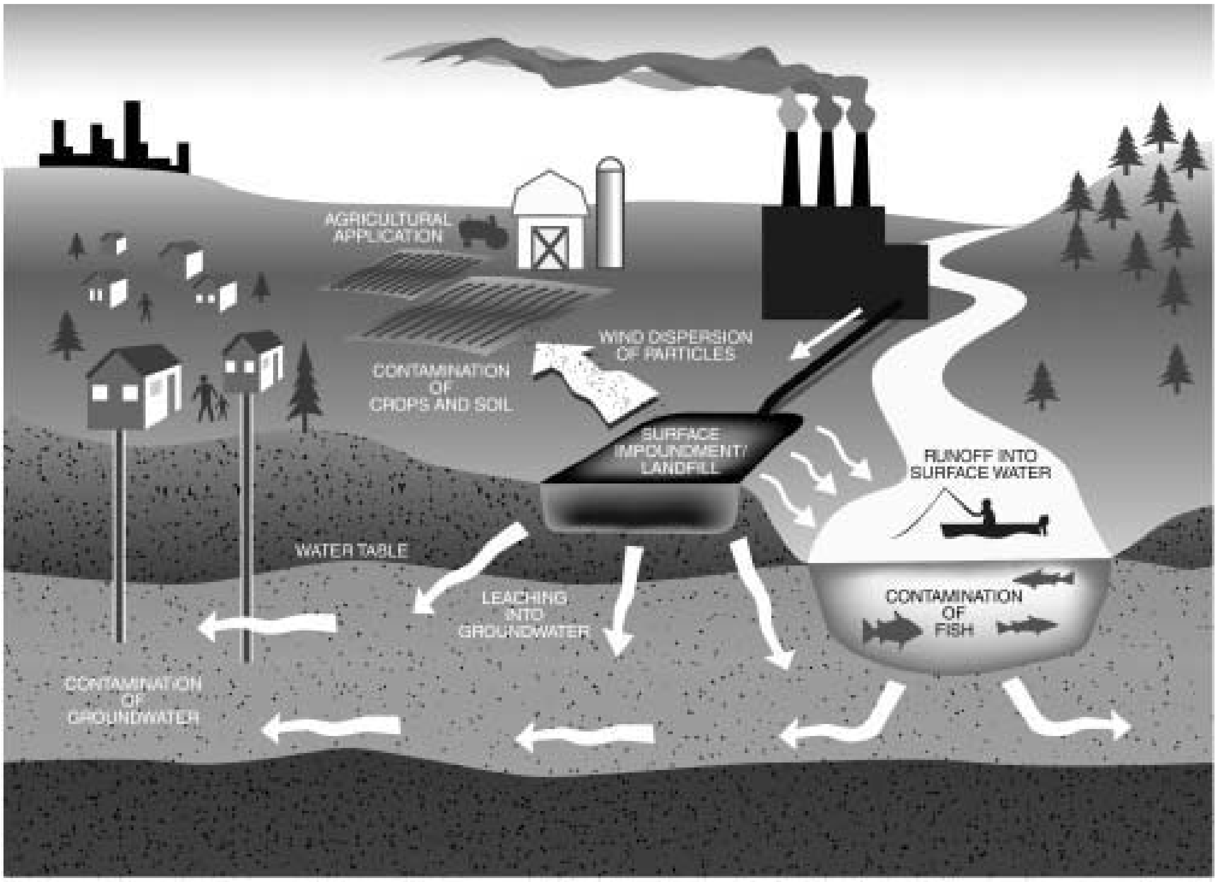

Illustration by Alan Morin

Figure 2: How and where toxics from power plants are released into our environment, and how we are exposed.

Inhalation is one way people are exposed to these pollutants, however exposure to air toxics from power plants also occurs from "indirect exposure". Indirect exposure is the ingestion of meat, dairy products, and fish, as well as water, soil, and vegetation that become contaminated by air emissions that have deposited to earth and accumulated in the food chain. Pollutants for which indirect exposure is particularly important are mercury, arsenic, dioxins, cadmium, and lead. Absorption through the skin of some power plant air toxics may also occur, especially from direct contact with contaminated water or soil. An important exposure pathway for children is the ingestion of contaminated soil during play. (Figure 2)

In addition, many power plant toxics belong to a class of chemicals that are PBTs. 2000 was the first year for reporting many PBT chemicals at lower reporting thresholds.[15] Data for two of the PBT chemicals – mercury and dioxin – are discussed in greater detail below. PBT pollutants either do not break down at all in the environment (for example, all metals) or break down very slowly (e.g., over decades, like dioxin). Continual loading of power plant pollution to the environment is especially important for PBT chemicals. Electric utilities released over 300,000 pounds of PBT chemicals to air in 2001 (Table 3). Mercury accounted for approximately one-third of these emissions, but power plants released other toxic chemicals such as lead and lead compounds, polychlorinated biphenyls (PCBs), and polycyclic aromatic compounds.

Even small releases of PBT toxins, especially mercury and dioxin, are a concern because they tend to accumulate and reach high concentrations in the food web. This process, called bioaccumulation, leads to human and wildlife exposure when contaminated food is eaten. Some PBT pollutants accumulate in animal tissues to levels hundreds, or even thousands, of times higher than levels found in the environment. Over a long period of time, a large fraction of these persistent contaminants can become buried in sediments, but they still may be incorporated into the food web. Even burial in sediments may not permanently store pollutants since they can be liberated again during flooding events.[16]

What is Bioaccumulation?

Persistent, bioaccumulative toxics like dioxin and mercury undergo bioaccumulation. Bioaccumulation is the process by which organisms (including humans) can take up contaminants more rapidly than their bodies can eliminate them. Thus the amount of a PBT in the body accumulates over time. If, for a period of time, an organism does not ingest a PBT, its body burden will decline. If, however, an organism continually ingests a PBT, its body burden can reach toxic levels. The rate of increase or decline in body burden is specific to each organism.

Where do the chemicals released by power plants come from?

Impurities present in coal are released to the environment when these fuels are burned by power plants. Although coal is mostly carbon, it also contains a small percentage by weight of sulfur compounds, compounds containing chlorine and fluorine, and various metals. While some coal is "cleaner" in that it has fewer impurities, all coal contains impurities that create a variety of chemical substances when the fuel is burned. These substances end up either as air pollutants or are present in the ash left over after fuel combustion and in soot captured from the exhaust streams of smokestacks equipped with electrostatic precipitators, scrubbers, or baghouses.

How much mercury did power plants release in 2001?

Electric power plants were the largest source of mercury air emissions in 2001. In total, power plants released more than 91,000 (Table 4) pounds of mercury as air emissions, more than all other industries combined (see Table 4).[17] American Electric Power, Reliant Energy, and Southern Company were the parent, or holding, companies responsible for the greatest mercury air emissions, accounting for nearly one quarter of the industry's mercury air emissions (see Table 5).

Why are mercury air emissions important?

Mercury is released to water and to land as well as to air.[18] It has been known since the 1950s that releases of mercury from human activity (as opposed to volcanoes, for example) can cause fish and other wildlife to build up mercury levels of concern in body tissue. However, there is a broad scientific consensus that it is air emissions of mercury that are responsible for contamination of fisheries, which results in human exposure through fish consumption.[19] Mercury is the pollutant most responsible for fish advisories, with advi-

Mercury in the Environment

After mercury is emitted from the power plant, it may either deposit nearby or be transported and subsequently deposited far from the source. Once deposited from the atmosphere, its greatest adverse impact occurs in the aquatic ecosystem.[21] In a series of chemical reactions, mercury can be converted by bacteria to methylmercury, a form that is especially toxic to humans and wildlife. Fish absorb methylmercury from the water as it passes over their gills and as they feed on other organisms. As larger fish eat smaller ones, methylmercury concentrations increase in the bigger fish, a process known as bioaccumulation. Consequently, larger predator fish usually have higher concentrations of methylmercury from eating contaminated prey. Humans, birds, and other wildlife that eat fish are exposed to methylmercury in this way.

sories in 43 states and one territory[20].

