the outlook for CCPs

BY KAREN D. SCHWARTZ

Despite hurdles on the way, electric utilities have brought their coal combustion products (CCPs) to market. Now they are closely watching to see whether impending regulations on air emissions will slow their progress down.

JIM ROEWER hates it when people refer to the materials produced during the burning of coal to create electricity as "byproducts" or, even worse, "wastes." The correct term, insists Roewer, executive director of the Utility Solid Waste Activities Group (USWAG), is "coal combustion products" (CCPs). "The term 'byproducts,' not to mention 'waste,' has a negative connotation," he says. They feed the perception that those materials—fly ash, bottom ash, boiler slag, and flue gas desulfurization material—are simply materials destined to fill up valuable landfill space, create health concerns, and have adverse environmental impacts.

Opposite: Florida's Sunshine Skyway bridge in Tampa Bay was built with concrete containing fly ash—a product of coal combustion.

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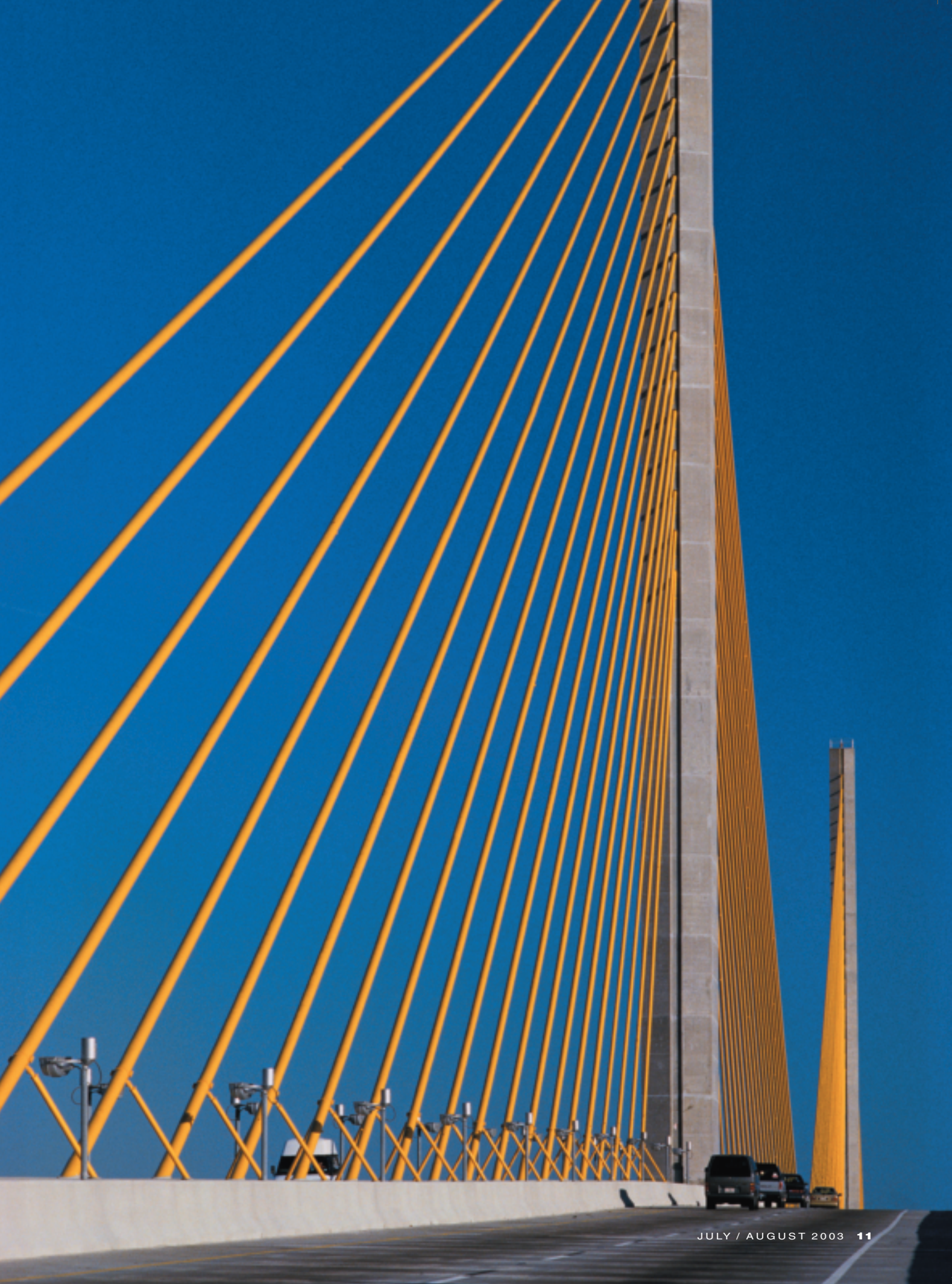

Roewer is concerned about getting the language right for good reasons. CCPs, when used in various applications, can result in benefits of which their detractors probably aren't all that aware. Environmental benefits include the reduction of greenhouse gas emissions, reduced land disposal requirements, and reduced use of raw materials. There are economic advantages as well, including reduced costs of materials disposal, increased revenue from the sale of CCPs, and savings from substituting them for other, more expensive materials. And the use of those materials can result in performance benefits—CCPs can enhance other products by strengthening them and making them more workable. For example, fly ash instead of Portland cement in concrete for pavements lasts 50 years—twice the lifetime of conventional pavements.

