

Coal Ash Is More Radioactive than Nuclear Waste

By burning away all the pesky carbon and other impurities, coal power plants produce heaps of radiation
December 13, 2007 |By [Mara Hvistendahl](#)



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The popular conception of nuclear power is straight out of *The Simpsons*: Springfield abounds with signs of radioactivity, from the strange glow surrounding Mr. Burn's nuclear power plant workers to Homer's low sperm count. Then there's the local superhero, Radioactive Man, who fires beams of "nuclear heat"

from his eyes. Nuclear power, many people think, is inseparable from a volatile, invariably lime-green, mutant-making radioactivity.

Coal, meanwhile, is believed responsible for a host of more quotidian problems, such as mining accidents, acid rain and [greenhouse gas emissions](#). But it isn't supposed to spawn three-eyed fish like Blinky.

Over the past few decades, however, a series of studies has called these stereotypes into question. Among the surprising conclusions: the waste produced by coal plants is actually more radioactive than that generated by their nuclear counterparts. In fact, the fly ash emitted by a power plant—a by-product from burning coal for electricity—carries into the surrounding environment 100 times more radiation than a nuclear power plant producing the same amount of energy. * [*See Editor's Note at end of [page 2](#)*]

At issue is coal's content of uranium and thorium, both radioactive elements. They occur in such trace amounts in natural, or "whole," coal that they aren't a problem. But when coal is burned into fly ash, uranium and thorium are concentrated at up to 10 times their original levels.

Fly ash uranium sometimes leaches into the soil and water surrounding a coal plant, affecting cropland and, in turn, food.

People living within a "stack shadow"—the area within a half- to one-mile (0.8- to 1.6-kilometer) radius of a coal plant's smokestacks—might then ingest small amounts of radiation. Fly ash is also disposed of in landfills and abandoned mines and quarries, posing a potential risk to people living around those areas.

In a 1978 paper for *Science*, J. P. McBride at Oak Ridge National Laboratory (ORNL) and his colleagues looked at the uranium and thorium content of fly ash from coal-fired power plants in Tennessee and Alabama. To answer the question of just how harmful leaching could be, the scientists estimated radiation exposure around the coal plants and compared it with exposure levels around boiling-water reactor and pressurized-water nuclear power plants.

The result: estimated radiation doses ingested by people living near the coal plants were equal to or higher than doses for people living around the nuclear facilities. At one extreme, the scientists estimated fly ash radiation in individuals' bones at around 18 millirems (thousandths of a rem, a unit for measuring doses of ionizing radiation) a year. Doses for the two nuclear plants, by contrast, ranged from between three and six millirems for the same period. And when all food was grown in the area, radiation doses were 50 to 200 percent higher around the coal plants.

McBride and his co-authors estimated that individuals living near

coal-fired installations are exposed to a maximum of 1.9 millirems of fly ash radiation yearly. To put these numbers in perspective, the average person encounters 360 millirems of annual "background radiation" from natural and man-made sources, including substances in Earth's crust, cosmic rays, residue from nuclear tests and smoke detectors.

Dana Christensen, associate lab director for energy and engineering at ORNL, says that health risks from radiation in coal by-products are low. "Other risks like being hit by lightning," he adds, "are three or four times greater than radiation-induced health effects from coal plants." And McBride and his co-authors emphasize that other products of coal power, like emissions of acid rain-producing sulfur dioxide and smog-forming nitrous oxide, pose greater health risks than radiation.

The U.S. Geological Survey (USGS) maintains an online database of fly ash-based uranium content for sites across the U.S. In most areas, the ash contains less uranium than some common rocks. In Tennessee's Chattanooga shale, for example, there is more uranium in phosphate rock.

Robert Finkelman, a former USGS coordinator of coal quality who oversaw research on uranium in fly ash in the 1990s, says that for the average person the by-product accounts for a miniscule amount of background radiation, probably less than 0.1 percent of total background radiation exposure. According to USGS

calculations, buying a house in a stack shadow—in this case within 0.6 mile [one kilometer] of a coal plant—increases the annual amount of radiation you're exposed to by a maximum of 5 percent. But that's still less than the radiation encountered in normal yearly exposure to X-rays.

So why does coal waste appear so radioactive? It's a matter of comparison: The chances of experiencing adverse health effects from radiation are slim for both nuclear and coal-fired power plants—they're just somewhat higher for the coal ones. "You're talking about one chance in a billion for nuclear power plants," Christensen says. "And it's one in 10 million to one in a hundred million for coal plants."

Radiation from uranium and other elements in coal might only form a genuine health risk to miners, Finkelman explains. "It's more of an occupational hazard than a general environmental hazard," he says. "The miners are surrounded by rocks and sloshing through ground water that is exuding radon."

Developing countries like India and China continue to unveil [new coal-fired plants](#)—at the rate of one every seven to 10 days in the latter nation. And the U.S. still draws around half of its electricity from coal. But coal plants have an additional strike against them: they [emit harmful greenhouse gases](#).

With the [world now focused on addressing climate change](#),

nuclear power is gaining favor in some circles. China aims to quadruple nuclear capacity to 40,000 megawatts by 2020, and the U.S. may build as many as 30 new reactors in the next several decades. But, although the risk of a nuclear core meltdown is very low, the impact of such an event creates a stigma around the noncarbon power source.

