REVIEW OF PENNSYLVANIA REGULATIONS, STANDARDS, AND PRACTICES RELATED TO THE USE OF COAL COMBUSTION PRODUCTS

Final Report

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EERC DISCLAIMER

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LIST OF ACRONYMS AND ABBREVIATIONS

AASHTO	American Association of State Highway and Transportation Officials
ACAA	American Coal Ash Association
ACI	activated carbon injection
AEA	air-entraining admixtures
AMD	acid mine drainage
AML	abandoned mine land
ASR	alkali silica reactivity
ASTM	ASTM (American Society for Testing and Materials) International
ASTSWMO	Association of State and Territorial Solid Waste Management Officials
BMR	Bureau of Mine Reclamation
BWM	Bureau of Waste Management
C^2P^2	Coal Combustion Products Partnership
$CaSO_4$	calcium sulfate
$CaSO_3$	calcium sulfite
CAIR	Clean Air Interstate Rule
CAMR	Clean Air Mercury Rule
CARRC®	Coal Ash Resources Research Consortium
CCP	coal combustion product
CFB	circulating fluidized bed
DOE	U.S. Department of Energy
DMO	District Mining Offices
IL DOT	Illinois Department of Transportation
EERC	Energy & Environmental Research Center
EIA	Energy Information Administration
EPA	U.S. Environmental Protection Agency
EPGA	Electric Power Generation Association
FBC	fluidized-bed combustion
FGD	flue gas desulfurization
IMCC	Interstate Mining Compact Commission
LEED®	Leadership in Energy and Environmental Design
MOU	memorandum of understanding
MW	megawatt
NAS	National Academy of Sciences
NETL	National Energy Technology Laboratory
NO_x	nitrogen oxides
ODOT	Ohio Department of Transportation
OSM	Office of Surface Mining
PA DEP	Pennsylvania Department of Environmental Protection
pc	pulverized coal
PennDOT	Pennsylvania Department of Transportation
PE	product evaluation
PURPA	Public Utility Regulatory Policies Act
SMCRA	Surface Mining Control and Reclamation Act

SO_2	sulfur dioxide
SWAC	Solid Waste Alliance Communities
SWOT	strengths, weaknesses, opportunities, threats
R&D	research and development
USGBC	U.S. Green Building Council
USGS	U.S. Geological Survey

REVIEW OF PENNSYLVANIA REGULATIONS, STANDARDS, AND PRACTICES RELATED TO THE USE OF COAL COMBUSTION PRODUCTS

EXECUTIVE SUMMARY

Over 49 million tons of coal combustion products (CCPs) is beneficially used in the United States each year, but over 73 million tons, or 59%, is still being disposed of in landfills or surface impoundments (American Coal Ash Association [ACAA], 2005). The U.S. Department of Energy (DOE) and the U.S. Environmental Protection Agency (EPA) set goals to increase CCP utilization to 50% by 2011. As 2011 draws near, this goal appears to be more difficult to attain, particularly as new emission regulations are implemented, resulting in larger quantities and changing qualities of CCPs produced.

To better understand the status and development of different CCP utilization profiles across the United States, the University of North Dakota Energy & Environmental Research Center (EERC) is conducting a series of state reviews. The first was conducted in Texas in 2004, the second was in Florida in 2005, and the third was in Pennsylvania in 2006. This report takes an in-depth look at CCP use in Pennsylvania and showcases keys to successful utilization, describes what barriers exist, recommends actions that can be taken to overcome those barriers, and identifies what threats could impact future CCP utilization. Following this series of three state reviews, a synthesis report will be prepared that transfers the findings into a national perspective.

Based on information obtained during the Pennsylvania state review process, the following items were identified as keys to successful CCP utilization in Pennsylvania and are discussed at greater length in this report:

1. Pennsylvania's Solid Waste Management Act excludes "coal ash" (defined as fly ash, bottom ash, or boiler slag resulting from the combustion of coal) that is beneficially used in accordance with Pennsylvania Department of Environmental Protection (PA DEP) standards and criteria from the definition of solid waste. The standards and criteria are incorporated into the Residual Waste Regulations.

2. The PA DEP Bureau of Mine Reclamation and the District Mining Offices (BMR/DMO) has a comprehensive regulatory program for the beneficial use of CCPs for mine reclamation.

3. The state's circulating fluidized-bed (CFB) plants offer an ideal opportunity to remine abandoned coal refuse piles, use the removed coal refuse as a fuel, and utilize the resulting alkaline CFB ash for mine reclamation, often returning the ash to the original coal refuse site.

4. The Pennsylvania Department of Transportation (PennDOT) regulations allow CCP use in concrete and flowable backfill applications. Class F fly ash plays an important role in mitigating alkali silica reactivity in concrete because 70% of PennDOT aggregate sources are reactive.