Other beneficial uses include, among many others, building materials, paint filler, and snow and ice control. Last year, Alliant Energy completed construction of its corporate headquarters in Madison, WI, using concrete made with 244 tons of fly ash in the building's footings, walls, columns, and parking garage. And companies are continuously searching for new and innovative ways to use CCPs, since disposal costs can run to 1-3 percent of a utility's annual budget—it's often cheaper to give the stuff away.

In 2001, more than one-third of CCPs were used in beneficial applications, according to the American Coal Ash Association's (ACAA's) 2001 survey. But the actual increase in tonnage use over the last decade is over 40 percent, according to ACAA: In 1991, 30.8 percent of 88 million tons was used, or 27 million tons; in 2001, 33.4 percent of 117 million tons, or 39 million tons, was used.

Still, most people who might use CCPs aren't receptive to the idea, says George Offen, area manager of emissions and byproducts at the Electric Power Research Institute (EPRI). "They don't appreciate the engineering and environmental benefits—and that is a barrier. Potential end-users still have the perception that CCPs are wastes that will make their building product less useful."

Along with negative perceptions, CCPs may have to contend with pending environmental rules that will change their usability. This and other economic and technical hurdles mean that, in the end, CCPs are an environmental solution that still has a way to travel.

Dealing with Environmental (Mis)Perceptions

One of the most common complaints about the use of CCPs is that they pose environmental and health risks. Health concerns include issues related to ingesting ash dust, exposure to compounds like arsenic and chromium, leaching from coal ash land applications and products containing coal ash, skin contact with ash, and the radioactivity of ash. In terms of the environment, many are worried about the effect of CCPs on aquatic life, absorption of the trace metals from coal ash into vegetation, and Superfund issues regarding disposal of hazardous waste.

"There is still a feeling in the environmental community that these are potentially dangerous products," says John Glenn, an environmental specialist with the office of solid waste in the Environmental Protection Agency's (EPA's) municipal waste reduction branch. Eventually, Glenn believes, the environmental community will accept the use of CCPs in concrete products but may have remaining concerns about other uses. To counter those concerns, Glenn cites the environmental benefits of CCPs. Using coal ash to replace Portland cement in concrete is particularly beneficial, he says, noting that for every ton of coal ash products used, there is a 0.89 ton reduction in greenhouse gases.

Numerous studies have contributed to dispelling environmental and health concerns, and to a certain degree so have

Courtesy: Alliant Energy

Waste not. The footings, walls, columns, and parking garage at Alliant's corporate headquarters contain concrete made with 244 tons of fly ash.