Mercury exists mainly in three forms: elemental mercury, inorganic mercury compounds (commonly mercuric chloride), and organic mercury (primarily methylmercury). All forms are toxic, and each has different health effects. Exposure to elemental or methylmercury can result in central nervous system effects, while exposure to inorganic mercury can result in kidney damage. Methylmercury is the form that is of concern for bioaccumulation in fish and other animal tissue.

The public health implications of mercury emissions are clear. In 2002, the Centers for Disease Control released findings on mercury levels in blood and hair from the 1999-2000 National Health and Nutrition Examination Survey. This is the first time that human tissues have been systematically analyzed for this pollutant. The survey found that eight percent of the women of childbearing age (1 out of every 12) that were tested were above the EPA's safe level.[26,27] Nationally, this translates into nearly five million women of childbearing age with elevated levels of mercury from eating contaminated fish, and approximately 322,000 newborns at risk of neurological effects from being exposed in utero to elevated levels of mercury.[28]

What are dioxin and dioxin-like compounds?

Dioxin and dioxin-like compounds are chlorinated chemicals that are byproducts of combustion, such as burning coal in electric power plants, and are not produced intentionally. They cause toxic effects at very low levels compared to other environmental toxins. However, some dioxin-like compounds are more toxic than others. Unfortunately, it is not possible to get a breakdown of the amounts of dioxin and each of the dioxin-like compounds from the TRI data.[29] Thus, this report cannot characterize the relative toxicity of dioxin emissions from the electric power industry compared to other industries.

Like mercury, airborne emissions of dioxin can travel long distances and deposit far from the source. Dioxin and dioxin-like compounds are extremely stable under most environmental conditions and persist in the environment for decades.[30] Dioxin and dioxin-like compounds have been found throughout the world in air, soil, water, sediment, fish, shellfish, meat, and dairy products. Dietary intake is thought to be the main pathway of human exposure. Immune system function, learning behavior, and the reproductive system all can be affected by prenatal dioxin exposure.

Children and adults exposed to dioxin can also experience immune system impairment and the chemicals may cause certain kinds of cancer. Dioxin and dioxin-like compounds may also be implicated in lowered human and animal fertility.[31]

How much dioxin did power plants release in 2001?

Electric utilities were the primary source of air emissions of dioxin and dioxin-like compounds in 2001, releasing over 700 grams (see Table 6). El Paso Merchant Energy, Cogenetrix Energy (power plants in 12 states, mostly on the East coast), and PPL were the top three parent or holding companies for dioxin air emissions. These three companies accounted for nearly 40 percent of electric utility dioxin air emissions in 2001 (see Table 7).

Are electric power plant emissions dangerous?

Direct inhalation of some air toxics can result in acute respiratory effects such as damage to the lungs and respiratory airways. Examples of acute effects are asthma attacks, respiratory infections, or changes in lung function. Except for highly reactive pollutants, most air toxics are absorbed and distributed in the body and therefore may produce systemic effects or effects distant from the entry point of the lungs. As a result, organs other than the lungs (e.g., the central nervous system, brain, heart, liver, and kidneys) can be affected by air pollutants. Systemic toxicants may cause both cancer and non-cancer effects.

Mercury is Poisonous

Exposure to methylmercury (the form of mercury that contaminates fish) is highly toxic, interfering with the development and function of the central nervous system. The fetus is most at risk from methylmercury exposure when mothers have eaten contaminated fish. Infants can ingest methylmercury from breast milk. Children are exposed when they eat such fish. While the fetus is most at risk, children and infants are also at high risk of mercury poisoning because their nervous systems continue to develop until about age 14. Health effects linked to prenatal methylmercury exposure include:[22,23]

- poor performance on tests of attention and language
- impaired memory inability to process and recall information
- impaired visual and motor function

In adults, methylmercury poisoning can adversely affect fertility and blood pressure regulation and contribute to heart-rate variability and heart disease.[24,25]

People that may be more sensitive to chemical exposures include infants and children, elderly people, pregnant women and nursing mothers, and people with chronic diseases, such as asthma. Children are not only more sensitive because they are at critical stages of physical and mental development, but they receive a relatively higher pollutant dose compared to adults because they have a lower body weight and higher breathing rate. People who tend to eat locally grown produce and locally caught fish may also receive higher than average exposure to power plant toxics if they live close to a facility.

It is difficult to estimate exactly how any one person may be affected by power plant emissions. The health risk from exposure to power plant toxics depends on how much of the pollutant a person is exposed to and over what period of time, the exposure pathway, whether the person is especially sensitive to the pollutant and the toxicity of the pollutant. Both short- and long-term (including lifetime) exposure to toxics from power plants is important. Evaluating the total health risks from power plant toxics is difficult. Because comprehensive emissions data are lacking, there is little or no air monitoring data and insufficient health effects information on both exposure to low levels of toxics or exposure to the mixture of pollutants emitted from power plants.

Major Questions about Dioxin Emissions from Power Plants

While mercury has been the most studied toxic pollutant from power plants, dioxin, one of the most toxic substances known, has been one of the least studied. Only eight power plants have ever been tested for dioxin emissions. EPA has identified dioxin emission testing as a research need. In particular, the potential for electrostatic precipitators to form dioxin needs investigation. To date, no research on this issue has been done.

The Edison Electric Institute (EEI), a group representing the electric power industry, has claimed that potential health effects from exposure to power plant emissions are negligible. EEI's statements were based on a 1998 EPA study of hazardous air pollutant emissions from power plants.[34] EPA stated in 1998 that some power plant emissions were a public health concern and required further study. However, the Agency has since made a regulatory finding that some pollutants from power plants are indeed a public health concern. On December 14, 2000, EPA announced that "mercury emissions from electric utility steam generating units are considered a threat to public health and the environment" and that the Agency would begin a process of setting a power plant mercury emission standard.[35] The court-approved deadline for proposing the standard is December 15, 2003, with a final standard due by December 15, 2004. Based on the requirements of the Clean Air Act, coal-fired power plants should be required to meet the standard by December 15, 2007, however, industry is lobbying hard to convince the Bush Administration that several more years are needed to comply with the standard.

EPA also determined that "arsenic and a few other metals (e.g. chromium, nickel, cadmium) are of potential concern" for causing cancer, and that the risk was not low enough "to eliminate those metals as a potential concern for public health. Dioxins, hydrogen chloride [hydrochloric acid] and hydrogen fluoride [hydrofluoric acid] are three additional [hazardous air pollutants] that are of potential concern and may be evaluated further during the regulatory process.…Due to data gaps and uncertainties it is possible that future data collection efforts or analysis may identify other [hazardous air pollutants] of potential concern."[36]

The EPA's 1998 study concluded that the high levels of acid gas emissions from power plants do not pose a public health risk, which is not surprising given the Agency's severely limiting assumptions made in modeling power plant acid gas emissions (and failure to analyze sensitive populations such as children and the elderly).[37] However, EPA's December 2000 announcement indicates that the Agency might now consider regulating power plant acid gas emissions.