5. Nearly all concrete poured for commercial and residential construction in Pennsylvania contains 10%–20% Class F fly ash. A nominal amount of Class C fly ash is imported from other states.

6. By providing easy access to its research and monitoring data, PA DEP BMR is able to provide information to environmental groups and government agencies to verify whether environmental damage has or has not occurred as a result of placing CCPs in mine sites.

The following were identified as barriers that currently hinder increased CCP utilization in Pennsylvania:

1. Pennsylvania's Solid Waste Management Act does not include flue gas desulfurization (FGD) material in the definition of "coal ash." Pennsylvania electric generating companies are expected to produce an additional 4 million tons of FGD gypsum per year once more wet forced-oxidized FGD systems are installed. Industry would like to use FGD gypsum in mining, structural fill, and agriculture applications; however, PA DEP cannot approve these uses under the current coal ash beneficial use of the Residual Waste Regulations. FGD gypsum must be mixed with coal ash in order to be considered for approval with a residual waste beneficial use general permit.

2. Internal communication and technology transfer among bureaus within state agencies is limited because of a lack of formal mechanisms to facilitate such communication. This barrier can result in the duplication of effort and/or contradicting opinions among bureaus.

3. PA DEP is sometimes perceived by industry as being overly conservative in accepting new beneficial uses and wants long-term field studies to alleviate any concerns it may have about the environmental appropriateness of using CCPs over time.

4. Industry indicated that the interpretation of PA DEP regulations varies among DMOs, which make it difficult to beneficially use CCPs in some applications. DMOs said interpretation varies because of different geographic conditions in each district/region and specific conditions at each mine site. Although industry generally agrees that site-specific exceptions are needed, they contend that the requirements are not consistent and they never know what to expect, making it difficult to plan projects.

5. Pennsylvania government agencies do not appear to consider the environmental sustainability associated with the beneficial use of CCPs when making their rules, regulations, or policies regarding coal ash management. There are some exceptions to this statement.

6. Advocacy groups in Pennsylvania have been effective in delaying or terminating some beneficial use applications.

7. Although the National Academy of Sciences (NAS) report on the placement of CCPs at mine sites was not damaging, it was a missed opportunity to showcase success stories, particularly for CFB ash. This is a potential national barrier because if regulatory agencies blindly adhere to the NAS report's suggestions, they would be missing the opportunity to beneficially use CCPs in some applications that have been successfully demonstrated in Pennsylvania.

The following potential threats were identified that could hinder CCP utilization in Pennsylvania in the future:

1. CCP stakeholders are concerned about the impact federal and state air emission rules will have on CCP management.

2. The Office of Surface Mining is developing new rules which may require modifications to the PA DEP coal ash beneficial use regulations.

3. Given the potential EPA ban on the use of fly ash from sorbent injection for mercury control as a cement kiln feed, there is some concern that EPA will also prohibit the use of FGD gypsum produced at coal-fired power plants using sorbents for mercury control for use in cement manufacture.

The following are suggested actions that could help increase CCP utilization in Pennsylvania:

1. PA DEP should develop regulations for beneficial uses for FGD gypsum because the wallboard and cement markets will not be able to absorb the expected 4-million-ton-per-year surplus.

2. Industry and state agencies should improve lines of communication to define what information and data are needed to make regulatory decisions.

3. When economically feasible, fly ash should continue to be imported from states where landfill costs are high for use in concrete and mine reclamation projects.

4. Industry should engage in a cohesive effort to encourage PennDOT to develop new specifications for coal ash use. This action could have a large impact on CCP use because PennDOT's specifications set the bar for other coal ash users in the state.

5. PA DEP should consider classifying CCPs as "products" and subsequently grant CCP producers the authority to market CCPs as products. Some pulverized-coal-fired power plant representatives indicated that this would enable them to use more CCPs in nontraditional applications.

6. National programs such as the Coal Combustion Products Partnership (C^2P^2) and the Green Highways Partnership could do more to increase awareness of their programs.

7. Pennsylvania should build upon the growing popularity of the Leadership in Energy and Environmental Design (LEED®) Program by actively promoting CCP use in Pennsylvania government construction projects and transferring the LEED® principles to residential and commercial construction.

