Coal Combustion Product Use - Program 78

Program Overview

Program Description

Disposal of coal combustion products (CCPs) is an expense, a potential long-term liability, and, in many locations, difficult due to limited site availability or environmental opposition. Other challenges include increasingly stringent regulations on ash disposal, as well as its use in civil engineering applications (e.g., road base); questions about the usability of ash generated when power plants add certain gaseous pollutant controls (especially sorbent or chemical injection), cofire biomass with coal, or deploy integrated gasification combined cycle (IGCC) power systems; and newly public concerns over the health and environmental safety of products that contain ash. At the same time, the doubling of installed SO₂ scrubber capacity is increasing the production of flue gas desulfurization (FGD) gypsum beyond the needs of the wallboard manufacturers, giving rise to searches for effective and environmentally acceptable new uses. In parallel, the growing demand for spray dryer SO₂ controls and fluidized-bed boilers will produce volumes of solid products that will require large-scale, accepted uses.

The Electric Power Research Institute’s (EPRI’s) Coal Combustion Product Use program (Program 78) builds on years of investigation into sustaining the use and value of CCPs, despite property changes due to the application of gaseous air pollutant controls. It also seeks new uses for current CCPs and markets for the new CCPs from biomass cofiring, IGCCs, and plants equipped with spray dryers. New in 2011 will be the testing of products made with CCPs to ensure acceptable environmental performance in typical applications, and life-cycle assessment to quantify benefits and costs. These new thrusts respond to the increased scrutiny of CCP management.

Research Value

The CCP Use Program demonstrates that these products can be used beneficially and in greater quantities, even in the face of property changes due to upstream air pollution controls or different fuels or generation technologies. The program’s R&D enables members to:

- Avoid disposal costs for CCPs, which range from $5 to $60/ton and require extensive staff and management time to find and permit a landfill
- Retain or earn new revenue by selling products to ready-mix concrete plants, wallboard manufacturers, agricultural soil amendment distributors, roadway builders, and others, typically for $10–$20/ton, although prices can be as high as $60/ton. This includes:
  - Products sold today, such as flyash and FGD gypsum
  - Products not currently sold in quantity, such as spray dryer or fluidized-bed combustion (FBC) solid products, and ash containing activated carbon, elevated sodium levels, or biomass products of combustion
- Anticipate and resolve issues that may be barriers to the use of CCPs from biomass cofiring and IGCCs
- Communicate the engineering benefits and environmental acceptability of CCP uses, both existing and new

Approach

The program collaborates with organizations such as the American Coal Ash Association (ACAA) to educate state government agencies and engineers on the environmental and engineering benefits of using CCPs, and with the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Agriculture (USDA) to address significant barriers to CCP use at a national level. As issues arise with materials that use CCPs, this program researches the root cause of the problems and develops solutions, including:
• Research to maintain, increase, and add new high-volume uses of coal ash looks at ways to counter any impact on ash usability of sorbents and chemicals injected into the flue gas or added to the coal for air pollution control (e.g., alkali for SO$_3$/SO$_2$ control); investigates commercially-offered solutions to elevated levels of ammonia on fly ash (as selective catalytic reduction [SCR] catalysts age); determines the opportunities for using the solid product from biomass cofiring/firing and IGCC plants; and assesses the environmental acceptability of fly ash use in civil engineering applications (especially road base) and in commercial products (e.g., rug backing).

• R&D involving technologies and information to increase the use of SO$_2$ control-derived CCPs continues the national network field tests of FGD gypsum as a soil amendment to demonstrate its agronomic value and environmental acceptability (via risk analyses), and demonstrates promising high-volume uses of spray dryer or FBC solid product.

• Research to assess and communicate the relative environmental risks and benefits associated with CCP products determines the potential health risk of common products that incorporate CCPs and compares these risks to the same applications and products manufactured with traditional feed materials. It also works jointly with other sponsors of EPA's Coal Combustion Products Partnership (C$^2$P$^2$) and the ACAA to communicate these findings, as well as to explain the engineering and environmental value of CCP use to potential users and regulators.

