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Risk in Perspective

HEALTH BENEFITS OF EMISSIONS REDUCTIONS FROM OLDER POWER PLANTS

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Hundreds of older power plants in the United States that were licensed before the Clean Air Act took effect in 1970 do not have to meet the more stringent emissions requirements the Clean Air Act imposes on new plants. These older facilities were 'grandfathered' under the rationale that they were near the end of their lifespans, and would eventually be replaced by cleaner new power plants. It was therefore argued that the cost of retrofitting them with pollution control equipment was not justified.

In practice, this protection from expensive retrofitting created an economic incentive for power companies to keep these plants operating, and many of them continue to produce power today. Pre-1980 coal-fired power plants contribute about half of all electricity generation in the US. They produce nearly all the sulfur dioxide (SO_2) and nitrogen oxide (NOx) emissions from the entire national power industry, which amounts to about two-thirds of SO_2 emissions and one-quarter of NOx emissions from all sources, nationwide.

A growing number of proposals would require these older power plants to meet the same standards required of new facilities. As of February 2001, four states - Massachusetts, Connecticut, New Hampshire, and Texas - had proposed regulations to achieve this goal. Legislation has also been introduced in Congress, including the Waxman-Boehlert Clean Smokestacks Act (H.R. 2900) and the Jeffords-Lieberman Clean Energy Act (S. 1369). President Bush recently stated that mandatory reductions of SO_2, NOx, and mercury are being planned. These proposals all put in place timelines for older facilities to apply the best available control technology (BACT) to substantially reduce emission rates.

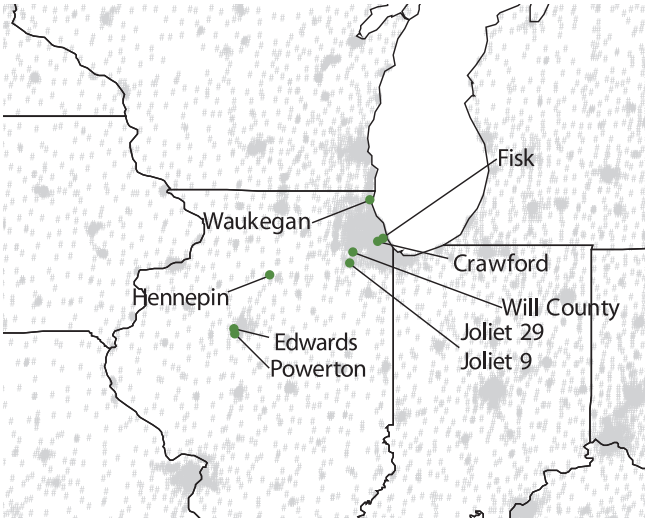
Opponents of these federal proposals argue that the environmental and health benefits would be negligible given current low levels of air pollution and therefore do not justify the costs. In response to proposals at the state level, opponents argue that power plants make relatively small contributions to local air pollution.

Among supporters of more stringent controls, some argue that the current system of market-based emissions trading (in which facilities facing high control costs can purchase emissions credits from facilities facing lower costs) is the most efficient way to improve overall air quality. Detractors of trading argue that people living near the power

plants are at higher risk and that the emissions credit system "trades away their health".

To help inform this debate, we constructed quantitative models to evaluate the magnitude and distribution of human health benefits associated with reducing emissions at older coal-burning power plants. In this *Risk in Perspective*, we focus on nine power plants in and upwind of Chicago. This work was commissioned by the Clean Air Task Force with support from the Pew Charitable Trusts, and the complete report is available on request.

POWER PLANT SITES AND MODELING REGION EVALUATED



PROJECT DESIGN

We used an atmospheric dispersion model to calculate the impacts of each of the nine facilities on air pollution concentrations over a 500 by 500 mile area that included portions of nine Midwestern states. We evaluated the contribution of each facility to ambient concentrations of particulate pollution in each census tract across the region. We focused exclusively on fine particulate matter ($PM_{2.5}$), since much of the available evidence points toward such particles as causal agents for cardiovascular and respiratory health effects. This includes both primary PM, emitted directly by the power plant, and secondary PM - sulfates and nitrates – which are particles that form over time when SO_2 and NOx emissions react with ammonia and water in the atmosphere.

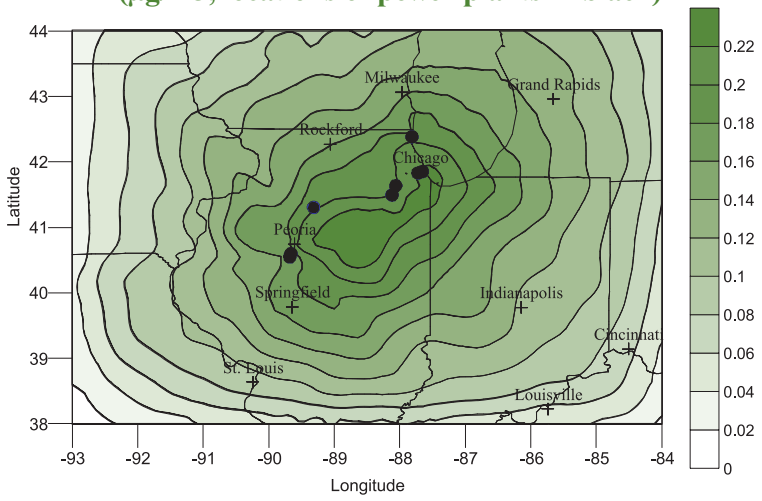
We calculated levels both for current emission rates and for lower rates that would result if emissions standards for these plants were made more stringent.

