Report Overview

NATIONAL WILDLIFE FEDERATION®
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Getting the Job Done

Affordable Mercury Control at Coal-Burning Power Plants

Mercury pollution is responsible for widespread toxic contamination of our nation's waters, fish, and wildlife. In 45 states across the country, advisories warn the public to restrict their consumption of many species of fish because of the dangers of mercury exposure. Coal-burning power plants remain the largest unregulated source of mercury pollution in the United States. In *Getting the Job Done*, NWF assesses the feasibility and cost of controlling harmful mercury emissions from power plants. We find that, even in states that rely heavily on coal, deep mercury reductions are technologically feasible and affordable today.

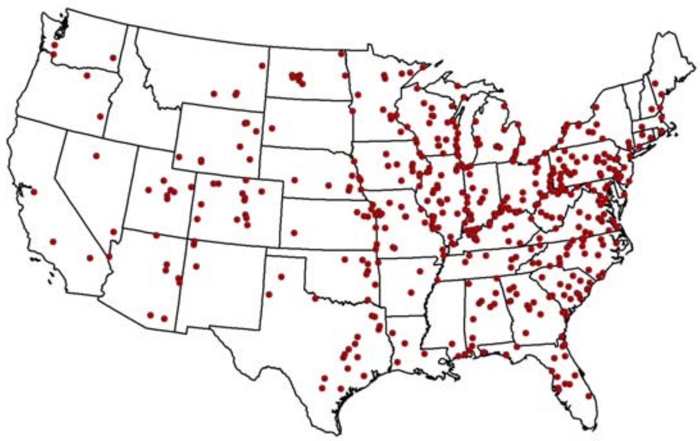
This overview provides a short summary of our report.

For the price of one cup of coffee per household per month, our nation could dramatically reduce the toxic mercury pollution from coal-burning power plants that contaminates our waters and wildlife.

Mercury From Coal-Fired Power Plants

In 1999 (the most recent year for which data are available), the EPA estimated that coal-fired power plants accounted for 41 percent of the country's total industrial mercury emissions. While some airborne mercury can travel long distances, mercury from power plants also deposits locally and regionally. Estimates from computer modeling by EPA indicate that up to 14 percent of the mercury emitted by coal-burning power plants deposits within 30 miles of a plant. Parts of the eastern seaboard receive a greater proportion of U.S. mercury emissions than areas in the arid west—for example, at Pines Lake, New Jersey, 80 percent of mercury deposition comes from North American sources. Recent modeling in the Great Lakes found that approximately 48 percent of the mercury depositing in Lake Michigan came from sources within 60 miles of the lake Though this study only examined North American sources, researchers concluded that coal combustion in the U.S. was "the most significant source category contributing mercury through atmospheric deposition to the Great Lakes."

Figure 1: U.S. Coal-fired Power Plants



Source: Clear the Air, 2001

Recent studies show that regulations restricting mercury air pollution have clear, measurable effects on the environment in a matter of years, not decades. For example, a multi-year study by the state of Florida found a nearly one-to-one relationship between mercury deposition and fish tissue levels. Following significant reductions in incinerator emissions starting in the early 1990s, mercury levels in largemouth bass and egrets declined substantially, up to 80 percent. A similar study in northern Wisconsin found that over a six year period, a 60 percent reduction in mercury deposition correlated with a 30 percent decline in mercury levels in yellow perch.

Methods of Reducing Mercury From Coal-Fired Power Plants

There are a number of approaches to reducing mercury emissions from coal-fired power plants. These include: coal cleaning processes which take mercury out of the coal before combustion; post-combustion technologies to capture mercury in the flue gas; improving power plant efficiencies (so that less coal is burned for the same energy output); switching fuels (e.g., to lower mercury coal or to cleaner natural gas); using renewable sources (such as wind energy); and reducing energy demand (e.g., through consumer energy efficiency improvements and energy conservation).

While NWF recognizes the need to consider all approaches for generating energy in the cleanest, most efficient manner, we focus here on assessing post-combustion retrofit control technologies because they are a proven, available, and widely applicable form of mercury control.