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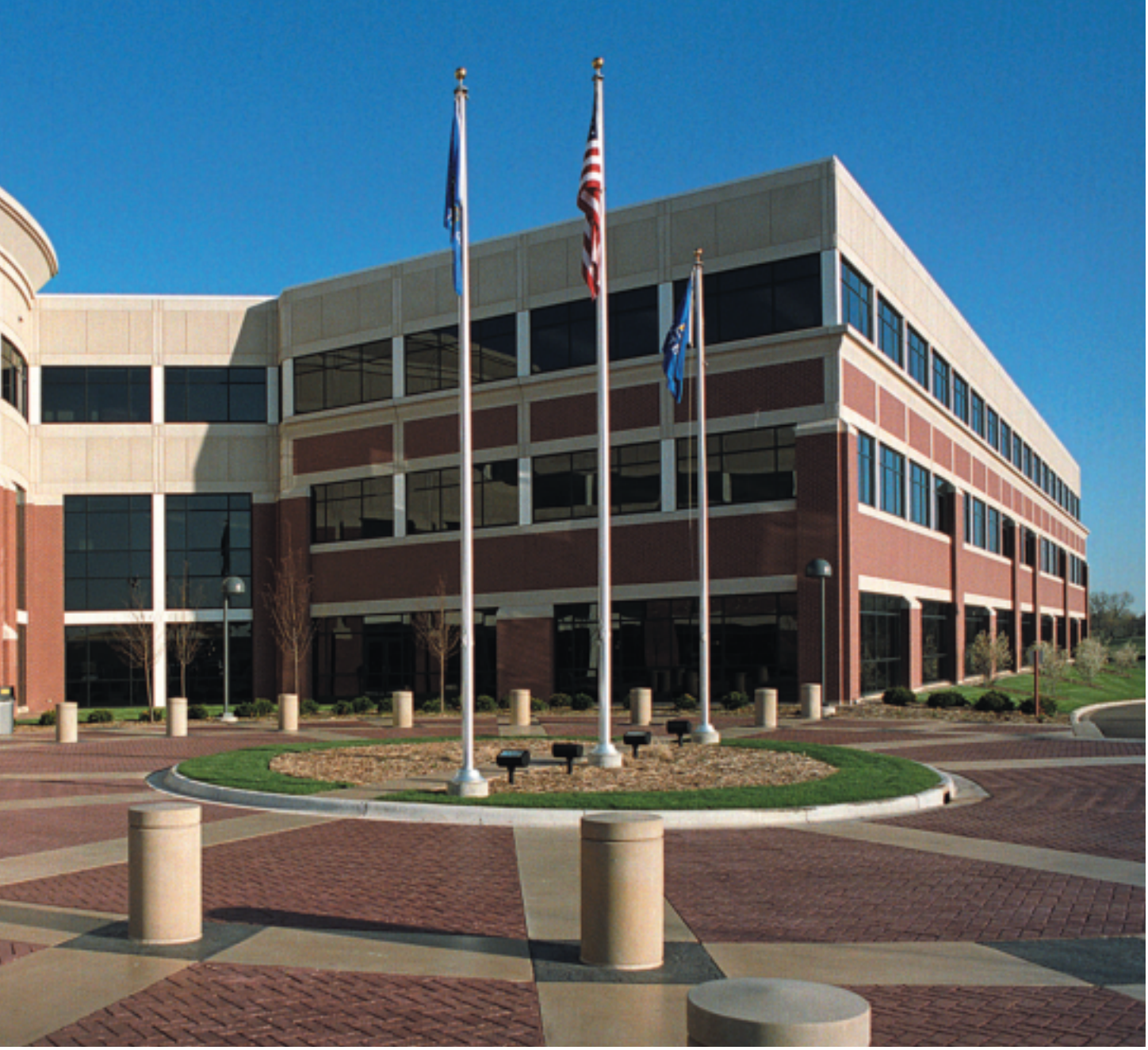

federal legislation and regulations. EPA stated in 1993 that the beneficial use of CCPs poses no risk. Again in 2000, EPA ruled that CCPs don't pose sufficient danger to the environment to warrant federal regulation but determined that national regulations should exist for CCPs that are disposed of in landfills or surface impoundments. EPA also stipulated that waste disposal should be regulated by the states. As a result, utilities are at the mercy of a wide variety of state regulations regarding use of CCPs. In some states, for example, utilities must secure specific permits as if it were a waste, even when it's being used in a beneficial manner.

"It's very difficult when they are constantly changing the rules," says Mike Thomes, a business development consultant at Xcel Energy in Minneapolis. What Xcel really wants, Thomes says, is more flexibility in the regulations surrounding CCPs. He may get it: Minnesota is in the process of revising its CCP rules. "We hope we get clarity with the new rules," he says.

Other issues can arise because of the lack of standardization. "When you are transporting material from one state to another, you can experience problems," explains Tom Jansen, supervising engineer at We Energies in Milwaukee. "Michigan, for example, has rules that are a bit more challenging to work with than the rules in Wisconsin."

Although some have called for standardization among the states, not everyone is in favor of the idea. "Those states that have open circumstances regarding utilization want to be left alone, while those of us who need clarity would be in favor of standardization," Thomes says. Xcel Energy, for example, has to deal with Minnesota's confusing and stringent state regulations, while utilities in states like Texas, Pennsylvania, North Carolina, and Ohio have much more flexible rules. California, for example, highly encourages the use of fly ash, making it relatively easy for companies to enter the market.

"Some states have good beneficial use regulations, and some don't," says Roewer. "We'd like to see EPA issue a strong statement to the states that when beneficially used, CCPs should not be subject to waste regulation. EPA is in a unique position, based on their exhaustive study of CCP management, to provide leadership by issuing such a statement."

GETTING THE WORD OUT

Although the coal combustion industry has spent significant time and money trying to convince environmental groups and other doubters that the use of coal combustion products (CCPs) are safe, environmentally friendly, and economical, they are still battling frustrating misperceptions.

Enter the Coal Combustion Products Partnership. C^2P^2, begun last January, aims to promote the beneficial use of CCPs through educational outreach, encouragement of procuring agencies, and the establishment of a recognition program for successful beneficial use programs.

"Architects and engineers who are moving toward 'green building' will often incorporate recycled industrial materials like fly ash and bottom ash into their designs," says David Goss, executive director of the American Coal Ash Association, "but there are still specifiers, architects, and designers who aren't aware of the characteristics and properties of bottom ash and fly ash. That's who the industry needs to reach out to."

To encourage greater beneficial use for coal ash, C^2P^2 offers a resource conservation challenge, which recognizes organizations that increase their use or sales of coal ash for beneficial uses, says John Glenn, an environmental specialist with the Environmental Protection Agency's office of solid waste and leader of the challenge portion of the program.

