

In all science, error precedes the truth, and it is better it should go first than last.

Hugh Walpole, novelist (1884–1941)

AIR POLLUTION

Mercury Emissions Not Shrinking as Forecast

Although amendments to the Clean Air Act in 1990 gave the U.S. Environmental Protection Agency (EPA) the authority to regulate mercury in coal-fired power plant emissions, no such rules are currently in place. Mercury emissions from coal-fired power plants nevertheless declined somewhat in the years directly after the act was amended. But in the March 2010 report *Dirty Kilowatts: America's Top Fifty Power Plant Mercury Polluters*, the nonprofit Environmental Integrity Project (EIP) shows emissions have remained fairly steady since 2000, hovering between roughly 44 and 48 tons per year, despite the existence of technology that could drastically reduce the amount of mercury emitted from smokestacks.

The EPA has estimated that coal-fired power plants are the source of about 40% of anthropogenic mercury emissions in the United States. Worldwide they account for an estimated 25% of anthropogenic mercury emissions, according to *The Global Atmospheric Mercury Assessment: Sources, Emissions and Transport*, a 2008 report by the United Nations Environment Programme (UNEP). The UNEP authors note, “Mercury control technology for coal-fired power plants capable of capturing up to 95% of the mercury has only recently become commercially available and very few governments require it. Thus currently it is found on only a handful of plants [worldwide].”

In *Dirty Kilowatts*, the EIP reports that between 2007 and 2008, total emissions from the top 50 mercury-releasing power plants in the United States—of some 470 with sufficient emissions to be followed in the EPA's Toxics Release Inventory (TRI)—fell by 0.26%, while total mercury emissions from all 470 plants fell by 4.71%. At many individual plants, however, mercury emissions actually rose, in one case by more than 100%. TRI data are self-reported by the utilities, who estimate emissions based on the amount of coal burned, the effectiveness of control devices, and characteristics of the coal, among other factors.

Some cases of increased emissions were probably due to switching coal sources, according to the report—burning bituminous coal like that mined in Appalachia typically releases less mercury than, for example, burning the same amount of sub-bituminous coal like that mined in Wyoming. But increased electricity demand also contributed to increased emissions, says Leonard Levin, technical executive of the Electric Power Research Institute in Palo Alto. In most cases, emissions increased or decreased with the quantity of coal burned, he says.

Elemental mercury emitted from power plants can reside in the atmosphere for 6 months to 2 years, and can travel from one hemisphere to another before being deposited on Earth's surface, says Susan Keane, a senior environmental analyst at the Natural Resources Defense Council. For the general public, both U.S. and worldwide, the biggest source of mercury exposure is eating contaminated fish, says Keane. And while fetuses and young children are most sensitive to mercury poisoning, in her 2009 book, *Diagnosis: Mercury—Money, Politics & Poison*, San

Francisco internist Jane M. Hightower recounts discovering mercury poisoning in adult patients who complained of headaches, cognitive difficulties such as trouble concentrating, stomach upsets, hair loss, and other symptoms.

The EIP report notes the 4.71% decline in mercury emissions is “nowhere near the levels that would be achieved if all plants installed modern pollution controls.” In 2005, when the EPA adopted a mercury cap-and-trade scheme in the form of the Clean Air Mercury Rule, the agency predicted mercury emissions from coal-fired power plants would fall to 31–34 tons by 2010 and could further drop to 15 tons with the use of “maximum achievable control technology” (MACT)—control devices, best work practices, and other methods that reduce emissions as much as possible.

In 2008 the U.S. Court of Appeals for the DC Circuit overturned the Clean Air Mercury Rule because the reductions sought would not have been achieved until 2018, says EIP attorney Ilan Levin. But new regulatory action is under way; the EPA intends to propose air toxics standards for coal-fired power plants by March 2011 and finalize a rule by the following November. Existing plants will need to reduce mercury emissions to levels now attained by the best-performing 12% of all similar sources, and new plants must incorporate MACT. One of the highest mercury emitters listed in the EIP report, Luminant, has already installed sorbent injection systems—state of the art for mercury mitigation—on 10 of its 12 coal-fired plants, says a company spokeswoman.