There are three primary post-combustion approaches that can be pursued to control mercury emissions from coal-fired power plants:

- Utilize or enhance existing control technology installed for other pollutants to effectively capture mercury.
- Adopt a mercury-specific control technique, such as activated carbon injection.
- Adopt a multi-pollutant approach, designed to control mercury along with other pollutants.

Under the Clear Air Act, coal fired power plants have been required for over a decade to limit emissions of particulates, nitrogen oxides and sulfur dioxide, pollutants which create smog and acid rain. Over the next decade, strengthened standards for these pollutants are expected, along with some further control technology adoption.

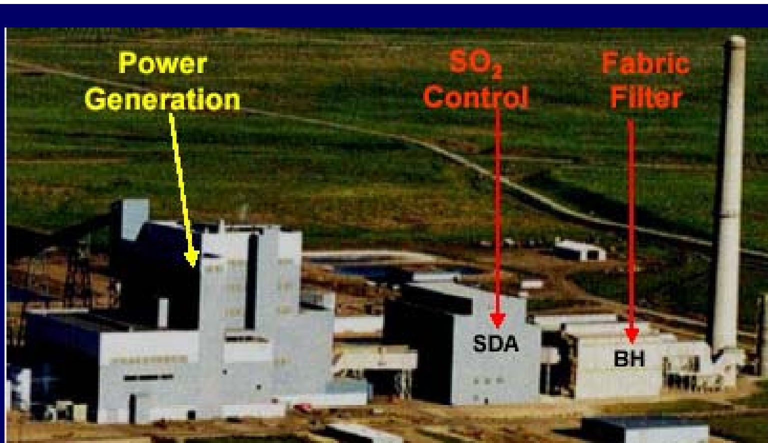
Some of these technologies – while designed to capture other pollutants – also capture mercury. In particular, fabric filters, which are used for particulate control in some modern plants, have been shown to capture 90% of mercury when used on plants burning bituminous coal and more than 70% of mercury on plants burning subbituminous coal. Sulfur dioxide scrubbers, when used with more common particulate control devices (electrostatic precipitators, or ESPs) can capture 50-75% of mercury on plants burning bituminous coal and around 30% of mercury in plants burning subbituminous coal. Unfortunately, for the power plant configurations which are most common nationwide, existing mercury capture is much lower, particularly for subbituminous coal.

In summary, while controls for other pollutants may provide effective means for achieving deep mercury reductions at certain plants – other mercury specific or multipollutant controls will be necessary to achieve effective mercury control across the industry. Fortunately, these technologies are available and affordable today.

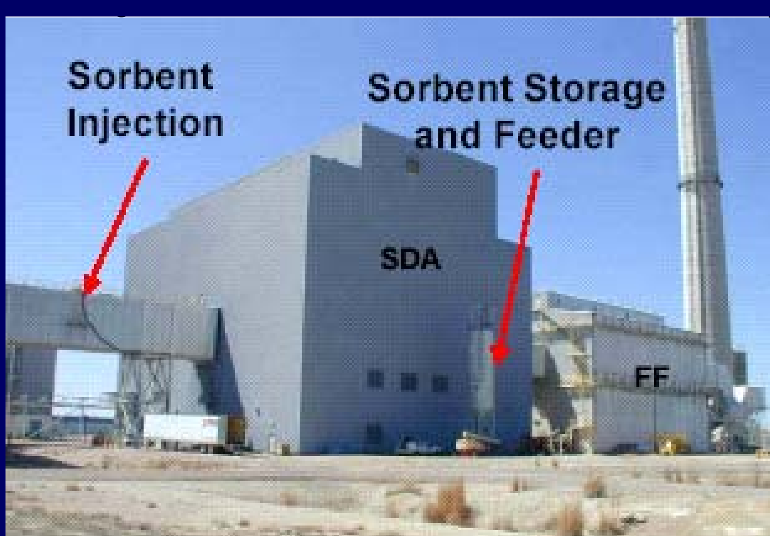
Mercury-Specific Control Techniques

Numerous technologies to capture high levels of mercury are currently being developed or commercialized. These range from modified wet scrubbers, to catalysts added to oxidize mercury and make it easier to capture, to injecting sorbents, such as carbon, into the flue gas to adsorb mercury. In our report, we focus primarily on carbon injection technology because it is commercially available for power plants and has been extensively tested.