The C^2P^2 consortium also is developing something it calls the "Green Book," which will highlight the positive environmental benefits gained by using CCPs. The Green Book will discuss environmental benefits and cite the results of various studies regarding the environmental soundness of beneficial use applications, explains Jim Roewer, executive director the Utility Solid Waste Activities Group, one of the main program partners.

For more information on C^2P^2, visit www.epa.gov/epaoswer/osw/conserve/c2p2/.

Although EPA has studied the disposal and use of these materials for 20 years and found no cases of adverse health or environmental impacts associated with that use, there still is a perceived issue, notes Roewer. To combat that perception, the Coal Combustion Products Partnership (C^2P^2), a joint agency-industry effort among EPA, ACAA, USWAG, the Department of Energy, and CCP generators and marketers, is working to help promote CCP use, especially by removing barriers to beneficial applications. (See the sidebar, "Getting the Word Out.")

Ahead of the Curve

By selling as much of the CCPs produced as possible, utilities can reduce the need for landfills, produce significant environmental benefits, and reduce the reliance on other natural resources. Some utilities, like the Tennessee Valley Authority (TVA), actually install more pollution control equipment in order to increase their CCP production. TVA

adds expensive scrubber units, which produce about six million tons of various types of CCPs (mostly flue gas desulfurization material, which can be used as a substitute for gypsum in wallboard) at its 11 operating plants. (See the sidebar, "Coal Combustion Primer.") Cheri Miller, a market development specialist at TVA's Chattanooga headquarters, says that as the utility adds more scrubbers it can increase its CCP production by more than 1 million tons.

It takes significant marketing expertise and technological know-how—not to mention favorable state regulations—to remarket CCPs successfully. Some utilities have significantly improved on the industry average for remarketed CCPs—about 33 percent. We Energies, for example, works with marketer LaFarge Corporation to market more than 100 percent of the ash it produces annually at its Pleasant Prairie powerplant. To create the overage, the utility recovers about 5 percent of the bottom ash from its landfill. "We're trying to increase the capacity of our landfills for availability in the future, which we may need due to future expansion of our generating capacity," Jansen explains.

Other utilities also are beating the industry average. Xcel Energy's Southwestern Public Service system in Texas has marketed or used all the ash it has produced for the past 27 years. That ash is found, for example, in the interstate highway between Amarillo and Lubbock—up to 29 percent of it is made with high-quality fly ash instead of Portland cement.

Persistence clearly is paying off. The use of synthetic gypsum in wallboard has grown tremendously over the past five years and is expected to grow even more. Until about 10 years ago, only a handful of wallboard plants could use even a small portion of synthetic gypsum because they weren't set

AP

Plumes of water vapor rise from the scrubber system at TVA's Cumberland Fossil Plant. The utility is spending $1.5 billion on new scrubbers in order to increase CCP production.

up to handle the material. Today, every new wallboard plant in this country is built specifically to use synthetic gypsum, Miller notes. Each new plant is capable of using between 600,000 and 900,000 tons of synthetic gypsum per year.

Cement is a major growth industry. In the past five years, more cement manufacturers have realized the benefits of using ash over clay or shale to beef up their product. In 1995, for example, Cincinnati, OH-based Cinergy counted no cement kilns among its customers. Today, it has five kilns as customers, using more than 120,000 tons of material. David Beck, byproducts manager at Cinergy, says the company makes no money by selling ash to cement kilns since it's a shared expense that's cheaper than disposal.

But in some cases, negative perceptions and attitudes have had a significant impact on the amount of ash and other coal products that utilities can remarket. "We could sell more of our ash if the misperceptions weren't there," Beck says. "We've lost a few product sales because of perceptions,