Meanwhile, UNEP has been working to negotiate global mercury emissions reductions among 140 participant nations. The United States had long resisted these efforts, preferring a voluntary approach to reducing mercury emissions. So when the U.S. government delegation announced they were ready to negotiate a treaty at the February 2009 biannual meeting of UNEP's Governing Council, Keane says, “You've never seen a thousand jaws drop to the ground faster.” Following the United States' lead, other recalcitrant countries came onboard to negotiate a legally binding instrument to control mercury pollution by the end of 2013, she says.

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MINING

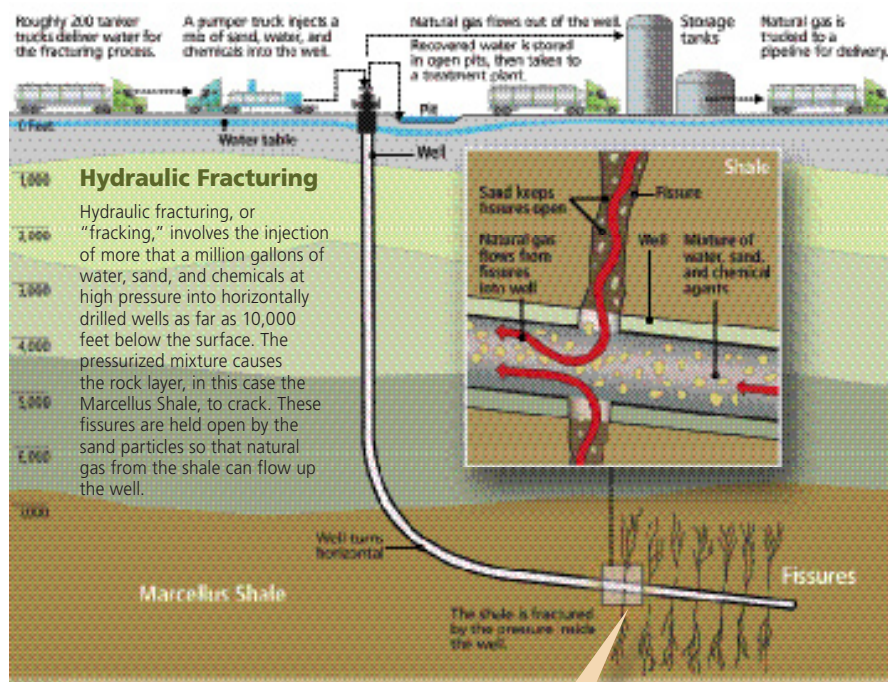
EPA Tackles Fracking

With the push for energy independence and fuels that emit fewer greenhouse gases, domestically produced natural gas has been growing in popularity. But alongside this growth have come concerns that hydraulic fracturing (“fracking”), a procedure used in the extraction of natural gas and oil, may pollute ground and surface waters. Responding to increasing public pressure for federal action and a call by the U.S. House of Representatives Appropriations Conference Committee, the U.S. Environmental Protection Agency (EPA) announced 18 March 2010 it will conduct a comprehensive study to investigate the potential adverse effects of fracking on water quality and public health.

Natural gas provides almost 25% of the U.S. energy supply and could provide 50% by 2035, according to the 2010 report *Fueling North America's Energy Future* by consultancy IHS Cambridge Energy Research Associates. In recent years, vast new deposits of natural gas have been discovered in layers of shale thousands of feet underground. Some of these deposits, such as the Marcellus Shale running under the Appalachian Basin, lie beneath watersheds supplying drinking water to millions of people. In many locations fracking—in which a mixture of water, sand, and chemicals is injected into natural gas wells under high pressure—occurs within hundreds of feet of residences that use wells for drinking water.

Recent evidence suggests fracking may have contributed to groundwater contamination with methane in some instances and that proprietary chemicals used in the procedure could theoretically pose a public health threat. However, because groundwater supplies and natural gas deposits are often separated by thousands of feet of rock and earth, and groundwater can be contaminated by many sources, it is difficult to establish a definitive connection between contaminated drinking water and fracking. Further, there has been very little in-depth research on the subject with respect to drilling in shale beds.