REVIEW OF PENNSYLVANIA REGULATIONS, STANDARDS, AND PRACTICES RELATED TO THE USE OF COAL COMBUSTION PRODUCTS

BACKGROUND

Over 49 million tons of coal combustion products (CCPs) are beneficially used in the United States each year, but over 73 million tons, or 59%, are still being disposed of in landfills or surface impoundments. The overall CCP utilization rate only rose 0.21% from 2004 (40.08%) to 2005 (40.29%) (American Coal Ash Association [ACAA], 2005). The U.S. Department of Energy (DOE) and the U.S. Environmental Protection Agency (EPA) set goals to increase CCP utilization to 50% by 2011. As 2011 draws near, this goal appears to be more difficult to attain, particularly as new air emission regulations are implemented, resulting in larger quantities and changing qualities of CCPs produced. Given these challenges, both agencies are committed to reaching their utilization goals and are conducting research studies and working together to create and support programs that encourage CCP use. Such programs include the Coal Combustion Products Partnership (C^2P^2), Green Highways Initiative, and U.S. Green Building Council (USGBC) Leadership in Energy and Environmental Design (LEED®) program. Other programs such as the newly formed Industrial Resources Council, join industry associations together (CCPs, foundry sand, construction and demolition debris, and rubber) to achieve similar goals.

Many of the technical barriers associated with CCP utilization have been solved, but social and knowledge barriers still exist. One of the key nontechnical barriers is the broad range of state laws, regulations, policies, and guidelines regarding the use of CCPs (ACAA, 1998; Pflughoeft-Hassett et al., 1999; Dockter and Jagiella, 2005). Some states have worked to develop progressive and effective guidance for CCP utilization that helps to increase CCP utilization while being protective of the environment. On the contrary, some states still lack the resources and information to feel comfortable with the environmental appropriateness of using CCPs in certain applications, particularly with nontraditional applications. In addition, changing state laws, regulations, policies, and guidelines can be a lengthy process, taking a number of years to come to fruition, which often frustrates CCP industry stakeholders.

To better understand the status and development of different CCP utilization profiles across the United States, the University of North Dakota Energy & Environmental Research Center (EERC) was given a grant by EPA and Headwaters Resources, LLC, to conduct a pilot review of state regulations, standards, and practices related to the use of CCPs. Texas was selected as the pilot state because of its progressive approach to CCP utilization. A subsequent grant was awarded by EPA and DOE to conduct a second state review. Florida was selected as the second state to review, primarily because it was undergoing changes to its CCP regulations. The EERC subsequently received a grant from EPA, DOE, and ACAA to perform a review in a third state that exhibited a different CCP use scenario and geographic area than the previous two states. As described in Task 2: Select a State, Pennsylvania was ultimately chosen as the third state. This report takes an in-depth look at CCP use in Pennsylvania and showcases keys to successful utilization, describes what barriers exist, recommends actions that can be taken to overcome those barriers, and identifies what threats could impact future CCP utilization. The final reports

from the series of state reviews can be accessed online at www.undeerc.org/carrc/html/review.html. Following the completion of the third review, a synthesis report will be prepared that translates the results from the three in-depth state reviews into a national perspective. The preparation of the synthesis report is funded by EPA and DOE. Additional reviews may take place in other states.

GOAL

The overall goal of the state reviews is to highlight successes in CCP utilization and move toward the development of a national analysis of actions that can be taken to remove barriers to increase CCP use. The specific goals of this third review are to 1) evaluate factors related to the use of CCPs in Pennsylvania; 2) summarize Pennsylvania's successes, barriers, and threats; and 3) develop recommendations (action items) that may help Pennsylvania and other states increase the use of CCPs in an environmentally sound manner.

STATE REVIEW PROCESS

The following tasks outline the steps taken to conduct this review. Experience with previous state reviews showed that the most effective method for conducting the review was to conduct a multiday site visit in a central location within the state. Panels of key stakeholders were assembled and interviewed during the course of this site visit. Information provided during the interviews was compiled and summarized in this report. The following sections describe each step of the review process in more detail. Tasks are listed in order; however, many tasks were implemented concurrently.

Task 1: Establish an Administrative Team

A project administrative team was established to perform the majority of the administrative work, including organizing the review, compiling findings, and writing reports. Ms. Tera Buckley, EERC Marketing Research Specialist, acted as team leader, with input from Ms. Debra Pflughoeft-Hassett, EERC Senior Research Advisor.

Task 2: Select a State

The project's administrative team, with assistance from project sponsors, conducted an in-depth evaluation to select the third state using the following criteria. The criteria are listed in order of importance:

1. The state should serve as a role model for other states. It should have established beneficial use rules in place. The EERC believes selecting a model state would be most beneficial to other states and that the information gained from a model state would be most beneficial in preparing the national synthesis report.

2. The state should be a northern-tier state with seasonal markets. The geographic area and climatic conditions offered by a northern state are different than the previous two southern states reviewed.