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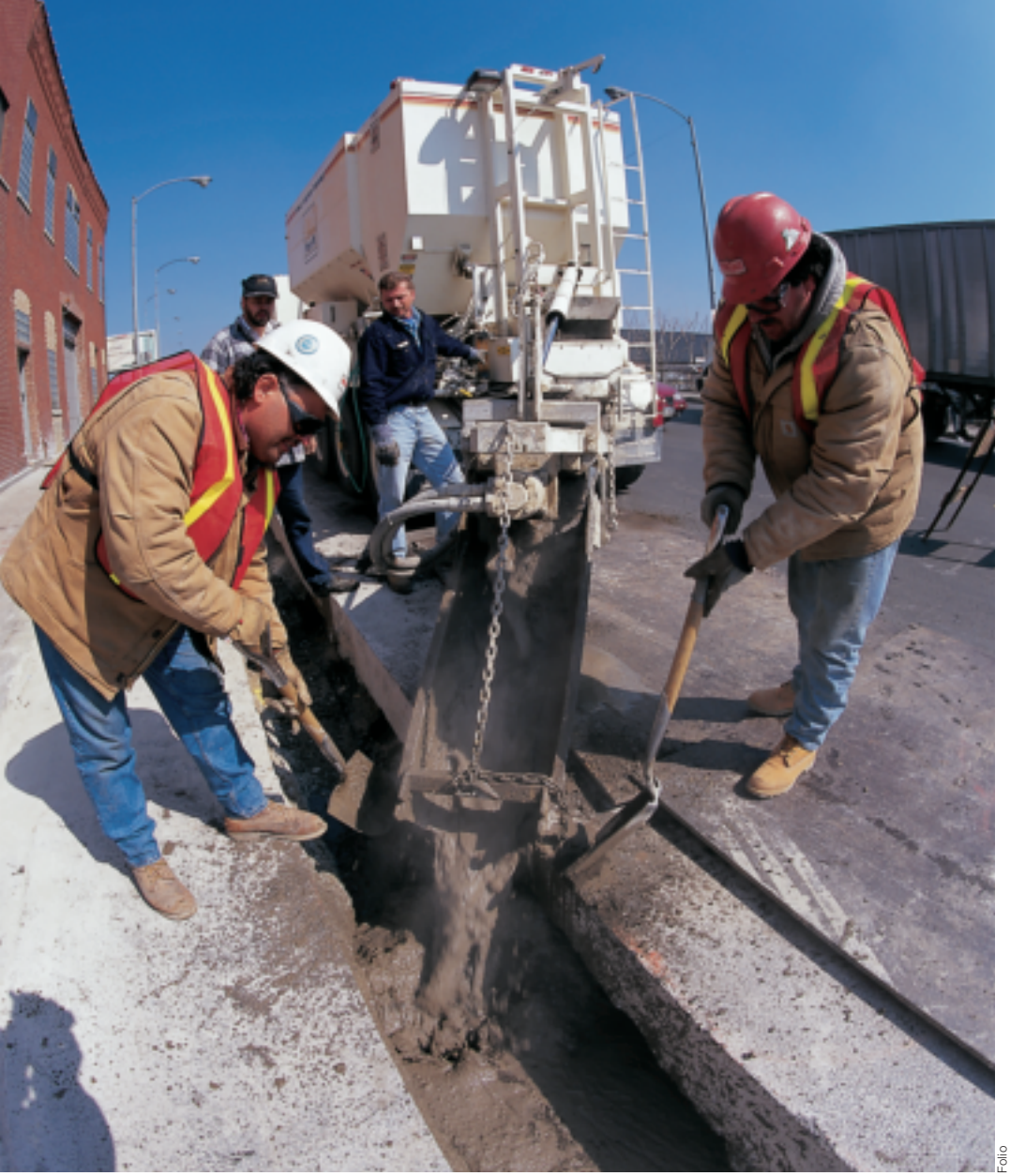


Follo

The cost of transporting CCP fill material to a site, like a highway project, can exceed disposal cost. Stricter disposal guidelines may change that.

where [potential buyers] have picked alternative materials instead."

Economic Hurdles

Although success stories abound, utilities still face daunting challenges in remarketing CCPs. "The first 3 million tons is the low-hanging fruit—materials that meet specifications for different industrial applications," says Miller. "But it's our job to try to sell everything our plants produce every day. Trying to find uses for materials that don't necessarily meet specifications is a big challenge."

To meet those challenges, utilities are constantly looking for alternative uses for CCPs. "Many of the construction materials markets we're looking at are very traditional, conservative, and risk-averse, making it hard to market new products," Thomes says. "For example, we're now producing a lightweight aggregate that can be used in concrete applications. It's difficult in this economic marketplace, though."

One innovative project that several utilities and other businesses partnered together on is the Fort Mandan Visitors Center. The center, part of the Lewis & Clark Bicentennial Foundation in North Dakota, is built almost entirely of CCPs: Concrete containing fly ash is the primary building material used in the walls. Pathways and floors contain fly ash, as does the stucco covering the interior walls. Even the carpets and acoustical ceiling tiles contain fly ash. In addition, much of the interior walls and ceilings are made of gypsum wallboard. TVA, Xcel Energy, Basin Electric Power Cooperative, Minnesota Power, Minnkota Power Cooperative, MDU Resources Group, BNI Coal, Otter Tail Power Company, Border States Electric, and others worked together to create the structure.

Distance is another economic issue. Most experts agree that there is probably a limit to how far you can transport ash to a construction site before it's more economical to use natural materials. "It really doesn't pay to move the material much further than 60 miles because transportation costs are huge," Roewer says. If you are generating the best quality ash but it's not near a market that needs the ash to replace Portland cement or as a structural fill, flowable fill, or in a road subbase, you won't be able to use that ash. But the CCPs generated close to markets that demand the material or provide an opportunity for entering the market to replace other materials is where you'll see growth in utilization, he points out.

Some utilities offer to offset transportation costs if the materials can be used in a specific application. "Let's say it costs $10 a ton to dispose of your material in a landfill that's 15 miles away from your powerplant," explains David Goss, executive director of ACAA. "Maybe there is a construction project 20 miles away. If you could pay the transportation of that ash to that construction project at $5 where it could be used, you've saved $5 over your disposal cost."