It is unclear at this point whether other hazardous air pollutants will be regulated on the same timetable as mercury, although EPA has stated that the Agency "must propose regulations to control mercury emissions – and any other air toxics the Agency deems necessary – from coal- and oil-fired power plants by December 15, 2003."[38]

The fact is that individual electric power plants release huge amounts of hazardous substances to the atmosphere and also create other types of pollution contributing to public health problems:

Acid aerosol emissions are corrosive and can cause acute respiratory problems, and aggravate asthma and emphysema. In addition, there is emerging evidence that breathing small concentrations of acid aerosols over time inhibits childhood lung development.[39] Furthermore, the fact that acid aerosol emissions from other industries are regulated and controlled demonstrates the recognized necessity of minimizing the health risks associated with their release.

Several substances released by power plants are also neurotoxins that damage the nervous system, such as manganese compounds and n-hexane, and reproductive and developmental toxins, such as toluene and lead compounds.

In addition to health effects for individual chemicals, power plant aerosol and metal emissions also contribute to secondary particulate pollution.[40] Emissions of acids and metals coalesce into small droplets and particles that are of particular concern for public health. As many as 30,000 people per year are estimated to die because of exposure to power plant fine particle pollution.[41]

What happens to the toxic chemicals in coal combustion waste?

Electric power plants reported more than a quarter of a billion pounds of toxic chemicals as released to land – these chemicals end up in ash from electrostatic precipitators or fabric filter baghouses. Coal power plant combustion wastes are typically disposed of in either landfills (for dry wastes) or surface impoundments (for liquid wastes).[42] Most power plant waste landfills and impoundments are located at the same site as the power plant. Ideally these disposal units would prevent the wastes from entering the environment. Unfortunately, the level of protection afforded by these disposal methods varies greatly. About 40 percent of the coal waste landfills and 80 percent of the coal waste surface impoundments are not lined, and less than half the landfills and only one percent of impoundments have leachate collection systems.[43] In some states, liquids from impoundments are not

Environmental Toxins and Children's Health

The potential effects of exposure to neurotoxins or developmental toxins are learning disabilities, attention deficits, loss of IQ points, or other disorders depending on the severity of exposure. The National Academy of Sciences (NAS) has concluded that as many as three percent of known developmental and neurological deficits in children are caused by exposure to known toxic substances, including developmental and neurological toxins. The NAS also concluded that 25 percent of these deficits may result from environmental and genetic factors working in combination and that toxic substances may play a significant but undetermined role.[32]

Using this estimate, the National Environmental Trust (NET) and two other organizations calculated that 360,000 children – or 1 in 200 children suffer from developmental or neurological defects caused by exposure to known toxic substances including developmental and neurological toxins.[33] NET notes, however, that this is probably an underestimate because the NAS only considered known developmental and neurological defects and refers only to well-recognized and clinically diagnosed mental and physical disabilities, not other subtle mental and physical deficits that are difficult to diagnose.

only allowed to percolate to the groundwater, the disposal units are actually designed to allow this. There are also direct discharges to surface waters, overflow drainage from impoundments, and surface water runoff.

Power plant waste contains concentrated levels of numerous contaminants, particularly metals like arsenic, mercury, lead, chromium, and cadmium, and radioactive elements found naturally in coal.[44] Power plant waste disposal has been documented as causing severe and potentially irreversible ecological damage.[45] Some of the contaminants found in power plant wastes accumulate in animal tissues to levels hundreds of times higher than levels found in the environment.

People can be exposed to toxics in power plant combustion wastes if these contaminants enter the environment, either through dust, leaching into groundwater, or from discharges into surface waters. The pollutants can contaminate drinking water supplies and accumulate in livestock and crops. As a result, people living in the vicinity of the power plant waste site can be exposed to the pollutants in these wastes by ingesting groundwater into which the contaminants (especially metals) have leached, eating the exposed livestock or crops, inhaling contaminants contained in windblown dust or from coming into contact with, or ingesting soils onto which these wastes have been applied.[46,47]

What are the cumulative and future releases of power plant toxins estimated to be?

We know that coal-fired power plants emit large amounts of toxics to our environment day in and day out and have been doing so for more than half a century. Given that metals never degrade in the environment, what does this mean in terms of cumulative releases of metals? Based on the 2001 TRI emissions, and conservatively assuming that the pollution controls in place in 2001 have always been in place, we estimated

Figure 3:

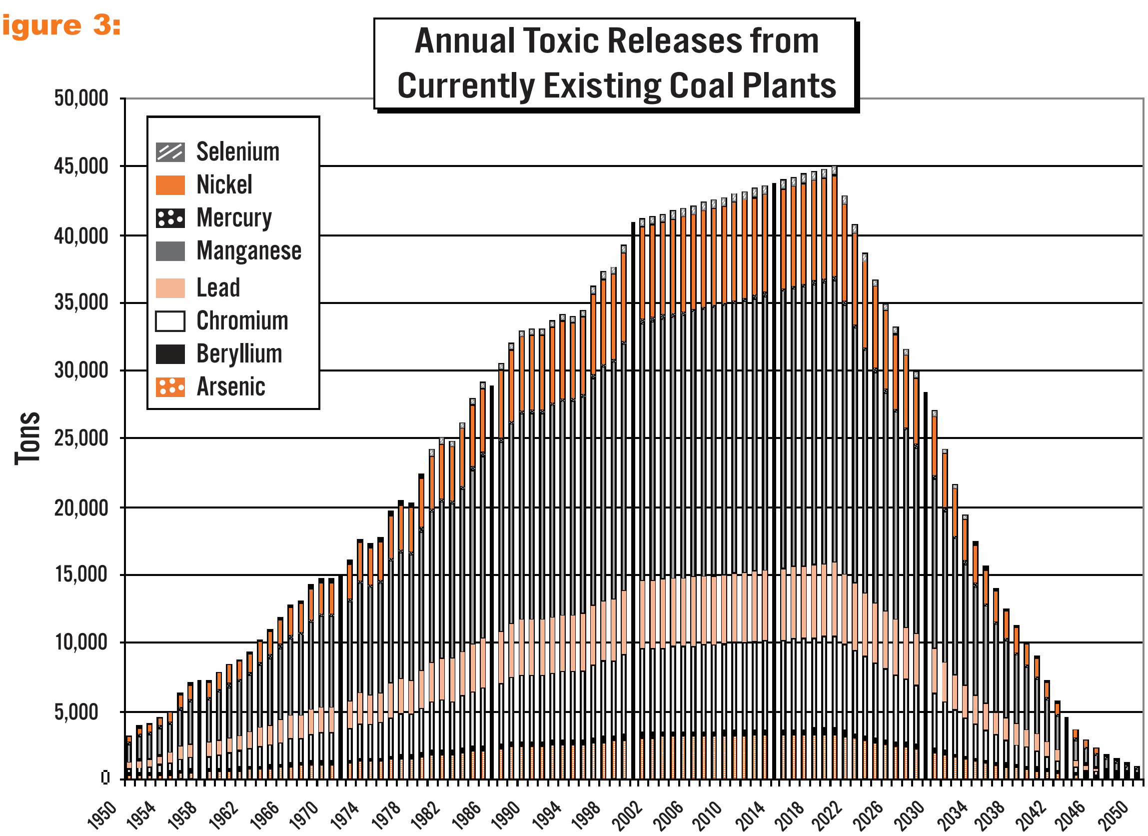

Illustration by MSB Associates.

how many tons of eight metals have been released to our air, land and water by coal-fired power plants every year since 1949. Using 2001 release data from the TRI, for each of the eight metals (arsenic, beryllium, chromium, lead, manganese, mercury, nickel, and selenium), we calculated how many pounds are emitted per megawatt hour of electricity generated. Records of national electrical generation from coal were available back to 1949, and these records were used to estimate the yearly releases of metals. Figure 3 illustrates how emissions have increased every year from 1949 to today. Coal-fired power plants are currently releasing about 40,000 tons (80 million pounds) of these eight metals to our air, land, and water each year.