In 2005 Congress exempted fracking from regulation under the Safe Drinking Water Act partly on the basis of the EPA report *Evaluation of Impacts to Underground Sources of Drinking Water by Hydraulic Fracturing of Coalbed Methane Reservoirs*. The authors of this report wrote that hydraulic fracturing poses “minimal threat” to drinking water and that “additional or further study is not warranted at this time.” However, the study involved no direct monitoring of water wells but instead relied on existing peer-reviewed literature and interviews with industry and state and local



government officials. It also was strictly limited to one specific type of drilling and did not address the effects in substrates other than coalbeds.

Operators surround drill holes with steel casings cemented into place to prevent groundwater contamination during fracking. In addition, a large volume of “back-flow fluids,” on the order of hundreds of thousands of gallons per well, are brought to the surface during drilling and production. Back-flow fluids are typically stored in on-site pits (which, depending on state regulations, may or may not be lined) and ultimately are disposed of either by injection into EPA-approved underground wells or by delivery to municipal waste treatment facilities. In January 2010 state officials testified before the Ohio House of Representatives that standards and enforcement regarding oil and gas well construction are not always adequate to ensure proper performance.

The EPA has reallocated \$1.9 million for the new study in this fiscal year and will request further funding in the President’s FY2011 budget proposal. The agency’s scoping document identifies three major categories for research: characterization of the fracking life cycle, potential relationships to drinking water sources, and potential health and environmental hazards. Explicit research goals, as yet undefined, will be divided into short term (1–3 years) and long term (3–5 years).

What’s Getting Pumped In?

A variety of chemicals—among them methanol, formaldehyde, ethylene glycol, hydrochloric acid, and sodium hydroxide—are used for purposes such as improving fluid viscosity, inhibiting corrosion, and limiting bacterial growth.

“We’re very pleased that EPA is doing this study,” says Amy Mall, a senior policy analyst with the Natural Resources Defense Council (NRDC), which has long pressured Congress for federal regulation of fracking. “There are communities around the country that are very concerned because their water has been contaminated or could be contaminated.”

The NRDC also supports passage of the Fracturing Responsibility and Awareness of Chemicals (FRAC) Act, which was introduced in Congress in 2009. The FRAC Act would permit regulation of hydraulic fracturing under the SDWA and would require oil and gas companies to disclose the chemicals used in fracking operations.

Energy In Depth, a nonprofit organization representing the oil and gas industry, has lobbied against the FRAC Act, but supports the new EPA study in concept. “We’ve said from the outset that any updated study in this area should be science-based, peer-reviewed, and completely isolated from political design or interference,” says Chris Tucker, spokesman for Energy In Depth. “Assuming those criteria are met, we’re confident the new study will end up reaching the same conclusions that were produced by the old study.”

John Manuel of Durham, NC, is a regular contributor to EHP and the author of *The Natural Traveler Along North Carolina’s Coast* and *The Canoeist*.

SECONDHAND SMOKE

Parental Smoking May Set Up Children for Atherosclerosis

Children frequently exposed to secondhand tobacco smoke may be at greater risk of developing atherosclerosis as adults, suggests new research published in the March 2010 issue of *Circulation: Cardiovascular Quality and Outcomes*. “Passive smoking has been associated with an increased risk of atherosclerosis in adults by altering arterial structure and lipid profiles, but there is growing evidence the trouble might begin in childhood,” explains first author Katariina Kallio, a research fellow at the Research Centre of Applied and Preventive Cardiovascular Medicine, University of Turku, Finland. “Our study shows changes do occur in the intima-media thickness of the arteries of healthy adolescents exposed to smoke, confirming this fear.”

The study, which involved 494 healthy 13-year-olds, measured three preclinical indicators of atherosclerosis: the carotid and aortic intima-media thickness (i.e., the thickness of the walls of these arteries), flow-mediated dilation of the brachial artery (a measure of endothelial function), and plasma apolipoprotein B (ApoB) levels (a measure of circulating atherogenic lipoproteins).

The researchers divided the children into low-, intermediate-, and high-exposure groups, which were determined on the basis of each child’s average serum cotinine level (0.1–0.4 ng/mL, 0.41–0.7 ng/mL, and 0.71–4.1 ng/mL, respectively) as measured at different times since age 8 years. High-resolution ultrasound scans showed the intima-media of the carotid artery was thicker in children in the high- and intermediate-exposure groups than in the low-exposure group. The same was true of the aortic intima-media. In addition, flow-mediated dilation in the brachial artery was significantly reduced in the high-exposure group.