Accomplishments

The CCP Use program is recognized in the electricity industry as an authoritative source for up-to-date, unbiased information on the benefits and environmental acceptability of using CCPs in commerce. Recent examples of value provided include:

• Documented, in a series of quick-turnaround reports, the environmental, resource, and financial benefits of using CCPs instead of raw materials; the chemical similarity between CCPs and natural or other large-volume materials commonly treated as solid waste (i.e., not hazardous); the substantially lower risk from CCP disposal at sites built in the last 30 years than occurred at sites categorized as "damage cases" by EPA, which had been constructed earlier with less protections; and the potential costs and impacts on grid reliability of regulating CCPs as hazardous materials

• Demonstrated that no significant mercury is released during concrete curing, or by leaching of demolished and crushed concrete, when fly ash containing mercury is used in the manufacture of the concrete

• Quantified the amount of mercury released by one type of wallboard manufacturing process when FGD gypsum containing mercury is used as the feedstock

• Demonstrated that concrete cracking due to reactions between cement and aggregate could be mitigated by replacing some of the cement with Class F ash; provided evidence that, for many aggregates, cracking could be mitigated by replacing large volumes of cement with Class C ash or ternary blends

• Organized a collaborative including utilities, government agencies, industry, and academia to demonstrate the value and environmental acceptability of using FGD gypsum and other FGD solids in agricultural applications

• Identified potential uses for spray dryer and FBC solid products based on engineering properties and European experience

Current Year Activities

The program R&D for 2011 will focus on continuing the main thrusts of demonstrating process benefits and environmental acceptability of CCP use, with greater emphasis on the latter, determining the impact on CCP use of air pollution controls, and seeking/evaluating potential uses for new CCPs. Specific efforts will include:

• Determination of the potential impacts of air pollution controls (especially sodium injection into the flue gas for SO$_3$ and possible SO$_2$ reduction) on fly ash use and disposal (with Program 49). Consideration of the potential impacts of other sorbents/chemicals (e.g., calcium, bromine, or small quantities of activated carbon) or ammonia slip on ash use (with Program 75)

• Initiation of multiyear effort to demonstrate the environmental acceptability of ash use in road base
Identification of factors potentially limiting use of fly ash from biomass cofiring or power generation via IGCC and plans to overcome these limits

Completion of five to six demonstrations of FGD gypsum use to improve crop growth in various soils with no environmental impact, including the use of gypsum from power plants that are using their SO$_2$ scrubber to capture the hazardous air pollutants (HAPS) likely to be regulated by EPA under a Maximum Achievable Control Technology (MACT) standard

Field tests of one or two potentially large beneficial uses of spray dryer or FBC solid products, including spray dryer/baghouse installations with fly ash pre-collection

Initiation of a multiyear project to determine the health risks of products that contain fly ash, especially products that individuals contact or are exposed to routinely

Estimated 2011 Program Funding

$0.7M

Program Manager

George Offen, 650-855-8942, goffen@epri.com

Summary of Projects

<table>
<thead>
<tr>
<th>Project Number</th>
<th>Project Title</th>
<th>Description</th>
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<tbody>
<tr>
<td>P78.001</td>
<td>Maintaining and Increasing High-Volume Uses of Coal Ash</td>
<td>By demonstrating the engineering benefits and environmental acceptability of fly ash containing other constituents due to air pollution controls, this research will help CCP managers promote the use of their solid products and avoid disposal.</td>
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<tr>
<td>P78.002</td>
<td>Technologies and Information to Increase Use of SO2 Control Products</td>
<td>Demonstrating the agronomic benefits and environmental acceptability of using FGD gypsum as a soil amendment, and developing new uses for spray dryer absorber and FBC products, will create new markets for the greatly increased production of SO$_2$ control materials as more plants install these devices.</td>
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<tr>
<td>P78.003</td>
<td>Assessment and Communication of Relative Environmental Risks and Benefits Associated with CCP Products</td>
<td>Information on the environmental performance of products containing CCPs, as well as comparison to relative risks of competing materials, is necessary to enable regulators, end-users, and the public to make informed decisions on the safety of using products that contain CCPs in various applications. EPRI's communication and outreach efforts on the environmental and resource advantages of greater CCP use can help power companies firing solid fuels convince regulators and potential users of the value of their product and convert disposal costs into revenues from product sales.</td>
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P78.001 Maintaining and Increasing High-Volume Uses of Coal Ash (046746)

Key Research Question

Several air pollution controls can affect fly ash use by altering the composition of the ash. More recent concerns are due to the injection of alkali (especially sodium) for SO₃ or SO₂ reduction or bromine (for mercury capture). New power generation sources, such as biomass cofiring/firing or IGCC, produce an ash for which usability has not yet been widely demonstrated. Given policy watchers’ statements that large-volume structural fills, which currently account for 25% of all fly ash use, may no longer be allowed, and industry reports on the difficulty of permitting new disposal facilities, research is needed to maintain current high-volume uses such as concrete, despite changing fly ash characteristics, and to increase other environmentally acceptable uses.