To estimate future releases, we used projections of coal-fired electrical generation published by the Annual Energy Outlook (to year 2020) and the Electric Power Research Institute (to year 2050). Our methodology did not account for any new coal plants but did assume that the existing fleet would be fully retired by 2050.[48] Projections show that releases of these metals will continue to increase to nearly 50,000 tons (100 million pounds) until 2023, when we assume plant retirements begin to take effect.

As Figure 4 shows, the cumulative loading of these metals to the environment over the past 50 years is staggering, with coal-fired power plants releasing one million tons (two trillion pounds) of just these eight metals. In addition, until the current plants are fully retired in 2050, they will have released an additional 1.5 million tons for a total environmental loading of about 2.5 million tons (five trillion pounds)! This cumulative loading of toxics to the environment across the U.S. makes the coal-fired power plant sector the most widespread, large scale, long-lived industrial generator of toxic releases in the U.S.

Can electric utilities effectively control power plant air emissions with existing technology?

Power plant operators report a wide range of emissions of mercury and mercury compounds, organic

Figure 4:

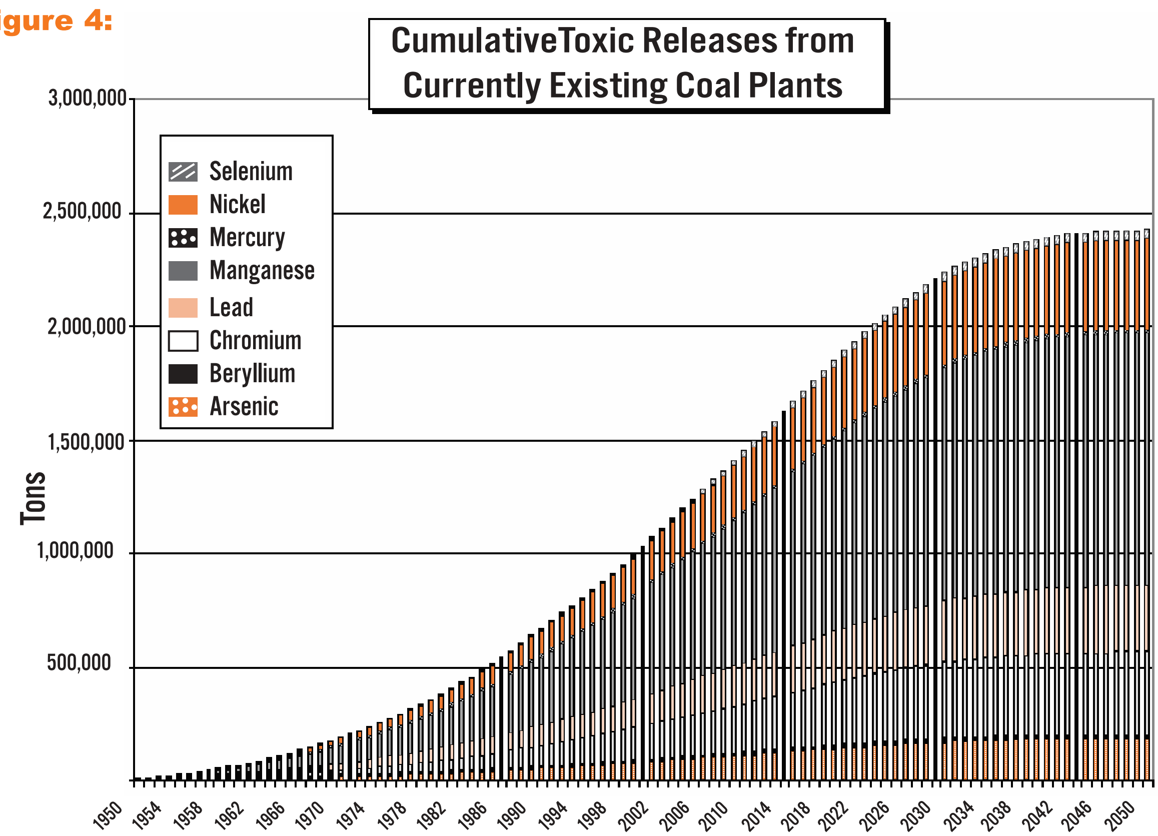

Illustration by MSB Associates.

chemicals, metals, and acid gases to TRI. When their emissions data are normalized with electric power generation, it is clear that some power plants already do a good job of controlling their air emissions of these pollutants – that is, they release fewer pounds of pollutants per megawatt-hour of electricity generated than other power plants. An examination of the 2001 TRI and Energy Information Administration (EIA) data for power plants shows that coal-fired plants can control more than 90% of these air pollutants with existing control systems such as fabric filters or baghouses, electrostatic precipitators, and SO2 scrubbers.

The Clean Air Act requires EPA to set control or MACT standards for sources of pollution based on the average control achieved by the top 12 percent of best performers in a source category. This report makes those calculations for power plants reporting 2001 TRI emissions data and EIA 759 and 906 data for electric generation. A total of 426 power plants that reported generating at least 90 percent of their electricity from coal combustion also reported TRI emissions data.[49] Most of these facilities also reported the types of coal burned and narrative descriptions of treatment or control processes at power plants to EIA.

The normalized emissions data were ordered from lowest emission rate to highest for four chemical categories: mercury and mercury compounds, non-mercury metals, organic compounds (including dioxins and persistent aromatic hydrocarbons), and acid gases (sulfuric, hydrochloric, and hydrofluoric acids). The top performing (lowest emission rate) 12 percent of power plants with non-zero emissions were selected, and the average emission rate was calculated for those 12 percent.[50] This average emission rate was then applied to the 426 power plants to calculate the amount of air pollutants that could be avoided, and the average percent control. The control systems information submitted by the top 12 percent was also examined to determine which, if any, control systems could be responsible for the lower emission rates.[51] The results, summarized in Figure 5, show that properly optimized control systems provide significant control

Figure 5: Potential Impact of Existing Controls on Power Plant Air Emissions*

Substances	No. of Power Plants Reporting Non-Zero Emissions	Total Air Emissions From These Power Plants (lbs)	Average Emission Rate for best 12% of Non-Zero Reporters	Reduction in Air Emissions Possible with Controls (lbs)	Percent Reduction Achievable with Controls	Control Equipment Reported by Best Performers
Mercury and Mercury Compounds	421	83,334	4.3E-06	76,006	91	Fabric Filters
Non-mercury Metals	420	4,347,614	0.00014	4,105,265	94	Fabric Filters Electrostatic Precipitators
Organic Compounds	212	22,210	2.7E-07	21,910	99	Wet SO_2 Scrubbers
Acid Gases	405	642,613,902	0.015	616,691,637	96	SO_2 Scrubbers (various types)

*Power plants generating at least 90% of electricity from coal.

of power plant air emissions.

The point of this analysis is not to state definitively the exact level of control possible at each and every plant. However, it is important to note that the top performing 12 percent of plants for each of the four pollutant categories reflect the range of coal types and generation capacities seen in the larger population of coal-burning power plants. It appears that power plants with larger and smaller capacities burning bituminous, subbituminous, and lignite coal can indeed achieve significant control of air emissions of toxic chemicals, and many of them are already doing so.

What do these findings mean for the EPA MACT process?

EPA is already engaged in a process to develop a MACT for mercury, and the findings of this analysis indicate that it is possible for the agency to set a relatively stringent emissions standard with available technology. Certainly, if EPA fails to set a standard that reflects high control efficiency, it will not be because the technology does not exist.