These preclinical signs of atherosclerosis were accompanied by significantly increased ApoB levels in the high-exposure group compared

with the low-exposure group. Their ApoB/ApoA-1 ratios also were significantly higher, a predictor of atherosclerosis and endothelial dysfunction in adults. Associations persisted after accounting for other atherosclerosis risk factors including serum lipids, sex, pubertal status, diastolic blood pressure, and body mass index.

“Intima-media thickness may be increased by a direct toxic effect of tobacco smoke, the enhanced binding of platelets to vessels causing the growth of vascular smooth muscle, or perhaps lipid peroxidation; we are not sure,” says Kallio. “Nor are we sure why ApoB is increased, although we believe liver enzyme function might be involved.”

“Passive smoking has been associated with an increased risk of atherosclerosis in adults . . . but there is growing evidence the trouble might begin in childhood.”

“Whether the changes seen are reversible on removing children from smoke exposure, and how long this would take, are also currently unknown,” comments John Cockcroft of the Wales Heart Research Institute, Cardiff University School of Medicine, who was not involved in the study.

The publication of these findings coincides with a 24 March 2010 call by the Royal College of Physicians (RCP) to ban smoking in cars in the United Kingdom to reduce children’s exposure to secondhand smoke. Several U.S. states and parts of Australia and Canada already ban smoking specifically in cars carrying children. “What is clear,” says Cockcroft, “is that [this Finnish study] provides further evidence to support the RCP’s call for a ban on exposing children to smoke inhalation—a proposal that the authors themselves support.”

Adrian Burton is a biologist living in Spain who also writes regularly for *The Lancet Oncology*, *The Lancet Neurology*, and *Frontiers in Ecology and the Environment*.

The Beat by Erin E. Dooley

Immunity Insight: Breastmilk and Allergens

A study by Valérie Verhasselt in a supplement to the February 2010 issue of *The Journal of Pediatrics* yields new insights into how breastmilk helps program the immune system of offspring. The milk of lactating mice exposed to the allergen ovalbumin contained ovalbumin and the immune factor TGF- β . Offspring of these mice exposed as adults to ovalbumin were less likely to show symptoms of asthma if their dams had been exposed to the allergen during lactation. The combination of allergen and immune factor in milk appears to be key to producing the protective effect.

Nzu: From Remedy to Malady?

In December 2009 the FDA issued a national warning advising pregnant and breastfeeding women to avoid consuming *nzu*, a West African traditional remedy for

morning sickness sold in pellet or powder form around the world. That warning was based on findings from Texas that samples of *nzu* contained high levels of arsenic and lead. In March 2010 the Guilford County (NC) Department of Public Health also found high levels of lead in samples of *nzu* (60–80 times the FDA limit), prompting a statewide warning. The remedy also may be called calabash chalk, calabar stone, la craie, argile, or mabele.



Nzu is sold in several different forms.

Improving Predictions of Climate Change Impacts

In March 2010 the National Science Foundation, along with the Departments of Agriculture and Energy, announced a new 5-year interdisciplinary program to develop high-resolution models for predicting climate change and its associated impacts at a local scale. The program, which received about \$49 million in funding for its first year, is expected to provide models at significantly improved geographic and temporal resolutions that will be able to help decision makers plan strategies for adapting to the health, ecological, economic, and social changes that could result from a rapidly changing climate.

High TB Rates among the Inuit

A 10 March 2010 news conference in Ottawa, Canada, highlighted findings that the Inuit population of Canada was infected with tuberculosis at more than 30 times the Canadian national average in 2008. Speakers at the conference, who represented Inuit governing agencies, focused on environmental

<http://www.foed.gov.uk>

MARINE AND COASTAL SCIENCE

Faster Test for Detecting Contamination of Recreational Waters

Swimmers and surfers face the risk of contracting gastrointestinal illnesses from exposure to water contaminated with human sewage. The current method for monitoring fecal indicator bacteria (FIB) in recreational waters requires collecting water samples, then culturing and counting microbes in the laboratory, a process that takes 24 hours. This delay may expose swimmers to tainted water or, conversely, unnecessarily close beaches that are no longer contaminated. Now engineers at the University of California, Los Angeles (UCLA) have designed a better rapid-detection method that directly analyzes FIB onsite in recreational waters in less than 1 hour.