Approach

This project will continue work on determining: a) the engineering acceptability of using ash in concrete or other applications if it contains elevated sodium levels due to sorbent injection for SO₃ or SO₂ control or halogens (especially bromine) added for mercury capture, and b) the engineering properties of concrete produced with ash generated by boilers cofiring biomass. This effort will build off work in 2010 to select the biomass/coal combinations and seek samples for engineering tests (coordinated with Program 84 Renewables and Program 76 Particulate & Opacity Control). It also will begin to evaluate the new generation of products from IGCC units.

Given that fly ash makes road base superior to that of natural materials (increased roadway life has been widely demonstrated), that its use in this application is supported by many departments of transportation, and that the nature of its use (a relatively thin layer covered by near-impermeable asphalt or concrete) is believed (but not thoroughly demonstrated) to result in negligible environmental impact, EPRI will scope a study in 2011 for implementation in 2012 and beyond to quantify the environmental footprint of several such applications. The scoping study will seek any previous environmental measurements (e.g., leachate data near roads that used fly ash as the base relative to those in similar geologies that did not), determine whether additional measurements are needed, and identify potential measurement sites. The scope of the resulting measurement effort is certain to be such that it will need to be funded supplementally.

Partial cement replacement by fly ash in concrete manufacture is the highest volume use of fly ash, is widely accepted, and has a potentially larger market. High-volume fly ash (HVFA) concrete has been used for many years in high-performance concrete applications. However, many specifications still limit the use of fly ash in concrete to 15 to 25% replacement. EPRI will follow developments in the use of higher replacement levels in concrete and support this effort with research as necessary. Additional work in this area may include basic concrete chemistry, and demonstrating/improving concrete performance measures such as set time, durability, and permeability. Specialty applications, such as flowable fill and conductive concrete, may also be considered.

Impact

By demonstrating the engineering benefits and environmental acceptability of using fly ash in numerous applications, despite changes to the fly ash brought about by air pollution controls or different fuel sources, and by addressing newly raised concerns about fly ash use in products, this project helps power plants:

- Avoid disposal costs and liabilities, which can be $10-60/ton ash
- Retain or earn new revenues from sale of CCPs, which can vary from a net $0 to more than $60/ton ash

How to Apply Results

Power company CCP managers and their CCP marketers can use the test data and supporting analyses to plan continued use of their fly ash and identify new uses consistent with local market and transportation conditions. They can use the same information to inform existing and potential users of the value and acceptability of these uses.
2011 Products

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<tr>
<th>Product Title &amp; Description</th>
<th>Planned Completion Date</th>
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<tr>
<td>Use Options for Fly Ash in a New Regulatory Landscape: Initial findings on the feasibility of using: a) sodium-, calcium-, or bromine-containing ash, or b) CCPs derived from biomass cofiring with coal in concrete and other conventional applications. Plans for determining the environmental footprint of ash use in road base, and expanding use in this application.</td>
<td>12/31/11</td>
<td>Technical Update</td>
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Future Year Products

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<tr>
<th>Product Title &amp; Description</th>
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<tbody>
<tr>
<td>Use Options for Fly Ash in a New Regulatory Environment -- Update: Further test data and survey results beyond 2011 report on use of fly ash with altered properties or in road base. Update of 2010 review of ash uses in Europe, with emphasis on blended cements. Plan for finding/evaluating/testing high-value beneficial uses of IGCC solid products (gasifier slag and synthetic gas particulate)</td>
<td>12/31/12</td>
<td>Technical Update</td>
</tr>
<tr>
<td>Use Options for Fly Ash in a New Regulatory Environment: Final results on comparative health risk studies. Measured performance of blended cements and quantitative support for the beneficial use of most/all gasifier slag/ash.</td>
<td>12/31/14</td>
<td>Technical Report</td>
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P78.002 Technologies and Information to Increase Use of SO2 Control Products (052539)

Key Research Question

Until recently, more than 80% of FGD gypsum produced was used in commerce, primarily for wallboard manufacturing. The availability of FGD gypsum is expected to saturate this market within the next few years, when the combined effects of economic recovery (i.e., resumption of building) and the doubling of FGD capacity manifest themselves. Hence, the industry needs new markets, and use in agriculture to improve crop growth is believed to offer the largest opportunity. The industry also needs to prove, via comprehensive scientific studies, that the gypsum produced in FGDs operated to maximize the capture of hazardous air pollutants (HAPS) is still acceptable for use in wallboard and the other markets. A need also exists to find uses for the solid products from spray dryers (whether concentrated alkali or alkali-ash mixes) or fluidized-bed combustion (FBC), because numerous power companies are considering the installation of these systems during the next decade.