Still, says Jim Irvine, of Flyashdirect.com, an internet clearinghouse and marketing tool for CCP producers, a lot of utilities don't see some applications—such as landfill—as worth it, simply because it costs too much to truck it. In some cases, the value in the marketplace makes CCPs cheaper to dispose of than to market. Thomes believes this challenge will be re-

Courtesy: Great River Energy

The Fort Mandan Visitors Center in North Dakota features fly-ash cultured stone on the building's exterior.

solved once EPA releases a set of voluntary guidelines on disposal practices. "My expectation is that some of the people who are finding disposal to be very cheap and convenient may change their minds, and utilization opportunities will become more and more lucrative," he says.

And, as Irvine points out, up to 3 percent of a utility's coal procurement budget goes to disposal.

Another economic barrier is failing to make enough money on CCPs to pay for marketing the products. "We have a saying here that for our CCPs to be competitive, they have to be cheaper than dirt and better than dirt," TVA's Miller says. One of the ways TVA can compete with natural mineral materials like sand, gravel, and naturally mined gypsum is by producing a more consistent, reliable product. "The synthetic gypsum we make at our plant from our scrubbers is much more consistent than any natural gypsum you could find, so the wallboard plants that use it don't have to have as many controls to adjust for variation in moisture content or the size of the rocks," she says.

Great River Energy of Underwood, ND, believes it has solved the quality issue. "The only ash that's not saleable to the concrete market is the ash you produce when you start up and shut down," notes Al Christianson, North Dakota business services representative for the cooperative's Coal Creek Station. In an average year, Coal Creek produces more than 500,000 tons of ash, 450,000 of which is saleable. Christianson predicts that by the end of 2005, the utility will sell all the ash it produces, thanks to improved technology.

Ash quality in general is critical to the growth of the CCP industry, especially when it's being used as a replacement for Portland cement. "If the characteristics of ash vary, designing engineers will decline to use it because they can't be sure of consistent quality," Roewer says. "The fact is that fly ash of

A COAL COMBUSTION PRIMER

What are coal combustion products (CCPs)?

Fly ash. This is the finely divided residue that results from the combustion of ground or powdered coal. These very light particles are captured in an electrostatic precipitator or fabric-filter baghouse, both of which remove more than 98 percent of the particles that would otherwise be released from the smokestack. The major elements of fly ash are heterogeneous glassy and crystalline phases of silicon, aluminum, iron calcium, and magnesium. Fly ash is most often used in concrete as a replacement for part of the Portland cement in the mix design. Fly ash also is routinely used as a mineral filler for paints, carpet backing, shingles, backer board, and other construction products; in the manufacturer of mortars and stuccos; and for a variety of agricultural applications.