Although EPA is required to develop a MACT for non-mercury hazardous air pollutants (HAPs), it is unclear if the Agency will indeed do so by the December, 2003 deadline. This analysis indicates that existing widely available technology can control HAPs air emissions, and if EPA fails to set MACT standards for these pollutants it will not be because control is not achievable.[52]

How do legal loopholes and special exemptions affect toxic emissions from power plants?

The huge amount of toxic air pollution from power plants is at least in part the result of special pollution exemptions for the electric industry that currently exist in the Clean Air Act. Electric utilities also enjoy an exemption under the Resource Conservation and Recovery Act (RCRA), [53] and as a result over 70 million tons of toxic combustion waste annually can be disposed of with virtually no restrictions. While ending these special exemptions for power plants will not, by itself, resolve the massive toxic pollution from electricity generation, it is an important part of the solution. In particular, acid aerosols and toxic metals would be reduced by ending special exemptions for power plants.

• Acid aerosol air pollution will be reduced by closing the Clean Air Act "grandfather" loophole. Because of a "grandfather" loophole under the Clean Air Act, the vast majority of coal-fired power plants fail to meet modern pollution standards for sulfur dioxide (SO_2). [54] Grandfathered power plants emit SO_2 at rates up to 10 times that of modern coal plants. Power plants exempted from having SO_2 emission controls under the "grandfather" loophole in Clean Air Act also have higher emissions of acid aerosols than plants that have control systems. Removing the special favoritism conferred by the grandfathering provision in the Clean Air Act would result in substantial reductions in acid aerosol emissions. If EPA decides to regulate acid aerosol emissions under the rulemaking for hazardous air pollutants, installing SO_2controls will be a logical way for power plants to comply with the regulation. These controls will also substantially reduce SO_2 emissions, decreasing acid rain, regional haze, and a major source of particulate pollution.

• Toxic metal air pollution will be reduced by closing the Clean Air Act utility air toxics special exemption. Electric utilities have avoided regulation of their toxic pollution due to an exemption granted under the 1990

IGCC - A Cleaner Coal Technology

Integrated coal gasification combined cycle units (IGCC) are emerging as a promising technology for electrical power generation.[59] Rather than burning coal directly, coal gasification reacts coal with steam and carefully controlled amounts of air or oxygen under high temperatures and pressures. The heat and pressure break apart the chemical bonds in coal's complex molecular structure, setting into motion chemical reactions with the steam and oxygen to form a gaseous mixture, typically hydrogen and carbon monoxide. Pollutant-forming impurities and greenhouse gases can be separated from the gaseous stream. As much as 99 percent of sulfur and other pollutants can be removed and processed into commercial products such as chemicals and fertilizers. Organic gases and dioxins are not formed in this process. Metals (except mercury) partition to the glass-like slag where they are stable and do not leach. Mercury can be collected efficiently (up to 99 percent) by fixed activated carbon beds.

The use of IGCC can solve many of the problems with conventional coal technologies. Inherent in the conventional coal-burning process is the release of toxics from the coal or the formation of toxics in the combustion process or plume. The pollutants that aren't released to the air are dispersed into large volumes of ash and other wastes that require disposal. This already large amount of solid wastes will increase both in volume and toxicity as more stringent air emission limits are enforced. The current practice is largely to treat this waste as if it were benign dirt – which it isn't. The solid waste from an IGCC unit is vitrified slag – a commercial product that is a solid matrix not known to be susceptible to leaching. IGCC units could be part of the solution to the long-term problem of conventional coal combustion.

Clean Air Act.[55] At that time, Congress was persuaded that not enough was known about toxics emitted by power plants to justify national regulations. No other major industry was given this exemption.

Mercury is one example of a toxic metal emitted by power plants that has been reduced through the use of controls by other industrial emitters of mercury, and EPA is now beginning the process of developing a mercury emissions standard for power plants. It is uncertain if the Agency will also require controls for other metals, but control technology exists for them. Other toxic metals can be captured to levels exceeding 95 percent and as high as 99.9 percent by more efficient particulate controls.[56]

• Toxic waste contamination of land and water would be reduced by closing the RCRA combustion waste special exemption. Combustion waste is the solid and liquid waste left over from burning coal and oil to make electricity — ash, sludge, boiler slag, mixed together with a dozen or so smaller volume wastes.[57] Every year, over 100 million tons of these wastes are produced at the more than 400 coal-fired power plants analyzed for this report. Seventy-six million tons are primarily disposed of at the power plant site in unlined and unmonitored wastewater lagoons, landfills, and mines.[58]

These wastes are highly toxic. They contain concentrated levels of contaminants like arsenic, mercury, chromium, and cadmium that can damage the nervous systems and other organs, especially in children. Analyses performed for EPA show that some of these pollutants eventually migrate and contaminate nearby groundwater. Incredibly, disposal of these toxic wastes is subject to no federal requirements whatsoever. In May 2000 EPA issued a regulatory determination for coal combustion waste exempting these wastes from hazardous waste disposal requirements and instead stated its intention to develop state guidelines. To date, EPA has not issued any such guidelines.

Contamination of land and groundwater by toxic coal combustion waste could be significantly reduced if EPA were to designate these wastes as “hazardous” under RCRA. Coal power plant combustion wastes should require federal regulatory oversight because of the toxicity of their components and the demonstrated and documented danger they pose to public health and the environment. State rules are inadequate to control or mitigate these risks and dangers. The effect of a federal designation of these wastes as hazardous would be significantly tighter controls on disposal of these wastes in landfills and lagoons with modern environmental controls such as liners, groundwater monitoring, and leachate collection systems.

What other measures would reduce toxic pollution from power plants?

Even if all existing legal loopholes are closed, there will continue to be massive toxic emissions from power plants. Impurities present in coal and fuel oil, including sulfur compounds, compounds containing chlorine and fluorine, and various metals, will continue to be a source of toxic releases so long as these fuels are burned to produce electricity.

Burning cleaner fuels with fewer impurities – such as natural gas – will help lower power plant toxic emissions. There is also the opportunity for industry to switch from conventional coal-fired boilers to integrated coal gasification combined cycle units (IGCC) to reduce air emissions and solid waste. IGCC units are routinely used in refineries and for chemical manufacturing. A change to this technology to produce electricity would be a significant step forward in cleaner coal technology (see sidebar).

We must also improve energy efficiency and increase the amount of electricity generated from renewable sources such as biomass, solar, wind and geothermal to further reduce overall toxic releases from the electric industry.

A national market-based renewable energy portfolio standard (RPS) that ensures growth in the percentage of electricity generated from renewable sources including biomass, geothermal, solar, and wind energy will help achieve this goal. The RPS requires that each electricity producer offer a set amount of renewable energy, either by acquiring renewable generating capacity or by buying surplus renewable capacity from others.

Finally, reducing overall demand for coal- and oil-generated electricity through energy efficiency measures will also reduce toxic emissions from the power industry. This goal can be achieved by making investments in energy efficiency through the establishment of a nationwide public benefits trust fund. Investment in the trust fund is accomplished by a uniform charge for transmitting electricity over the existing utility grid.

State TRI Data on Electric Power Plants

How do power plant emissions compare among states?

• Table 8 compares electric utility emissions in each state for 2001 TRI air emissions, releases to land and water, and production-related waste. North Carolina ranked highest for air emissions, followed by Ohio, Pennsylvania, Florida, and West Virginia.

• Table 9 compares mercury emissions from electric utilities by state. Texas had the highest electric utility mercury air emissions, followed by Ohio, Pennsylvania, Indiana, and West Virginia.

• Table 10 lists electric utility dioxin emissions by state. Pennsylvania ranked highest in 2001, followed by Virginia, Florida, North Carolina, and Wisconsin.

• Table 11 is a state-by-state listing of all power plants included in the 2001 TRI data. It contains information on reported toxic air emissions and total toxic releases.