Approach

In 2011, the project will continue to focus on agricultural uses of FGD gypsum. A national network, established in 2006, coordinates field tests of FGD gypsum application to the range of underperforming soils and crops grown in the United States. Region-by-region, the network seeks to connect gypsum sources with nearby agricultural users who could use gypsum amendments beneficially; provides these teams of sources and users with test plans and analytical protocols; and conducts the laboratory analyses for teams that do not have that capability. The network also assembles, archives, interprets, and synthesizes the results, and organizes periodic workshops to disseminate the results and provide a forum for sharing issues and insights.
Increasingly, the project is addressing the potential risks of this gypsum use. Leachate tests will be conducted on soils that have been treated with FGD gypsum to improve plant productivity. As more power plants rely on their scrubbers to meet anticipated HAPS standards, this project will seek gypsum samples from these units for further agricultural application demonstrations, which will include field leachate and crop constituent analyses to determine if this gypsum contains and releases any HAPS that find their way into the crop at harmful levels. The project will evaluate gypsum from plants that do and do not separate their fines from the bulk gypsum that is offered for reuse. It also will study the alleged release of mercury and hydrogen sulfide from wallboard manufactured using FGD gypsum, especially gypsum from power plants that use a sulfide-based additive to fix the soluble HAPS (mercury and selenium). If it finds such releases, the project will assess its health risk of any such releases, and seek countermeasures or product specifications, if found necessary.

With increasing use of spray dryers for SO₂ control, EPRI will monitor power company strategies for managing the solid product and determine what, if any, research could be conducted to facilitate widespread use of this product. Different opportunities exist for combined ash/alkali mixtures (the only particulate control is behind the spray dryer) and low fly ash content mixtures (the spray dryer/baghouse are placed after the primary particulate control). EPRI’s actions will depend on its findings in 2011 on how power plants are dealing with this material, if any have found uses, and, if not, what barriers they have faced.

Impact

By demonstrating the engineering benefits and environmental acceptability of using FGD gypsum in agriculture and finding beneficial uses for spray dryer or FBC solid discharges, this project helps power plants:

- Avoid disposal costs and liabilities, which can be $10-20/ton for gypsum
- Retain or earn new revenues from sale of CCPs, which can reach $20/ton for gypsum

How to Apply Results

Power company CCP managers and their CCP marketers can use test data and supporting analyses from the FGD Gypsum Network to encourage use of their gypsum by farmers (and their advisors in the local agriculture extensions) within an economical haul range of their FGD-equipped power plants and to gain acceptance by state regulators. These same staff can use the assessments and demonstrations of the uses of CCPs from spray dryers and FBC units to deploy a targeted marketing plan for these materials.

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<tr>
<td>Agronomic use of Gypsum Materials: Summary and synthesis of all results to date (~8 sites) on field applications of FGD gypsum to a range of crops and soils, along with expert assessment of their implications for the value of the resulting crop (quantity and quality), resource use (water, fertilizer, field labor), environmental acceptability, and economics. Will include risk assessments for one to two of these sites, and may include sites using gypsum (if provided to project) from plants relying on their FGD to capture all soluble HAPS.</td>
<td>12/31/11</td>
<td>Technical Report</td>
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Future Year Products

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<tr>
<td>Beneficial Uses of Spray Dryer and FBC Solid Products -- Interim Field Test Results: Interim field test results (engineering and environmental performance) of applications using spray dryer and/or FBC solid products.</td>
<td>12/31/12</td>
<td>Technical Update</td>
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</table>
Agronomic use of Gypsum Materials: Final report (projected) with test results from field applications of FGD gypsum to a range of crops and soils, along with expert assessment of their implications for the value of the resulting crop (quantity and quality), resource use (water, fertilizer, field labor), environmental acceptability, and economics. Will include risk assessments for one to two additional sites (beyond the 2011 report). Also will include results of tests comparing the effective on crop productivity, crop safety, and the environment of using gypsum from plants that attempt to separate HAPS-enriched fines from the coarser material versus gypsum from those that do not.