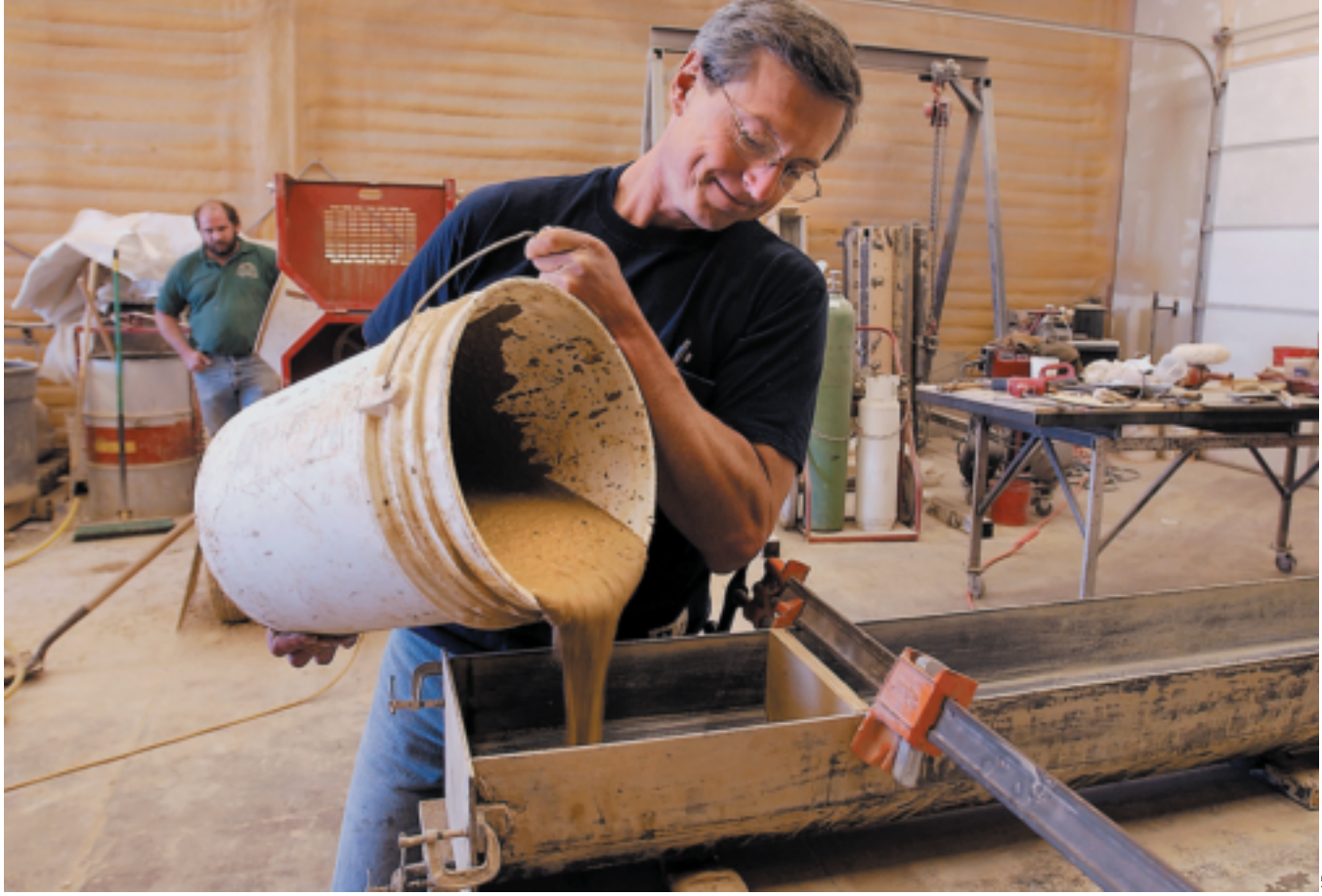
Courtesy: Alliant

CCP filler can be used as base material for road construction.

Bottom ash. A coarser material than fly ash, this material is similar to sand or fine gravel. Uses include snow and ice control, ground stabilization around feed lots, an asphalt concrete aggregate, granular base material for pavement construction, a stabilized base aggregate, and as a structural fill material for the construction of highway embankments.

Boiler slag. When molten slag comes in contact with the quenching water in the ash hopper of wet-bottom furnaces, boiler slag is created. The material is coarse, hard, black, angular, and glassy. Boiler slag is used for asphalt concrete aggregate, structural fill, snow and ice control, granular base material for pavement construction, as a stabilized base aggregate, blasting grit, and for some metalworking applications.

Flue gas desulfurization (FGD) material. Sometimes called scrubber sludge, FGD material is basically the "scrubbed" gases coming out of powerplant stacks. FGD technology commonly uses sorbents such as calcium carbonate or calcium oxide to scrub sulfur dioxide gas from the flue gases generated by coal-burning powerplants. The process of recycling this material involves grinding the limestone into a fine powder, adding water, and then spraying the resulting slurry into smoke as it comes up the powerplant stack. The plant then must collect the calcium sulfite, which is the FGD material. FGD material can be made into synthetic gypsum which can be used as a soil enhancer or as raw material for wallboard manufacturers. Other products made with FGD material include wallboard, structural fill, cement, concrete, and grout. It is also used for some mining applications.



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Courtesy: American Coal Ash Association

Above: This countertop manufacturer uses a recycled mixture of glass and fly ash to create durable, inert materials including counters, flooring, and benches. Left: Scrubber materials can be made into synthetic gypsum for wallboard.

consistent quality can produce a concrete that is more durable and lighter than non-fly ash concrete."

Technical Challenges Ahead

But the issue of quality is facing considerable uncertainty as a result of impending environmental regulations that may indirectly affect the content of CCPs. One of the biggest challenges looming ahead for utilities with CCP programs is, ironically, the Clear Skies Act, which would create a mandatory program to reduce powerplant emissions of three pollutants, including mercury. Further control of powerplant emissions always will result in the generation of larger volumes of CCPs (scrubbers will create more calcium sulfate, more ash will be collected, etc.), meaning utilities either will need to find more ways to sell it or spend more on disposal.

At the same time, EPA is readying its maximum achievable control technology (MACT) standard for mercury, which would require plant-specific controls to reduce the release of mercury. The MACT reflects the maximum degree of emissions reduction that can be achieved considering availability and current use of emissions control technologies. MACT regulations will either set a percentage amount of reduction in mercury emissions or set an emissions rate all powerplants would have to meet, explains Robert J. Wayland, leader of the combustion group in EPA's office of air quality planning and standards, emissions standards division. Existing plants would have to meet the standards by December 2007, while new plants would have to meet them by December 2004.