3. Because the National Academy of Sciences (NAS) issued its position on using CCPs in mining applications, the EERC would like to address the mining issue in a state where mining is prominent. Mining was not addressed in the previous state reviews, as an attempt to not interfere with the ongoing NAS study.

4. The state should have diversified beneficial use markets, which include small, nontraditional use applications and produce a variety of CCPs. The EERC does not want to select a state where CCP use is dominated by one or two industries.

5. To facilitate a smooth state review, the state's environmental and transportation departments must be willing to participate in the review.

6. Preference would be given to a state with an active research community.

Based on the criteria listed above, Illinois, Ohio, and Pennsylvania came to the forefront as potential candidates. Each of these states was reviewed at length, and the following information was gathered from various discussions with key CCP stakeholders in each state and a review of literature on current regulations and use practices in these three states. It should be noted that this information reflects the conditions that existed in August 2006 when the state was selected.

Illinois

Illinois is a large producer of CCPs (including fluidized-bed combustion [FBC] ash and wet and dry flue gas desulfurization [FGD] material). It is also a large coal producer, with numerous active and abandoned underground and surface mines.

The Illinois EPA (IL EPA) does not have an established beneficial use program or specific beneficial use rules, but it does have specific statutory language regarding coal ash, which was recently updated. However, there is still significant confusion as to how to apply the rule. A local electric generating company submitted its first beneficial use determination to IL EPA and has not heard comments yet, so it is not known how effective the new statute is.

IL EPA has expressed significant interest in beneficial use, e.g., by participating in previous by-product summits, and the Illinois Department of Transportation (IL DOT) seems open to using recycled materials, based on its previous track record.

At the time of state selection, Illinois did not appear to be a good candidate because its new statute was not adequately tested.

Ohio

Ohio is a coal-mining state and authorizes the most beneficial use applications for coal ash out of the three proposed states. Ohio State University offers an established coal ash research program with contacts within Ohio, an extension agent focusing on CCP utilization, and support from the Ohio Air Quality Development Authority's Coal Development Office. It has a history of working with industry, government, and the public to remove CCP utilization barriers. However, Ohio State University has already assembled information similar to that obtained during the previous state reviews (Butalia and Wolfe, 2000), so new information gained from an in-depth review may be limited.

The Ohio EPA is in the process of issuing new beneficial use rules that would regulate CCPs and other industrial by-products under one rule. The change came about because the original CCP policies were declared invalid. The Ohio EPA is looking for guidance from other states in preparation of the new rules. The proposed rules are expected to be released around September 2006, but a new governor will be elected in November 2006, with the subsequent appointment of a new Ohio EPA director, which will delay the legislative process.[1] A review in Ohio is not recommended until the new rules are passed.

More than 90% of the Ohio Department of Transportation's (ODOT's) paving work is asphalt, not concrete. Fly ash concrete in paving is a key use application, so ODOT may not be the best source of information on encouraging this use.

Pennsylvania

The Pennsylvania Department of Environmental Protection (PA DEP) was identified as being very active in the development of CCP beneficial use policies, particularly with regard to its mining regulations. Pennsylvania authorized CCP beneficial use with the passage of an act in 1986, suggesting that the current regulations have been tested over time. Pennsylvania currently authorizes eleven beneficial use applications and produces a range of CCPs, including circulating fluidized bed (CFB) and FGD material. Pennsylvania has support from the Association of State and Territorial Solid Waste Management Officials (ASTSWMO) members, the Electric Power Generation Association (EPGA), and ARIPPA (formally known as the Anthracite Region Independent Power Producers Association). Public acceptance of CCP use in Pennsylvania has been problematic, particularly in the mining application area, but PA DEP, state electric generating companies, and mining companies support this use. Penn State University has an ongoing CCP research program.

Ultimately, Pennsylvania was selected because it best met the criteria outlined above at the time the state selection process took place in August 2006.

[1] The draft rules were published November 8, 2006 and the comment period was open until February 6, 2007 (www.epa.state.oh.us/dsw/rules/industrial_waste_beneficial_use.html).

Task 3: Form an Advisory Board

A second team, the project advisory board, was formed to provide input to interviewee selection, assist in the development of a standard questionnaire, and review findings. Advisory board members included Mr. John Sager, EPA; Mr. William Aljoe, DOE National Energy Technology Laboratory (NETL); Mr. David Goss, ACAA; Mr. Kim Vories, Office of Surface Mining (OSM), and Mr. Jason Harrington, Federal Highway Administration. Associated contact information is listed in the project participant list in Appendix A.

Task 4: Assemble a Review Team

A select group of individuals comprised the review team. The primary role of the review team was to administer the meetings at the review. Review team members were Mr. John Sager, EPA; Mr. William Aljoe, DOE NETL; Mr. David Goss, ACAA; and Ms. Mary Hunt, EPA Region 3. Associated contact information for review team members is listed in Appendix A.