Benificial Uses of Spray Dryer and FBC Solid Products -- Final Field Test Results: Final field test results of applications using spray dryer and/or FBC solid products.

P78.003 Assessment and Communication of Relative Environmental Risks and Benefits Associated with CCP Products (055576)

Key Research Question

Since the Kingston, Tennessee ash pond dike failure in 2008 and the subsequent EPA re-evaluation of its earlier designation of CCPs as nonhazardous, the environmental characteristics of CCPs have received intense scrutiny in the media and regulatory arenas. Some members of the public have raised concern over CCP use in construction projects such as concrete in school buildings and wallboard in residences, civil engineering applications such as road base, and consumer products such as carpet backing. Constraints on ash use counter the goals of national, local, and environmental nongovernmental organizations (NGOs) to increase CCP use, while also creating other environmental issues (disposal, virgin resource use) and adding operating costs for power companies. Many potential CCP users are not users because they, or their regulators (state environmental or transportation agencies), do not understand the relative risks, technical value, and environmental acceptability of CCP applications. Technical evaluations of comparative risks and lifecycle assessments, along with outreach efforts — user-focused briefing papers, conference presentations, and sometimes personal visits — can show potential users and their regulators how they and the environment can benefit by using CCPs in appropriate applications.

Approach

EPRI will perform evaluations of the potential human health and ecological risks posed by products containing CCPs. These evaluations may include topics such as leaching of disposed concrete and wallboard, off-gassing of volatile elements in building applications, hydrogen sulfide (H\textsubscript{2}S) generation in wallboard use and disposal, potential exposures from a variety of road base applications, and direct contact exposure by the public to CCP-containing products. Integral to this effort will be comparative risks posed by products when manufactured with traditional feed materials, or other products with which humans routinely come in contact. The environmental benefits of using CCPs in these products will be further quantified to provide a complete lifecycle picture. This work will be coordinated with the ACAA and will include guidance from marketers, end users, and regulators with respect to the key issues of concern.

Communication of the technical information developed by this program to a wide-ranging audience is critical to the successful acceptance of CCP use applications. This project will prepare technical briefs as needed to provide the scientific basis for regulatory, policy, or public acceptance of greater CCP use. It will present papers at meetings of potential users; participate in the EPA’s Coal Combustion Products Partnership (C\textsuperscript{2}P\textsuperscript{2}) program; support member requests for assistance with technical information for state or local agencies; create a public website that contains these issue briefs in conjunction with the EPRI Environment Sector’s Program 49 on CCP Environmental Issues; and maintain a Tech Watch function for new issues limiting current or potentially expanded use of CCPs.
Impact

EPRI’s outreach efforts on behalf of greater CCP use could enable power companies firing solid fuels to:

- Earn a net $10–$60/ton for CCP (revenue + avoided disposal), depending on location and use, if the outreach effort enables a power company to divert its CCPs from disposal to beneficial use.
- Increase the awareness of their customers and communities of their promotion of re-use over disposal.

How to Apply Results

Environmental compliance and CCP management staff can use the risk information and technical briefs to show their community, potential CCP users, and local regulatory authorities that CCP use can be environmentally, technically, and financially sound.

2011 Products

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<tr>
<td>Benefits and Acceptability of Using CCPs: Development of a framework for assessing and communicating the relative risks and benefits posed by products containing CCPs. Begin data collection to support detailed technical assessment of product leaching, off-gassing, and direct contact for most common applications.</td>
<td>12/31/11</td>
<td>Technical Update</td>
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Future Year Products

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<tr>
<td>Benefits and Acceptability of Using CCPs: Annual set of technical briefs and presentations informing the public of the value and acceptability of using CCPs, focused on issues of most interest during the year.</td>
<td>12/31/12</td>
<td>Technical Resource</td>
</tr>
<tr>
<td>Benefits and Acceptability of Using CCPs: Comparative risk assessments of CCP-containing products versus the same products made with competing materials. Comparisons will be framed in a life-cycle assessment, including environmental benefits of CCP use. Findings also will be communicated in public technical briefs.</td>
<td>12/31/13</td>
<td>Technical Report</td>
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