Activated carbon injection (ACI) works by injecting powdered carbon, a highly adsorbent material, into the flue gas to adsorb elemental and oxidized mercury. The carbon particles are then trapped by a



Power plant with semi-dry scrubber for sulfur dioxide control and fabric filter for particulate control.



Power plant with SDA and Activated Carbon Injection upstream of an existing fabric filter.

Photo Source: ADA-ES

particulate control device (an ESP or fabric filter). While the activated carbon can be injected upstream of an electrostatic precipitator or fabric filter, it also can be injected downstream of an electrostatic precipitator, and then collected by a second (usually smaller) 'polishing' fabric filter, called a pulse jet fabric filter (PJFF). For many plants currently using an electrostatic precipitator, studies suggest the latter approach may be more cost effective, even though it requires an additional upfront capital investment. The cost of a polishing fabric filter would be offset by the reduced amount of powdered carbon needed to capture high levels of mercury.

Full-scale test results

Numerous full-scale tests involving ACI have been performed over the past five years. The table below summarizes the results of completed full-scale tests at power plants of various configurations burning different coals. An additional 18 full-scale tests are ongoing or scheduled for 2004-2005.

Tests completed to date show that greater than 90 percent mercury control is possible at plants equipped with A.CI and a fabric filter burning bituminous and subbituminous coals. Also, at least 80 percent control is possible for plants burning lignite coal using ACI and a fabric filter, with higher reductions likely with a modified activated carbon or higher activated carbon injection rates.

Technology to reduce mercury from power plants is not only being widely tested, but is also commercially available. Driven by state rules, consent decrees and new permit requirements power plants are already bidding on or finalizing contracts for mercury control equipment.

Aside from activated carbon injection and activated carbon injection/ polishing fabric filter systems which are commercially available today, there are nearly a dozen other pollution control technologies under development, several of which are also expected to be commercially available within the next year. A summary of the full range of mercury control technologies and their commercial status is available in our larger report.

Mercury Control Efficiencies With Powdered Activated Carbon Injection in Full-Scale Tests at Coal-Fired Power Plants[a]

Plant (State)	Coal Type	Existing Controls*	Add-On Technology*	% Mercury Reduction	Reference
ACI alone					
Southern Co. – Yates Units 1,2 (GA)	bituminous	cs-ESP	ACI	Up to ~75	Richardson et al., 2004
PG&E –NEG Brayton Point Unit 1 (MA)	bituminous	Two cs-ESPs	ACI	Up to 90	Durham et al., 2003a
WEPCO – Pleasant Prairie Unit 2 (WI)	subbituminous	cs-ESP	ACI	70 (long-term)	Durham et al., 2003b
DTE Energy Detroit Edison St. Clair Power Plant (MI)	85/15 subbituminous/ bituminous	cs-ESP	Brominated ACI	Up to 80 (note: latest tests acheive 90+)	McCoy et al., 2004
Leland Olds Station Unit 1 (ND)	lignite	Two parallel cs-ESPs	ACI	63** (average for month-long test)	Thompson et al., 2004
ACI with a fabric filter					
Alabama Power –Gaston Unit 3 (AL)	bituminous	hs-ESP	ACI and COHPAC fabric filter	Up to 90	Bustard et al., 2002
Sunflower Electric's Holcomb Station	subbituminous	Spray dryer (SDA), FF	ACI – several sorbent types	Up to 90+	Sjostrom et al., 2004
Great River Energy – Stanton Unit 10 (ND)	lignite	Spray dryer (SDA), FF	Untreated ACI Iodine-impregnated ACI	Up to 81 Up to 96	Sjostrom, et al., 2002

* hs-ESP is hot-side electrostatic precipitator, cs-ESP is cold-side electrostatic precipitator, FF is fabric filter, ACI is activated carbon injection, COH-PAC is Combined Hybrid Particulate Collector (patented type of fabric filter).
**For Leland Olds test, target mercury removal rate was only 55 percent, and carbon injection rate was adopted accordingly.