Task 5: Create a Review Guide

A review guide was developed for Pennsylvania interviewees that included an agenda, background information, and targeted questionnaires for each discussion group (see Appendix B). To facilitate appropriate discussions, the following five discussion groups were formed to answer questions posed by the review team:

- Government agencies – directors and other key personnel of state or regional transportation and environmental agencies
- CCP generators – electric generating company environmental and ash managers
- Concrete and other engineering applications – CCP marketers, engineering/consulting firms, ready-mix concrete suppliers
- Wallboard – users of synthetic gypsum for wallboard production[2]
- Mining – Bureau of Mine Reclamation (BMR) officials and engineering/consulting firms

The review took place December 13–15, 2006. EPGA hosted the interviews in Harrisburg, Pennsylvania, although the PA DEP and the Pennsylvania Department of Transportation (PennDOT) sessions were held at their respective offices.

Task 6: Develop a List of Interviewees

With input from the advisory board, the administrative team developed a list of potential interviewees for each of the discussion groups identified in Task 5. Over 150 individuals were invited to participate in the review. The final participant list for the review is included in

[2] The wallboard session was cancelled because of lack of interest from wallboard producers in the state.

Appendix A. Those on the participant list attended a discussion session, submitted written comments, or participated in a telephone interview.

Task 7: Prepare Final Report and Disseminate Information

The primary objective of this task was to prepare a final report that can be used to encourage CCP use in Pennsylvania and other states. Target audiences for the final report include CCP industry representatives and users, members of American Association of State Highway and Transportation Officials (AASHTO), ASTSWMO, and other state and federal agency groups and individuals.

The results of the report are organized into keys, barriers, threats, and actions. These sections were modeled after a SWOT (strengths, weaknesses, opportunities, threats) analysis commonly used by marketing professionals to audit an organization and the environment in which it operates. It is the first stage of planning and helps identify key issues. The SWOT terms were modified to reflect terms that the authors felt were more applicable to the CCP industry.

STATUS OF CCP PRODUCTION AND UTILIZATION IN PENNSYLVANIA

Coal Production

The Energy Information Administration (EIA) reports that Pennsylvania produced over 67 million short tons of coal in 2005. Of that, 97.6% was bituminous, and 2.4% was anthracite coal. Pennsylvania used over 54 million short tons of coal to produce electricity in 2005. A nominal amount of coal was imported to Pennsylvania (EIA, 2006).

Expansion of coal-mining operations in eastern and interior U.S. coal basins is currently on the rise. As more and more eastern coal-fired power plants retrofit their boilers with pollution control equipment to reduce sulfur oxide (SO_2) and nitrogen oxide (NO_x) emissions, medium- and high-sulfur coal grades are once again usable and, in most cases, cheaper and closer to the end user. This is one factor that is creating increased demand for coal from the Illinois Basin and Appalachian regions. CONSOL Energy announced plans for a $500 million expansion of its Pennsylvania coal operations. This is a good example of an ongoing trend in the United States, where coal-mining companies are looking at expanding production to meet forecasted growth in domestic and international coal consumption (Industrial Outlook, 2006). It should be noted that this magnitude of projected expenditure for coal mine expansion is unprecedented. Furthermore, Pennsylvania's coal-fired power plants may elect to burn low-sulfur coal instead of installing emission control technologies, thus requiring the import of coal from other states or international sources. However, it is unknown if the installation of SO_2 emission controls, even with burning low-sulfur coal, can be avoided with the next phase of SO_2 mandated emission reductions.

Conventional Pulverized-Coal-Fired CCP Production and Utilization

Pennsylvania has nine electric generating companies with conventional pulverized-coal (pc)-fired power plants. These companies include AES Beaver Valley Cogeneration; Allegheny Energy Supply; Cogentrix Energy, Inc.; Edison Mission Group; Exelon Power; FirstEnergy Generation Corporation; PPL Generation; Reliant Energy; and UGI Development Company. According to EPGA (Kulp, 2004), these companies own and operate more than 130,000 megawatts (MW) of electric generating capacity in the United States. Approximately half of this capacity is located in Pennsylvania or surrounding states. These plants burn primarily bituminous coal and produce fly ash, bottom ash, slag, FGD gypsum, and sulfite-rich FGD material. Annual CCP production varies depending on the electric generation demand, coal vs. boiler fuel prices, combustion efficiency, emission control technologies, and coal ash content. EPGA (Biden, 2004) estimates that a typical pc-fired generation station in Pennsylvania produces 300,000 tons of fly ash and 50,000 tons of bottom ash annually. A small one-unit plant may produce as little as 45,000 tons, and a large multiunit plant could generate in excess of 1,000,000 tons of CCPs annually. Based on information provided by EPGA (Biden, 2004) and information gained from the review process, it is estimated that pc-fired power plants in Pennsylvania produce more than 10 million tons of coal ash a year.[3] This number is expected to dramatically increase in the near future, and many Pennsylvania electric generating companies are considering installing wet FGD forced-oxidized systems to control SO_2 and will subsequently be producing in excess of 4 million tons of FGD gypsum per year.