CURRENT CONTRIBUTIONS TO PARTICULATE CONCENTRATIONS

At current levels of emissions, these plants together contribute a maximum of 0.6 micrograms per cubic meter of air ($\mu g/m^3$) to the annual average $PM_{2.5}$ concentration. To put that in perspective, total $PM_{2.5}$ concentrations in this region are approximately 15-20 $\mu g/m^3$.

To estimate health impacts, we multiplied the particulate concentration by the number of people in the affected population in each census tract. The resulting average $PM_{2.5}$ exposure from these nine power plants, within the defined region, was 0.3 $\mu g/m^3$ per person. Half of this exposure was from secondary sulfates, with 37% from secondary nitrates and 13% from primary particles. Given pollutant dispersion patterns and variability in meteorology and specific emissions from each plant, the impacts were not uniform across the study area. Impacts tended to be greater closer to the plants, implying that the structure of the control policy (e.g., degree of emission trading allowed) would likely affect the magnitude of benefits received within specific cities or states.

DISTRIBUTION OF SECONDARY SULFATE IMPACTS
(µg/m3, locations of power plants in black)



HEALTH BENEFITS

Previous epidemiological studies have shown a relationship between current levels of particulate pollution and morbidity and mortality. Using the evidence from cohort studies, which follow individuals over time to assess the effects of long-term exposure, we estimate that the incremental increase in particulate concentrations attributable to these nine plants result in approximately 400 deaths per year. This mortality impact is spread across a population of 33 million individuals.

The following chart indicates our best estimates of some of the health benefits if the tighter emissions standards were applied to the nine plants we studied. The proposed BACT emissions controls are not 100% efficient in reducing emissions of $PM_{2.5}$ or particulate matter precursors, so not all of the health risks can be eliminated which is why the number of deaths avoided, 300, does not match the number of deaths caused by the emissions – 400).

SELECTED HEALTH BENEFITS FROM EMISSION CONTROLS

Health outcome	Best estimate (fewer cases/year)
Mortality	300
Emergency room visits (cardiovascular and respiratory)	2,000
Asthma attacks	10,000
Incidents of daily upper respiratory symptoms	400,000

Although we have presented point estimates for concentration reductions and health benefits, these estimates are in fact somewhat uncertain. Concentration estimates depend on assumed emission rates, weather, meteorological and pollutant parameters in the dispersion model, and assumptions about the interpretation of model outputs. Our uncertainty analysis found that nitrate estimates were the most uncertain, followed by sulfates and primary particulate matter.

Uncertainty is also associated with the health evidence, including the possibility that the $PM_{2.5}$ effect is attributable in part to other pollutants, the difficulty in determining if differential effects by particle type exist, and issues related to the interpretation and application of a limited number of studies. Considering the array of uncertainties, our benefit estimates could vary by nearly two orders of magnitude. But the extreme values are unlikely and a plausible range is that controls would prevent 100-600 deaths per year.

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DISCUSSION

There are pros and cons, beyond the human health impacts from PM, that should be considered in an analysis of tightening emissions standards for older power plants. Additional benefits might include reduced health risk from ozone formation and decreased acid precipitation. Requiring all plants to meet similar emissions standards might level the economic playing field in the power industry and encourage new entrants into the power market, with a potential benefit in supply. Newer plants are likely to be more efficient and more environmentally benign. On the other hand, requiring expenditures on additional emissions controls will raise electricity bills. Further, newer power plants would be likely to rely heavily on natural gas, creating issues of fuel diversity/dependence as well as cost, given recent increases in natural gas prices.

That being said, the central question we seek to address is whether the proposed regulations provide sufficient human health benefits to justify taking action. Since we have not analyzed information about costs, we can only evaluate whether the health benefits appear substantial enough to justify a more comprehensive benefit-cost analysis. In this study area, reductions would be expected to prevent 300 deaths per year and reduce the most exposed individual's annual risk of death due to particulate pollution by approximately 5 in 100,000. Further, a study by Abt Associates found that if all power plants across the US reduced their emissions by 75% (similar to the reduction for grandfathered power plants using BACT), approximately 20,000 premature deaths per year might be prevented. If correct, this would seem to justify closer scrutiny of the benefits and costs of controls.

Our analysis cannot be directly applied in other settings, nor can it be directly used to make national-level calculations (although our impacts per unit emissions are similar to the Abt Associates findings). But other studies have shown that the risks from power plants can be reasonably predicted with only limited knowledge of source characteristics, population patterns, and meteorology. Reliable modeling of a representative subset of sources can allow findings to be extrapolated to other settings, helping to inform both local and national policy in a timely fashion.

In conclusion, our analytical framework allows us to understand both the magnitude and distribution of the benefits of proposed emissions controls, and it can be used to help develop policies that balance cost, health effects, and equity considerations.

President George W. Bush has nominated John Graham, Ph.D., Founder and Director of the Harvard Center for Risk Analysis, to head the Office of Information and Regulatory Affairs within the federal Office of Management and Budget. This influential post requires him to step down as Director of HCRA and take a leave of absence from the Harvard faculty.

The nomination is subject to the approval of the Senate Committee on Governmental Affairs. The committee chairman is Senator Fred Thompson of Tennessee. Ranking minority member is Senator Joseph Lieberman of Connecticut.

George Gray. Ph.D. will serve as Acting Director as the Harvard School of Public Health conducts a search for a permanent successor.