The question boils down to the accumulating impacts of daily incremental pollution from burning coal or the small risk but catastrophic consequences of even one nuclear meltdown. "I suspect we'll hear more about this rivalry," Finkelman says. "More coal will be mined in the future. And those ignorant of the issues, or those who have a vested interest in other forms of energy, may be tempted to raise these issues again."

**Editor's Note (posted 12/30/08): In response to some concerns raised by readers, a change has been made to this story. The sentence marked with an asterisk was changed from "In fact, fly ash—a by-product from burning coal for power—and other coal waste contains up to 100 times more radiation than nuclear waste" to "In fact, the fly ash emitted by a power plant—a by-product from burning coal for electricity—carries into the surrounding environment 100 times more radiation than a nuclear power plant producing the same amount of energy." Our source for this statistic is Dana Christensen, an associate lab director for energy and engineering at Oak Ridge National Laboratory as well as 1978 paper in Science authored by J.P.*

McBride and colleagues, also of ORNL.

As a general clarification, ounce for ounce, coal ash released from a power plant delivers more radiation than nuclear waste shielded via water or dry cask storage.

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physicsadherent

February 1, 2009, 12:39 AM

The point of the article is that burning coal to produce electricity is an extremely poor alternative to nuclear energy in every measure, and that the reasons the practice of burning coal to produce electricity are public

stupidity and corporate greed.

Is that clear enough?

Assuming that the human race survives long enough, a future first grade student will exclaim, "They burned and polluted the atmosphere to make electricity? How stupid!"

Until then, there are still more mountains to flatten and valleys to fill to obtain coal to burn and spew pollutants throughout our environment, instead of containing them.

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player6565

February 19, 2009, 11:52 AM

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Or can you only come up with there is more with coal!!!!!!!!!!!!!!!!!!!!!!!!!!!!

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emwendy

March 13, 2009, 12:57 AM

I'm writing a story about the health effects of coal fly ash for my college environmental journalism class... would any of you be willing to speak with me about it? Especially if you are working in this sort of field??

my email: wendleej@email.uc.edu

please, if you are available I could use the reference

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ckmapawatt

March 18, 2009, 11:45 PM

Great article. I had to reference it in my blog post on why nuclear should be considered more when we talk about Clean Energy. It's definitely much cleaner than Coal!

<http://blog.mapawatt.com/2009/03/18/repower-america-100-clean-electricity/>

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Kal Skirata

April 2, 2009, 8:50 AM

NHChemist at 08:16 PM on 12/13/07

I can't believe that Scientific American published this. The title is totally misleading. It should be Radiation Exposure is Higher near Coal Fired Power Plants. If nuclear waste is so benign, why is it stored in casks or under water to prevent radiation exposure by nearby people? When I lived in upstate NY in the late 1970's, coal ash was used in place of sand as a traction aid on slippery roads. This was a poor practice, but how much worse would it have been if the State of NY used spent nuclear fuel?

in response to this you could not have used Nuke waste because it has the wrong consistancy- second no one said nuke waste was benign they said coal ash is worse its like a 9mm pistole vs the main gun on a battle ship...your argument that nukes are dangerous is ignorant and born of fear...TMI (three mile island) was the greates succes in the Nuke industries history...nearly complete melt down and yet no one died and there is only some evidence the workers even got sick and thats by groups like Green Peace who are anti-nuclear so would love you to think nukes are that dangerous.

secondly nuke waste is avoidable...the way to do that is called a breeder reactor it converts the U-235 from its original form to 1 of 2 other options one is weapons grade plutonium...and the other is more fissionable material then there was to start...name another fuel source that generates more by being used...you cant it does not exist...

third anther person made the ignorant statement that coal is less radioactive which is not true coal ash releases 100 times tha radiation and we are all being affected by it since they can spew it into the air without filtering it out they filter some out but most is simple expelled

learn the facts before you argue i am writing a 50 page paper on the benifits of nuke energy so you all lose to the 40 sources i have and the list continues

to grow by the day...

regards

Graham

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Iron Mike

April 20, 2009, 1:10 PM

I was exposed too flyash at a power plant in Illinois , for 2 years, I worked in the flyash pits as a heavy equipment operator, is my health at risk? I seem too wease alot in my breathing.

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Iron Mike

April 20, 2009, 1:13 PM

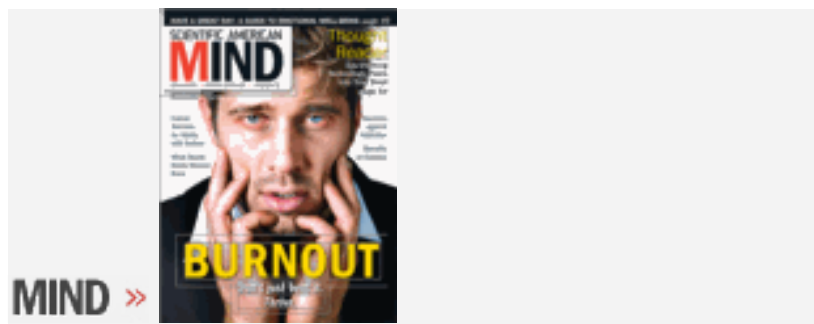
I worked in the flyash at a pcoal fired power plant in Illinois for 2 years, as a heavy equipment operator, in the flyash pits, is my health at risk, I seem too wease alot since the period I worked there this was in the late 1990's.

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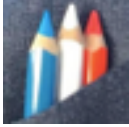
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