Beneficial use of CCPs produced by pc-fired power plants in Pennsylvania is estimated to be 60%–70%. Class F fly ash meeting ASTM (American Society for Testing and Materials) International C618 (Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete) is used in concrete. It is estimated that 240,000 tons of fly ash was imported to Pennsylvania from Ohio and Illinois for use in concrete applications. Fly ash not meeting concrete specifications is used to manufacture cement, for structural fill and flowable fill applications, and for mining applications. Most bottom ash is used as antiskid material, lightweight aggregate, or for protective cover and dust suppression at disposal sites. Some bottom ash is commingled with fly ash for mining applications. It is estimated that 1.4 million tons of fly ash and bottom ash were used in mining applications in Pennsylvania in 2002 (Dalberto and others, 2004). Connecticut is providing a very small amount (4000–5000 tons) of fly ash and bottom ash for mine reclamation applications. One electric generating company is converting about one-third of its sulfite-rich FGD material to gypsum for wallboard manufacture. Other sulfite-rich FGD material is being used in mine applications when stabilized with lime and fly ash for mine reclamation, subsidence control and underground mine fire control. Currently, most FGD gypsum produced in Pennsylvania is used for wallboard manufacture, although supply is expected to exceed demand as more electric generating companies install wet FGD systems. A small amount of FGD gypsum is interground with cement clinker during cement production. One electric generating company has two plants that are scrubbed with magnesium oxide and produce a unique magnesium-rich by-product. This material was beneficially used to stabilize sewage sludge and sold as a raw ingredient to manufacture fertilizer.

[3] This production statistic includes fly ash, bottom ash, FGD gypsum, and sulfite-rich FGD material only. It does not include slag.

Circulating-Fluidized-Bed Production and Utilization

Fourteen of the nineteen CFB electric generating plants in the United States are located in Pennsylvania. Owners of these plants include Cambria Cogen Company; Cogentrix; Ebensburg Power Company; Gilberton Power Company; Inter-Power/Ahlcon Partners, L.P.; Northhampton Generating Company, L.P.; Northeastern Power Company; Panther Creek Partners; Piney Creek, L.P.; Reliant Energy; Schuylkill Energy Resources, Inc.; Wheelabrator Frackville Energy Company, Inc.; and WPS Westwood Generation, LLC. The Kimberly Clark CFB plant was not included in this list because it is an industrial site power plant, and the remaining power plants are commercial power producers. Some are also cogeneration[4] facilities in that they supply heat to one or more customers. These facilities range in size from 32 to 520 MW. In Pennsylvania, three new CFB plants are in various stages of permitting, obtaining regulatory approvals at the local level and financing.

The CFB industry began in Pennsylvania in response to the oil and gasoline shortages during the 1970s and passage of the Public Utility Regulatory Policies Act (PURPA) in 1978. This act required that electric generating companies buy the electricity produced by facilities that met certain qualifications, such as the use of nontraditional fuel. The piles of coal mine refuse (otherwise generically referred to as waste coal, culm in anthracitic fields, or gob in bituminous fields) in Pennsylvania met the criteria for nontraditional fuel under PURPA. At about the same time, the CFB technology was being developed which was capable of burning a low-heating-value carbonaceous material and had emission controls that met regulations mandated by the Clean Air Act of 1970. The first CFB plant in Pennsylvania became operational in 1987, and since that time, the plants have collectively burned 110 million tons of refuse and used over 73 million tons of CFB ash for reclamation of abandoned mine lands. ARIPPA estimates that the state's CFB plants now burn 10.7 million tons of refuse coal annually and consequently produce approximately 7.9 million tons of alkaline-rich by-products per year. More than 90% of these by-products are used for mine reclamation projects, filling mine pits, and the reclamation of coal refuse areas. Another 5%–8% is used as a replacement for lime for acid mine drainage prevention or as a soil amendment/replacement at mining sites. The remaining 2% is used for other beneficial uses such as antiskid material for roadways, pipe bedding, and other uses (Joint Legislative Air and Water Pollution Control and Conservation Committee, 2004).