These air emission controls may have an effect on the engineering properties and composition of CCPs, making it more difficult for them to meet the standards set by the American Society of Testing and Materials. For many utilities, the changing composition of CCPs will be most detrimental to their use in concrete applications. "Either the low nitrogen oxide burners will raise the level of carbon in the ash beyond the industry standard," explains Xcel's Thomes, "or

Courtesy: American Coal Ash Association

Very fine particles of fly ash called cenospheres can be used as mineral fillers in paint.

catalytic reduction will lead to ammonia slipping into the ash (which can be objectionable to the end user). Between the two, much of the ash that traditionally has gone to market no longer will be able to."

There are two ways utilities may be able to comply with the impending regulations to reduce mercury emissions, both with potentially negative effects for CCPs. The first, a mercury-specific control technology—injecting activated carbon into the flue gas before it enters a plant's particulate control system—could affect the resulting fly ash to the point where it is no longer saleable. The second, which relies on the ability of pollution controls designed to remove NO_x and SO_2 also to remove some mercury—such as installing a scrubber at the plant to capture a large fraction of the mercury in coal—can be prohibitively expensive.

The first method results in the activated carbon ending up in the fly ash, adversely affecting the quality of the ash vis-à-vis its use to replace cement or in concrete products. The carbon interacts with air entrainment chemicals in the concrete mix (which are added to ensure concrete durability and workability), effectively preventing them from doing their job without the addition of specialty chemicals that can raise the cost of the concrete mix. The result, therefore, of high or variable carbon in the ash is the loss of usability for concrete markets. This is particularly true with ash that has activated carbon, since the reactivity of the carbon is the critical factor in its effect on the air entrainment agents. "If there is activated carbon in the fly ash, that will effectively kill the concrete market," Roewer says.

Xcel, for example, currently produces about 2.4 million tons of CCPs per year, using about 40 percent of that, or 1 million tons, in high-value applications like cement replacement and concrete. The company earns a net revenue of

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about $2 million on that 1 million tons. "Some presume that a MACT would rule out most of these uses," says Thomes. "If we had to dispose of that material [instead of selling it], it would cost about $15 per ton—or as much as $15 million."

In addition, carbon in fly ash changes the ash's appearance and could cause some end users to believe mistakenly that its quality has been compromised, explains Miller. "If you go to a grocery store, you expect your cereal to look the same no matter which box you pick," she says. "If you opened the box and it looked off-color, you might be a bit suspicious even though it tasted the same and had the same nutritional ingredients."

Another concern with the activated carbon method is that the resulting ash would contain a small percent of activated carbon that contains mercury. The perceived concern is that mercury could be rereleased when the ash is used. But that's simply not the case, Offen says. "Our research shows that in all applications except high-temperature applications like asphalt or using the ash as a feed stock in a cement kiln, we've seen no release or such small release rates that it's inconsequential."

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Some utilities may opt to use activated carbon injection to control mercury emissions, but "downstream" of the precipitators so they will not affect the fly ash quality. Another technology companies can use is combined hybrid particulate collection (COHPAC), which will prevent the carbon content of ash from being affected. Great River Energy has already made the decision to use technologies like COHPAC. In their calculations, such a commitment is well worth being able to preserve the use of fly ash for concrete markets.

A third method of removing mercury involves the use of a selective catalytic reduction (SCR) system and then removing it via a scrubber. It is unclear how effective this method is, and it can be very expensive to add the catalytic converter and additional scrubbers, notes Diane Stockdill, an environmental coordinator at Coal Creek Station. "If you remove mercury by putting it through a catalyst, you have to buy additional machinery," Stockdill says. "If you choose to add activated carbon, your capital expense is small, but the cost of the carbon can run into the millions of dollars. And then you have to dispose of fly ash that is no longer saleable, which translates into millions more."

This set of solutions "requires doing a cost/benefit analysis. It's only worth it in certain parts of the country, but it's not something we're looking at," Cinergy's Beck says.

Hoping for Clear Skies

Despite these uncertainties, many utilities remain committed to using as much of their CCPs as possible. To do so, they are willing to wait and see how the regulations shake out before determining the best way to reach that goal. "We Energies still has a goal to use 100 percent of its CCPs," Jansen says. "We have an aggressive research program to address anticipated changes to CCPs from additional air quality controls."

The next step is finding out whether Clear Skies or MACT will dictate new mercury control laws. If President Bush succeeds in getting the Clear Skies Act passed before MACT's December 15 deadline, MACT will end up being moot, says Wayland. Clear Skies is currently working its way through Congress.

Some utilities have a preference for Clear Skies because it provides regulatory certainty for building new plants and for installing emissions controls. [See "Clear Skies: A Better Way to Regulate," May/June 2003 *Electric Perspectives*.] It also phases in emissions reductions over time, compared with some more drastic proposals that would cut emissions in a very short timeframe. For companies that have invested in the CCP market, the choice is definitely clear: "We'd far prefer Clear Skies to pass," Xcel's Thomes says. "It appears to give greater flexibility and time for a lot of the technologies now being assessed to mature." That's important because "while there are some very exciting options being researched right now, I don't think any of them are mature enough such that we could quickly employ them under the more aggressive schedules of the MACT restrictions." ◆