Costs of Achieving 90% Mercury Control

In several recent reports, EPA has presented cost estimates for installing technology to control mercury emissions at coal-fired power plants with different coal types, sizes and configurations. We matched these model plant cost estimates with 2002 data on coal consumption, generation, and existing and planned pollution control configurations at each power plant boiler in five states. We calculated annualized costs for mercury control boiler-by-boiler, and then estimated what the statewide costs would mean for the rate-payers in each state.

While plants can use a number of technologies to meet mercury reduction standards, we narrowed our analysis by focusing only on the cost of using activated carbon injection with or without a polishing fabric filter. For a relatively small number of plants burning high sulfur bituminous coal, we applied advanced dry scrubbers to achieve over 90 percent mercury control (and over 95 percent sulfur dioxide control).

By applying what is effectively a single technology solution to all plants as they are configured today, our cost calculations are likely overestimated. Not only are mercury control technologies emerging which may prove less expensive than activated carbon, but plants, especially those burning bituminous coal, may find they can achieve 90 percent or greater mercury control by optimizing existing or planned conventional controls for nitrogen oxides, sulfur dioxides and particulates.

Nonetheless, our analysis found that retrofitting every coal-fired utility boiler with mercury control equipment sufficient to achieve 90 percent mercury control would cost the average household from about 70 cents to a little over $2.00 a month, depending on the state. Commercial and industrial increases were similarly reasonable—between 1 and 3 percent. The charts below summarize our findings.

Estimated Cost of 90% Mercury Control in Five Coal-Burning States

	PA	OH	IL	MI	ND	IN	NH
Percentage of electricity generated from coal	56%	90%	46.1%	57%	95%	93.7%	23.3%
National rank in mercury emissions from utilities	3rd	2nd	5th	13th	15th	4th	45th
Primary type of coal burned (percentage)	Bituminous (85%)	Bituminous (89%)	Sub-bituminous (80.5%)	Sub-bituminous (50%)	Lignite (97%)	Bituminous (62.3%)	Bituminous (100%)
Number of coal-fired boilers	78	80	56	57	13	67	5
Number of plants	36	22	21	20	7	22	2
Estimated addition to household electric bill if total cost of technological upgrade are passed onto the consumer	**$1.08 (1.4% increase)**	**$2.14 (2.9% increase)**	**$0.69 (1.1% increase)**	**$0.69 (1.2% increase)**	**$1.94 (2.9% increase)**	**$1.95 (2.8% increase)**	**$0.28 (0.4% increase)**

More detailed methodology, and state-by-state case studies can be found in our full report.

New test in Michigan shows potential for rapid increases in mercury control performance, decreases in cost

A DOE sponsored test of activated carbon injection just completed at Detroit Edison's St. Clair Station in August 2004 provides a glimpse of the rapid evolution of the mercury control industry. For plants burning subbituminous coals, previous tests had shown that 90% mercury control required either very high amounts of ACI or ACI and the installation of a polishing fabric filter (we assume the latter configuration for the subbituminous boilers in our study). In the full scale St. Clair test, brominated ACI was injected upstream of a cs-ESP on a 80MW boiler burning 85% subbituminous coal. Not only did the test achieve consistent 90%+ (93% average) mercury control, but it did so at about 15% of the cost expected for this configuration.*

*Information presented at the Combined Power Plant Air Pollutant Control Mega Symposium.
Washington, DC, Aug. 30 – Sept. 2, 2004. "Full-Scale Mercury Sorbent Injection Testing at DTE Energy's St. Clair Station".

Benefits of Reducing Mercury Emissions

The primary focus of this report is to quantify the cost of mercury reductions. However, the benefits for public health, the economy, and the environment that can be associated with reduced mercury emissions are many and should be taken into consideration when setting policy goals.

Improving Public and Environmental Health

In 2003 EPA identified 11 health and welfare benefits that would result from reducing mercury emissions from power plants. These included health benefits such as reduced neurological disorders, learning disabilities and developmental delays, as well as reducing cardiovascular impacts and reproductive effects in adults. Other benefits included reducing negative impacts on birds and mammals, protecting of currently healthy ecosystems and protecting commercial, subsistence and recreational fishing.