KEYS TO SUCCESSFUL CCP UTILIZATION IN PENNSYLVANIA

Based on the information obtained at the Pennsylvania state review discussion group sessions, the authors believe the following are the keys to successful CCP utilization in Pennsylvania. The keys highlight "strengths" or positive aspects. The keys are listed in order of importance.

[4] A CFB power plant is considered a cogeneration project if it markets at least 5% of its steam to a thermal energy user (Dalberto and others, 2004).

Key 1: Industry Drove Sound Residual Waste Regulations

A significant development in the history of beneficial use of coal ash in Pennsylvania occurred in 1986 with the introduction and passage of House Bill No. 2274, commonly referred to then as "the coal ash bill."

Mr. Douglas Biden (2004), EPGA, in written comments to the PA DEP, summarized the history of the bill. He indicated that HB 2274 originated in 1985 with the House Mines and Energy Management Committee (hereinafter referred to as the Committee) requesting testimony from the electric power industry on House Resolution No. 19, which directed the Committee to explore ways to promote the use of Pennsylvania coal and its by-products. At this time, electric generating companies were planning to install air pollution control devices that would significantly increase the amount of CCPs produced and quickly take up precious landfill space. The industry made considerable research and development (R&D) investments in developing beneficial uses for CCPs. So much progress was made that questions arose among policymakers as to why CCPs were considered a "waste," rather than the "resource" they had become. However, industry efforts to beneficially use the material were frequently frustrated by the PA DEP (then Pennsylvania Department of Environmental Resources) solid waste regulations, which governed the disposition of coal ash. Using CCPs required a permit from PA DEP, a process that could take a year or more to obtain. PA DEP staff appeared sympathetic; however, they said their hands were tied by the Solid Waste Management Act which defined coal ash as a solid waste, so that all materials thus defined had to be handled and disposed of according to the regulations (Biden, 2004).

Proposed legislation excluded coal ash from the definition of solid waste and established provisions for the beneficial use of coal ash. The proposed legislation defined "coal ash" as fly ash, bottom ash, or boiler slag resulting from the combustion of coal, that is or has been beneficially used, reused, or reclaimed for a commercial, industrial, or governmental purpose. The term includes such materials that are stored, processed, transported, or sold for beneficial use, reuse, or reclamation. After thorough legal and environmental research, HB 2274 was signed into law as Act 168 of 1986 as an amendment to the Pennsylvania Solid Waste Management Act of 1980. In 1992, provisions describing standards for the beneficial use of coal ash were placed in the residual waste management regulations and were revised in 1997.

Today, Pennsylvania regulates the beneficial use of coal ash under Pennsylvania's Residual Waste Management Regulations (Title 25 PA Code, Chapter 287, Sections 661–666) (PA DEP, 2001). These regulations define the following eleven beneficial uses for coal ash and do not require a permit:

1. As a structural fill material (287.661)

2. As a soil substitute or additive (287.662)

3. For defined uses at active coal-mining sites (287.663)

4. For use at abandoned coal or noncoal surface mine sites (287.664)

5. In the manufacture of concrete (287.665.1)

6. To extract or recover minerals and compounds contained within the coal ash (287.665.2)

7. As a fly ash-stabilized product (287.665.3)

8. Use of bottom ash or boiler slag as an antiskid material (287.665.4)

9. As a raw material for a product with commercial value, including the use of bottom ash in construction aggregate (287.665.5)

10. For mine subsidence control, mine fire control, and mine sealing (287.665.6)

11. As a drainage material or pipe bedding (287.665.7)

The beneficial uses defined above are generally accepted by industry and have cleared the way for increased CCP utilization in the state. The exception to this is FGD material,[5] which was not included in the regulations because it was not readily available as a product when the regulations were put in place. The elimination of FGD material is discussed at length in Barrier 1 of this report.

Key 2: PA DEP Has a Comprehensive Regulatory Program for the Beneficial Use of CCPs for Mine Reclamation

CCP placement in Pennsylvania mines began in the 1970s. The use was initially regulated jointly by the Bureau of Waste Management (BWM) and BMR programs of the PA DEP. In the 1980s, the Secretary of the PA DEP delegated the right to issue approvals for the placement of CCPs in coal mines to the BMR. Today, PA DEP has a comprehensive regulatory program concerning the use of CCPs in mines. The PA DEP's BMR/District Mining Offices (DMO) regulates coal ash placement at mine sites under the Solid Waste Management Act and BWM residual waste management regulations, Pennsylvania Surface Mining Conservation and Reclamation Act, and federal Surface Mining Control and Reclamation Act. Further, the BMR/DMO has developed comprehensive technical and permitting guidance on the use of CCPs in mine reclamation.