• Table 12 is a plant-by-plant listing of data for mercury.

• Table 13 contains plant-by-plant data for dioxin.

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Appendix B:
Data and Methodology

TRI Data. Data in this report come from the 2001 Toxics Release Inventory database. Facilities designated as electric utilities reported SIC code 4911, 4931, or 4939 as their primary SIC code. In most cases, no other SIC code was reported, although some facilities designated as electric utilities may have other subsidiary operations on site.

New Data for 2000 and 2001 – New Substances and Lowered Reported Thresholds. The 2000 Toxics Release Inventory data contained new substances, all persistent bioaccumulative toxic (PBT) chemicals. These substances persist in the environment for at least two months without degrading and concentrate in body tissue. The impact of persistence and bioaccumulation is to increase potential exposure. The new substances reported for 2000 include dioxin and dioxin-like compounds.

All substances designated as PBTs by EPA, both the new substances and substances already on the TRI reporting list (such as mercury and mercury compounds) were also assigned lower reporting thresholds. This means that the 2000 data contain information not previously reported, even though these facilities may have submitted other TRI data in the past. Lead and lead compounds were added to the PBT list for the 2001 reporting year.

The TRI Reporting Threshold – Old and New. Facilities report to TRI based on total annual throughput, not on the amount released to the environment. Throughput is defined as the amount of a chemical brought on site plus the amount produced on site during the year, plus the difference in inventory at the beginning and end of the year. It is essentially the amount of a chemical that passes through the facility on an annual basis. Even if a facility has zero releases to the environment, it still must submit a TRI form for each substance meeting the throughput threshold. On the other hand, even if a facility's entire throughput is released to the environment, the facility will not have to report to TRI if the throughput does not meet the threshold.

Originally, the TRI throughput threshold was 25,000 pounds for chemicals manufactured or processed on site – including some impurities in raw materials, such as mercury contained in coal burned by electric power plants – and 10,000 for substances "otherwise used" such as solvents and catalysts.[60] Virtually no electric power plants had 25,000 pounds of throughput of mercury, even though most of the mercury in coal burned at power plants ends up released to the environment, so very little data on mercury emissions from power plants was available from TRI.

Thresholds for substances designated as PBTs were lowered to 10 or 100 pounds, depending on the substances' chemical properties. The threshold for mercury and mercury compounds was set at 10 pounds, meaning that nearly every coal-fired electric power plant reporting to TRI for 2000 and 2001 reported its mercury emissions. The threshold for dioxin and dioxin-like compounds was set at 0.1 grams, reflecting their acute toxicity and the extremely small amounts of these substances generated by facilities.

Mercury and Mercury Compounds. As with some other metals, facilities report to TRI separately for elemental mercury and compounds that contain mercury. Total throughput for compounds containing mercury are added to compare against the 10 pound reporting threshold for the "mercury compounds" category but only the weight of the mercury is included, not the other elements in the compounds. Although elemental mercury and the different mercury compounds may have different chemical and toxicological properties, most tables in this report contain summed data for mercury and mercury compounds together for comparison purposes.

Dioxin and Dioxin-Like Compounds. Unlike metals and metal compounds, dioxin and dioxin-like compounds are included in a single TRI substance category, meaning that the total throughput of these compounds are added together and compared against the 0.1 gram threshold (as opposed to one calculation for dioxin and another for dioxin-like compounds). This approach yields a single number, but that number is difficult to interpret, because one dioxin-like compound can be radically different from another in terms of toxicity. Typically, all dioxin-like compounds are assigned a toxicity weighting factor that indicate each compounds' potency compared to dioxin. That weighting factor is then multiplied by the weight of each compound to give its equivalent toxicity, and the equivalent toxicities of the compounds are added together to give a total "weight" of dioxin based on toxicity. EPA chose not to take this approach in reporting on dioxin-like compounds for many reasons, among them: (1) toxicity weighting factors can change based on new information, and (2) identifying each dioxin-like compound could be time-consuming and costly for facilities.

TRI Releases and Production-Related Waste. Facilities report their air emissions, surface water discharges, releases to land, and amounts of waste injected into on-site deep wells. These quantities were aggregated into total releases as used in this report. Air emissions are the total of stack air emissions and fugitive air emissions, which are reported separately.

Facilities also report amounts of waste managed on site by recycling, burning for energy recovery, and treatment, as well as amounts of waste shipped off site for recycling, energy recovery, treatment, or disposal. These quantities are summed with total releases to calculate production-related waste, which represents amounts of chemicals used on site that do not end up as product. Electric utilities reported some on-site treatment of waste, such as SO2 controls, but the vast majority of production-related waste from electric power plants ends up as releases.

How Power Plants Estimate Their Emissions. Facilities reporting to TRI are not required to measure their emissions but to use the best available information. If measurement data are available, facilities will use them to report to TRI.[61] Facilities measure some of their emissions because of permitting requirements under other environmental statues, such as the Clean Air Act or Clean Water Act. However, since electric utilities do not have permits for toxic chemical releases, they generally don't measure emissions. Only nine percent of power plant toxic chemical air emissions reported to TRI were measured in 2001.

The vast majority of electric utility toxic chemical releases are estimated by emission factors. An emission factor is essentially a multiplier used with known variables such as fuel consumption or amount of electricity generated. These variables combine to yield emission estimates for various chemicals. Some emission factors can be extremely accurate. For instance, if a facility monitors the amount of various impurities in coal burned, these data can be used to develop emission factors that paint an accurate picture of the quantity of those impurities emitted to the air. In some cases, these emission factors are as accurate, or even more accurate, as measurement for purposes of estimating annual emissions. They do not reflect variability in operating conditions, however, and cannot be used for setting emissions standards or regulatory compliance.

Parent Company Aggregations. Facilities report the name of their parent companies to TRI. This report uses the parent companies identified by facilities in the TRI database, with no update of parent companies for mergers and acquisitions after December 31, 2001. Facilities may in fact report a subsidiary parent instead of the ultimate parent, so the totals for parent companies may not reflect actual parent company emissions. In addition, some plants report multiple parent companies and percentage ownership from each parent. These parent names may be expressed as initials, and no attempt was made to give them names.

Appendix C:

Method for Estimating the Past and Future Release of Toxic Metals from Currently Existing Coal-Fired Power Plants – 1949 to 2050

The purpose of this analysis was to estimate the tonnage of metals already released by coal-fired power plants (1949 to present), how much is likely to be released in the future (to 2050), and to determine the fractions released to air, land, and water. The focus was on coal-fired power plants which currently exist (or existed in the past). New coal-fired power plants are not included in the analysis.

The analysis focused on eight metals – arsenic, beryllium, chromium, cadmium, lead, mercury, manganese, and nickel. All are present in coal and are released when coal is burned.

The source of data for releases of these metals from the power plant sector is the 2001 Toxics Release Inventory (TRI) (www.epa.gov/tri). This inventory does not include all power plants (some are not included because of either the size of the facility or the amount of the release). As a result, this analysis is likely to underestimate somewhat the amount of toxic releases.

Estimating Past Coal Generation. Total estimated electricity generation from coal was taken from the Energy Information Administration report Annual Energy Review – 2000. This report provided the total U.S. coal-fired generation from 1949 to 2000. The coal-fired generation was divided up by state based on the Energy Information Administration report Electric Power Annual. This report is published annually and provides a great deal of detail about electricity production and sales for the year. Electric Power Annuals were available for 1993 through 2000. These were used to determine the state shares for these years.

Electric Power Annuals were not available for years prior to 1993. As a result, it was not possible to directly determine the state share of coal-fired generation for the years before 1993. Instead, the shares calculated for 1993 were used for each of the years back to 1949.