Bolstering the Fishing and Tourism Industries

Recreational fishing is a major component of our local and national economies. More people in the U.S. fish than play golf and tennis, combined, and research shows that nearly 70 percent of anglers consume their catch. Recent reports from the U.S. Fish and Wildlife Service and the American Sportfishing Association indicate that recreational fishing annually generates:

- $116 billion in overall economic activity
- 1 million jobs, resulting in more than $30 billion in salaries and wages
- $36 billion in expenditures
- $7 billion in state and federal taxes

Forty-five US states and territories currently issue fish consumption advisories due to mercury contamination. Studies show that these advisories lead anglers to take fewer trips, spend less money on trips, and choose non-contaminated fishing destinations—whether in-state or elsewhere. For local economies that are heavily dependent on sport fishing, the impact of this lost revenue could be significant.

Creating jobs and spurring economic growth

A central economic benefit of requiring stringent mercury reductions nationwide has little to do with improving environmental or public health. Significant investments in cleaner energy technology—and specifically, mercury retrofits—will create and maintain jobs. Like improving roads, modernizing the nation's utility industry—the average coal-burning power plant is nearly 40 years old—is an important infrastructure investment with major employment and economic benefits. Investing in new energy technology not only bolsters innovative new industries, but spurs demand for labor as well as the materials necessary to install the technology—such as structural steel and electrical equipment—that can be supplied by local companies. The Institute of Clean Air Companies (ICAC) estimates that the manufacture, installation and operation of pollution control equipment would create 300,000 jobs nationwide over the next decade. Already, pollution control equipment manufacturers employ more than 130,000 people.

The primary focus of this report is to quantify the cost of mercury reductions. However, the benefits for public health, the economy, and the environment that can be associated with reduced mercury emissions are many and should be taken into consideration when setting policy goals.

Conclusions and Recommendations

There are various technologies available for reducing mercury emissions from coal-fired power plants. This report demonstrates that it is economically feasible to install currently available mercury controls to meet a stringent mercury reduction target. In fact, cost estimates completed by NWF are encouraging: ***Increases in electric bills ranging from about 70 cents to a little more than $2.00 would finance steep cuts in mercury pollution.***

NWF is confident that policy makers, power plant managers and executives, and equipment manufacturers can meet the challenge of 90 percent mercury control before the end of the decade. The troubling effects of mercury contamination, coupled with the proven feasibility of reducing mercury emissions from the nation's largest unregulated source, create a convincing case for requiring significant mercury reductions today.

Specifically, NWF recommends that:

- The federal government finalize a mercury emissions standard for coal-fired power plants that would reduce mercury emissions by up to 90% by the end of the decade, as stipulated by the current Clean Air Act.
- State governments enact regulations and other policies to facilitate innovation and rapid adoption of pollution control and clean energy technologies.
- State and federal policy makers pursue a comprehensive energy strategy that provides incentives for multi-pollutant reductions, increased fuel efficiency, and enhanced reliance on renewable energy sources.

We have the means and the responsibility to deeply reduce mercury pollution over the next decade. There is no need to hand this problem down to our children.

Carbon injection storage and feeder

Photo Source: ICAC

Getting the Job Done:

Affordable Mercury Control at Coal-Burning Power Plants

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Research and writing for this report was done by National Wildlife Federation's Clean the Rain Campaign staff: Michael Murray, Zoe Lipman, Felice Stadler, Catherine Bowes, and contractor Maureen Swanson. NWF wishes to thank Martha Keating of the Clean Air Task Force for her thorough review of the report, and the Institute of Clean Air Companies for providing input on the technology chapter. Review of this report does not suggest reviewers' endorsement of the report's conclusions and recommendations.

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For more information about NWF or to view this report online visit: www.nwf.org/mercury

Cover Photos: Monroe Power Plant - Center for Great Lakes & Aquatic Sciences; Young girl catching bluegill at Occoquan Bay NWR - FWS - Robert H. Pos

A Look at Our Full Report

For a copy of *Getting the Job Done: Affordable Mercury Control at Coal-Burning Power Plants:*

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References:

For a full list of references, our methodology, and more information on the cost of reducing mercury emissions from coal-fired power plants, please see the complete report, *Getting the Job Done, Affordable Mercury Control at Coal-Burning Power Plants.*