Called the covalently linked immunomagnetic separation/adenosine triphosphate (Cov-IMS/ATP) technique, the portable process uses magnetic beads linked covalently to antibodies that bind FIB. The bead-captured FIB are ruptured and treated with an enzyme (luciferase) that catalyzes a light-emitting reaction powered by ATP. A luminometer measures the amount of light emitted, which correlates with bacterial concentrations.

UCLA's Jennifer Jay, an associate professor of civil and environmental engineering, graduate student Christine Lee, and coworkers collected ocean samples from a California beach and from freshwater streams that flow into the beach area. They checked for two common FIB—*Escherichia coli* and *Enterococcus*. The Cov-IMS/ATP method correctly identified 87% of *E. coli* and 94% of *Enterococcus* in the samples, producing results similar to standard culture-based methods performed for comparison. Moreover, the new method detected FIB at limits below what the U.S. Environmental Protection Agency deems

healthy for recreational waters. The findings were published online 24 December 2009 ahead of print in the *Journal of Applied Microbiology*.

Other efforts to develop rapid tests for recreational water quality are based on the quantitative polymerase chain reaction (for example, see *EHP* 114:24–28 [2006]). A field test based on Cov-IMS/ATP would be easier to use, according to Mark Gold, president of Heal the Bay, an environmental group in Santa Monica, California, that monitors aquatic habitats. That's because quantitative polymerase chain reaction takes about 3 hours and requires cumbersome equipment, plus samples must be transported to a laboratory.

Now the UCLA team is adapting the method to identify *Bacteroidales* species, microbes that can be definitively linked specifically to human fecal pollution. "*E. coli* and *Enterococcus* are not ideal fecal indicators because they do not tell you the source of the fecal pollution, and they grow naturally in the environment," says Jay. In contrast, bacteria in the *Bacteroidales* family grow only in the intestines of warm-blooded animals, with different species targeting different animals. These bacteria also do not replicate well in the environment. So the detection of *Bacteroidales* signals recent fecal pollution. "Even more important," says Jay, "you can tell whether *Bacteroidales* comes from humans or an animal to target cleanup efforts." The team's measurements of FIB in freshwater streams to test whether the method could track beach pollution to a particular storm drain will be submitted for publication separately.

The Cov-IMS/ATP method could potentially become a tool for beach managers to analyze water samples in the morning and post public health warnings within a few hours. Gold says, "This would protect public health better than the current system, where beaches are closed based on yesterday's results."

Carol Potera, based in Montana, has written for *EHP* since 1996. She also writes for *Microbe*, *Genetic Engineering News*, and the *American Journal of Nursing*.



Left to right: Raymond Gehman / © Corbis; © Darren Greenwood/Design Pics/Corbis

factors including overcrowded housing and lack of clean drinking water and affordable nutritious food as primary factors in the disparity; many Inuit communities also lack access to quality medical care. They called on the Canadian government to develop a national strategy specific to the Inuit that provides culturally relevant solutions that address living conditions for Canadian Inuit.

e-Waste Laws for India

By early May 2010, the Indian Ministry of Environment and Forests expects to approve rules putting responsibility for the disposal of Indian-made electronic products on their manufacturers. The rules were proposed in 2009 by a coalition of environmental advocacy groups and the Indian Manufacturers' Association for Information Technology. India produces more than 300,000 tons of e-waste annually, a figure that may triple by 2020, according to a recent UNEP report. The new regulations would prohibit the cottage industry of dismantling electronics and recovering the valuable metals they contain, but informal recyclers could still find employment by assisting in the collection of e-waste.

Animals en Masse

Livestock in a Changing Landscape, a two-volume report released in March 2010 by a multi-institution collaborative including the FAO, documents how animal production is causing widespread effects on the environment and human health. Livestock worldwide has tripled

over the last 30 years. According to the report, 1.7 billion head of livestock currently occupy more than one-fourth of the land on Earth, and one-third of the Earth's arable land is devoted to crops used to feed these herds. The report reviews several options for more sustainable animal production. "We want people engaged in the livestock industry to look closely at the report and determine what improvements they can make," said report co-editor Harold Mooney.