Projecting Future Coal Generation. For projecting future coal generation, the time period was broken into two parts – 2001 to 2020 and 2021 to 2050. For the time period 2001 to 2020, there is a great deal of projected information in the Energy Information Administration's Annual Energy Outlook 2002. Each year the EIA prepares a new Annual Energy Outlook that includes the agency's best estimate of energy use and trends. Among the tables included are projected coal-fired generation.

The Annual Energy Outlook 2002 separates existing coal-fired capacity and new coal-fired capacity. For this analysis only the existing coal-fired capacity was included. The Annual Energy Outlook does not make projections past 2020. In order to estimate the coal-fired generation for this extended period, we looked at the age profile of existing coal-fired power plants. Approximately 60% of coal-fired capacity is post-1970, 20% post-1980, and 2% post-1990. We assumed a 60-year lifespan for coal-fired power plants. This means that 40% of the existing fleet would be retired by 2030, 80% by 2040, and 98% by 2050. These retirement factors were applied to the projected existing coal-fired generation in 2020 from the Annual Energy Outlook to get projections for 2030, 2040, and 2050. A smooth retirement curve was drawn between these years.

In order to divide the projected coal-fired generation among the states, the state fractions from 2000 were used into the future.

Metal Releases. Emission rates (in lb/MWH) for each of the metals of interest were developed by dividing the total release from the power plant sector of each metal by the total MWH generated by coal-fired utilities. The emission rates were then multiplied by the estimated historical and projected coal generation. The source of the emissions data was the 2000 Toxics Release Inventory (TRI) (which contains emission estimates for 1999). As discussed earlier, the TRI is not complete, so it is likely that the emission factors and total releases are somewhat underestimated.

The TRI totals for 1999 for each of the eight toxic metals were calculated and divided into three endpoints – air, water, and land. Using the Electric Power Annual 2000 value for coal-fired generation in 2000, a set of 24 release factors was calculated – one for each metal and for each of the three endpoints. These factors were then applied to the estimated historical and projected future coal-fired generation. The result was a set of tables by metal that specify the annual release of each metal and the total historical and projected releases to each endpoint.

Endnotes

1. See Appendix A for Tables.

2. Note that municipal waste incinerators, a significant source of airborne mercury, do not report to TRI.

3. Abt associates, The Particle-related Health Benefits of Reducing Power Plant Emissions, October 2000. (http://www.clnatf.org/resources/reports/Abt_PM_report.pdf)

4. For more information on legislative developments concerning power plant cleanup go to: www.cleartheair.org.

5. This number only includes plants that generate at least 90% of their electricity from coal combustion.

6. The TRI program (§313) is administered by EPA under the Federal Emergency Planning and Community Right-to-Know Act (EPCRA), 42 U.S.C. §11001 et seq.

7. U.S. EPA, 1999. Report to Congress, Wastes from the combustion of fossil fuels. Volume 2 – Methods, findings and recommendations. Office of Solid Waste and Emergency Response, Washington, DC. EPA 530-R-99-010. March 1999.

8. For an analysis of TRI's impact on emissions reduction, see A. Fung and D. O'Rourke, "Reinventing Environmental Regulation from the Grassroots Up: Explaining and Expanding the Success of the Toxics Release Inventory." Environmental Management., Vol. 25, No. 2, pp. 115-127 (2000)

9. This figure includes only facilities in the manufacturing sector, and includes only the core set of chemicals that has been reported continuously since 1988. It does not include the electric power industry.

10. Nationally, annual power plant emissions are responsible for 36 percent of carbon dioxide (2 billion tons), 64 percent of sulfur dioxide (13 million tons), 26 percent of nitrogen oxides (6 million tons) and 52 tons of mercury (note that this is not the mercury data submitted to TRI, but an EPA estimate from other data collection efforts). US EPA, National Air Quality and Emission Trends Report, 1997 (December 1998), Tables A-4 and A-8, pp. 114, 117. Available online at http://www.epa.gov/oar.

11. Among power plants, older coal-fired facilities produce the most pollution. Fifty-six percent of power plant boilers in operation in the U.S. are fueled by coal. However, they account for over 93 percent of nitrogen oxides, over 96 percent of sulfur dioxide, over 88 percent of carbon dioxide, and 99 percent of mercury emissions for the entire electric industry. US EPA, Acid Rain Program, National Summary Percent Contribution by Unit Fuel Type. Available online at http:// www.epa.gov/acidrain/emissions/us_sum.htm.

12. Facilities report their industry to TRI by means of Standard Industrial Classification (SIC) codes. A facility may report more than one SIC code to TRI, although the first SIC code reported is supposed to represent the major activity of the facility. This report uses the primary SIC code as the designation for the entire facility.

13. Although power plants report the names of their parent companies to TRI, they do not always report their ultimate parent company, especially when the electric utility that owns the plant is a subsidiary of a holding company. In addition, facilities reporting the same parent companies may use slight variations in name that do not allow the data for a parent company to be easily aggregated (for example, "The Southern Company" as opposed to "Southern Company," or using initials or abbreviations). Given the lag between data reporting and data availability, these parent company or holding company designations may not represent the current status as to number of plants and total emissions.

14. U.S. EPA, 1998a. Study of hazardous air pollutant emissions from electric utility steam generating units – final report to Congress. February. 453/R-98-004a.

15. See Appendix B, Data and Methodology, for an explanation of lowered TRI reporting thresholds for persistent, bioaccumulative, toxic (PBT) chemicals, which include lead and lead compounds in the 2001 data.

16. For a discussion of PCBs, mercury, and other endocrine disruptors, see Colburn et. al., Our Stolen Future: Are We Threatening Our Fertility, Intelligence, and Survival? New York: Dutton, 1996.

17. This total includes elemental mercury and mercury

contained in compounds. Note also that municipal waste incinerators, a significant source of mercury emissions, do not report to TRI.

18. With the exception of the mining industry (metal and coal) and facilities that manage and dispose of waste, the majority of industrial mercury releases are air emissions.

19. U.S. EPA. Mercury Study: Report to Congress. Office of Air Planning Quality and Standards and Office of Research and Development. EPA-452/R-97-003.

20. U.S. EPA, 2003. Update: National Listing of Fish and Wildlife Advisories. EPA-823-F-03-003. May 2003.

21. U.S. EPA, 1997b. Mercury Study Report to Congress, Volume III: Fate and Transport of Mercury in the Environment. EPA-452/R-97-005.

22. U.S. EPA, 1997f. Mercury Study Report to Congress, Volume V: Health Effects of Mercury and Mercury Compounds. EPA-452/R-97-007.

23. Toxicological Effects of Methylmercury, National Academy Press, Washington, DC, 2000.

24. High levels of mercury in seafood linked to infertility. BJOG: an International Journal of Obstetrics and Gynecology. 109:1121-5, 2002.

25. Toxicological Effects of Methylmercury, National Academy Press, Washington, DC, 2000.

26. U.S. Centers for Disease Control and Prevention. Blood and hair mercury levels in young children and women of childbearing age - United States 1999. Morbidity and Mortality Weekly, March 2, 2001.

27. The EPA has estimated how much methylmercury is harmful to the developing fetus by developing a "reference dose" or RfD. An RfD is a dose that can be ingested daily over a lifetime without harmful health effects.

28. Derived from 1990 census data. http://www.census.gov

29. Facilities report the total amount of releases of dioxin and dioxin-like compounds all together. They may also report the weight fraction of each of the 17 compounds reportable to TRI if they have that information readily available. However, the facility can report the breakout for its largest emission or for total emissions, and it is not possible to determine which one the breakout applies to. Some industry associations have provided blanket estimates of the breakdown for their industries, however, these estimates are not necessarily representative of individual facilities.

30. Persistence is a measure of how long a chemical remains in the environment and is typically measured by half-life: the amount of time it takes for half of the original amount of a chemical to degrade into another substance. TRI data must be reported at lower thresholds for bioaccumulative chemicals that have half-lives of two months or more.

31. See Poisoning Our Future: The Dangerous Legacy of Persistent Toxic Chemicals (National Environmental Trust and U.S. Public Interest Research Group, November 1998) for a listing of some U.S. EPA publications with information on dioxin and dioxin-like compounds, including health effects information and estimated emissions for various industries.

32. National Academy of Sciences (NAS). Scientific Frontiers in Developmental Toxicology and Risk Assessment. National Academy Press, June 2000. http://www.nap.edu/books/ 0309070864/html/

33. National Environmental Trust (NET), et al. 2000. Polluting Our Future: Chemical Pollution in the U.S. that Affects Child Development and Learning. September. www.environet.org The Census Bureau estimates that nearly 12 million U.S. children under 18 (17% of children) suffer from one or more developmental, learning, or behavioral disabilities. If, according to the National Academy of Sciences, known toxic exposures are directly implicated in approximately 3% of these disabilities, then 360,000 U.S. children – or 1 in every 200 – suffer from developmental or neurological defects caused by exposure to known toxic substances, including developmental and neurological toxins.

34. U.S. EPA: Study of Hazardous Air Pollutant Emissions from electric utility Steam Generating Units –Final Report to Congress. Volume 2: Appendices. 453/R-98-004b. February 1998.

35. EPA Federal Register notice 6560-50P, December 14, 2000. See www.eap.gov/ttn/atw/combust/utilitox/utilfind.pdf.

36. See endnote 35, supra.

37. While falling short of implicating average emissions of acid gases, the 1998 EPA study did point out that hydrochlo-

ric acid emissions have detrimental environmental effects. These emissions significantly enhance the acidity of cloud water and thus can indirectly affect acid rain (by interacting with SO2 in the atmosphere). It also contributes to the formation of fine particles. According to EPA, hydrochloric acid in the atmosphere can affect the atmospheric chemistry of mercury, which may affect how long mercury remains in the atmosphere before being deposited to earth.

38. EPA Fact Sheet, December 14, 2000. "EPA to Regulate Mercury and Other Air Toxics Emissions from Coal- and Oil-Fired Power Plants." (http://www.epa.gov/ttn/atw/combust/utiltox/hgfs1212.html).

39. Raizenne, M. et al (1998). "Air Pollution Exposure and Children's Health." Canadian Journal of Public Health 89: S43-48.

40. U.S. EPA: Study of Hazardous Air Pollutant Emissions from Electric Utility Steam Generating Units –Final Report to Congress. Volume 2. 453/R-98-004b. February 1998.

41. Abt Associates, The Particle-related Health Benefits of Reducing Power Plant Emissions, October 2000. (http://www.clnatf.org/resources/reports/Abt_PM_report.pdf)

42. U.S. EPA, 1999. Report to Congress, Wastes from the combustion of fossil fuels. Volume 2 – Methods, findings and recommendations. Office of Solid Waste and Emergency Response, Washington, DC. EPA 530-R-99-010. March 1999.

43. U.S. EPA, 1999. Report to Congress, Wastes from the combustion of fossil fuels. Volume 2 – Methods, findings and recommendations. Office of Solid Waste and Emergency Response, Washington, DC. EPA 530-R-99-010. March 1999.

44. U.S. EPA, 1999b. Technical background document for the report to Congress on remaining wastes from fossil fuel combustion: waste characterization. March 15, 1999.

45. Hopkins, W.A., C.L. Rowe, J.H. Roe, D.E. Scott, M.T. Mendonta and J.D. Congdon. 1999. Ecotoxicological impact of coal combustion byproducts on amphibians and reptiles. Savannah River Ecology Laboratory, presented at the Society for Environmental Toxicology and Chemistry, 20th Annual Meeting, Philadelphia, PA. November 14-18. Abstract # PMP009.

46. U.S. EPA, 1998c. Technical background document for the report to Congress on remaining wastes from fossil fuel combustion: groundwater pathway human health risk assessment. June 1998.

47. Research Triangle Institute, 1998. Draft final report. Non-groundwater pathways, human health and ecological risk analysis for fossil fuel combustion phase 2 (FFFC2). Prepared for U.S. EPA, Office of Solid Waste, Washington, D.C. June 5, 1998.

48. See Appendix B for full discussion of data and methodology.

49. Note that this calculation differs from the official MACT process in two ways: The MACT process applies to individual boiler units, not entire power plants; and the Clean Air Act also requires MACT emissions data to be measured, not estimated by other means. TRI data are reported for the entire power plant, and although they may be measured, facility operators are required only to use the best available information to report the data.

50. The composite TRI data used to create this analysis did not distinguish among the two potential reasons for zero emissions reports: Power plants operators could indeed have reported zero emissions, or they could have not submitted reports for particular substances because they did not meet the reporting thresholds. Either instance provided a zero for the purposes of calculation, therefore all zeros were excluded. This effectively raises the average emission rate because legitimate zero reports were excluded. Therefore, this estimate is relatively conservative, and power plants may be able to control pollutants even more effectively.

51. Control data were not available for all of the top 12 percent of performers, and no attempt was made to determine if particular control systems were more prevalent among the best performers than among the rest of the power plants.

52. As stated previously, EPA is required to use specific monitoring data on individual boiler units to create a MACT standard under the Clean Air Act. The agency is also allowed to create different standards for different units under particular conditions. This analysis uses TRI data and does not differentiate power plants by size, type, or class.

53. 42 U.S.C. §§ 6901 et seq. (1988) (also known as the Solid Waste Disposal Act).

54. "Grandfathering" also refers to the absence of modern pollution controls for oxides of nitrogen (NOx) that are emitted by power plants. Electricity generation is responsible for approximately twenty-five percent (25%) of annual national NOx emissions.

55. Clean Air Act, 42 U.S.C. Sec. 7412(n). Congress ordered EPA to prepare a utility air toxics report and to make a determination on whether to regulate utilities for their toxic emissions. When EPA finally released its utility air toxics study in February 1998, EPA asserted that it did not have enough information to make a positive regulatory determination. At that time, EPA negotiated an extension to December 15, 2000 for making its final determination. Because EPA has now determined that utility air toxics should be regulated, and has committed to finalizing rules by December 2004, power plants in the future should emit far smaller quantities of toxic metals and other compounds than they have historically.

56. Brown, T.D.; D.N. Smith, R.A. Hargis, Jr., W.J. O'Dowd. Mercury Measurement and its Control: What we Know, Have Learned and Need to Further Investigate. J. Air and Waste Management Assoc., June 1999, pp. 1-97.

57. The total amount and potential toxicity of such wastes could increase once controls for air toxics such as mercury, metals, and acid gases are installed, since these controls remove the metals from the air stream as solid or liquid waste.

58. For more details on the hazards of toxic combustion waste, see "Laid to Waste: The Dirty Secret of Combustion Waste From America's Power Plants," (March 2000), available on-line at: http://www.cleanair.net/Resources/laid-towaste.htm

59. Gasification technologies. http://www2.fossil.energy.gov/coal_power/gasification/

60. Although mercury is present as an impurity in coal, EPA determined that electric utilities would have to report mercury emissions because various new mercury compounds are formed during the coal combustion process.

61. "Measurement" does not necessarily mean continuous or even frequent measurement. A facility can take a few measurements during the year and extrapolate for the entire year as long as the facility operatorrepresentatives believe that these data are representative of the year's operations. Obviously, this is not always the case.

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