BMR/DMO has a memorandum of understanding (MOU) with the BWM as of 1990 to approve the beneficial use of coal ash at mine sites. BMR/DMO coordinates coal ash beneficial use at mine sites with BWM. The BWM handles the beneficial use of coal ash at sites other than coal-mining operations. This MOU allows for coordinated regulations and for mutual conversations to take place between the two departments.

[5] FGD material is defined as material generated from various wet forced-oxidized systems or unoxidized systems producing an either sulfate-rich (calcium sulfate [$CaSO_4$], commonly referred to as FGD gypsum) or sulfite-rich (calcium sulfite [$CaSO_3$], also know as scrubber sludge). Dry FGD systems are not presently used in Pennsylvania.

The beneficial use of coal ash at active coal mine operations is accomplished through the coal mine permitting process outlined in the following:

- *Residual Waste Management Regulations* (287.663-287.664) – Defines the beneficial uses for coal ash at active coal-mining sites and abandoned coal or noncoal surface mine sites.

- *Beneficial Use of Coal Ash at Active Coal Mine Sites* (563-2112-206) – This document describes the procedure for the DMOs to review requests for the beneficial use of coal ash at active mine sites.

- *Certification Guidelines for Beneficial Use of Coal Ash* (563-2112-224) – This document provides the guidelines for certifying coal ash for beneficial uses and the forms with instructions that are necessary for the department to certify coal ash for beneficial use.

- *Technical Guidance Document for Beneficial Use of Coal Ash* (563-2112-225) – This document describes the four beneficial uses – 1) placement, 2) soil substitute or additive, 3) alkaline addition, and 4) low-permeability material of coal ash – that can be approved in active coal mine permits or that can be approved as part of the department's mine reclamation contracts or other department-approved mine reclamation projects.

Two additional permit application modules were developed for use with the coal mine permit application for evaluating proposals for beneficial use of coal ash. Module 25 was developed for placement of coal ash as fill material and Module 27 for use of coal ash as a soil substitute or additive. These documents and permit application modules, in conjunction with Pennsylvania's residual waste management regulations, very clearly outline how coal ash is to be used in mine settings in Pennsylvania.

Coal ash utilization in mine settings continues to rise, as shown in Table 1. In 2005, over 8 million tons of coal ash was used in mine settings in Pennsylvania, a quantitative indication of a successful and growing beneficial use program.

Table 1. Coal Ash Used at Pennsylvania Mine Sites (PA DEP, 2006)

DMO	1998	1999	2000	2001	2002	2003	2004	2005
Pottsville	3,014,992	3,208,899	3,856,633	3,875,422	3,805,578	4,352,868	3,505,009	3,385,458
Cambria	1,489,327	1,308,652	1,107,077	1,188,684	1,195,144	1,171,469	1,291,000	1,295,773
Moshannon	165,343	159,240	130,254	145,599	208,805	155,477	213,037	183,752
Greensburg	279,076	251,168	283,900	350,957	260,465	293,015	211,733	265,266
Knox	224,046	213,182	170,764	264,239	201,540	141,018	294,793	258,217
California	895,807	823,958	911,804	803,768	718,759	1,025,105	1,670,770	2,984,313
Total	6,068,591	5,965,099	6,460,432	6,628,669	6,390,291	7,138,952	7,186,342	8,372,779

The comprehensive and dependable program developed by PA DEP may be more stringent and costly in the short-term than other states, but industry believes the strict policies and enforcement will actually save them money in the longterm by not having any damage cases. In

the review sessions, industry representatives indicated that they appreciated that PA DEP reached out to electric generating companies, the mining industry, and academia to develop a program that outlines what is expected in order for coal ash to be beneficially used in mine sites.[6] For these reasons, many consider Pennsylvania to have model regulations for the beneficial use of CCPs in mine reclamation, particularly for abandoned mine land (AML) reclamation.

Key 3: CFB Plants Produce Ash That Is Well Suited for Reclaiming Abandoned Mine Land

According to BMR, Pennsylvania has more than 5000 abandoned, unreclaimed mine problem areas and over 820 abandoned coal refuse piles. It is estimated that Pennsylvania suffers from up to 3100 miles of streams degraded by acid mine drainage (AMD) as a result of AML's (Dalberto and others, 2004).

Coal refuse piles represent a significant subset of AML sites in Pennsylvania. The piles are typically toxic to plant life, and thus are barren and highly erosive. They are expensive to reclaim, and standard reclamation techniques do little to address the extremely poor water quality (Dalberto and others, 2004).

CFB plants produce an ash that is an exceptional material for AML reclamation. The conditions of combustion and ash formed by CFB plants differ from pc combustion plants. CFB plants are capable of burning fuels that contain as little as one-quarter of the heating value of commercial coal while controlling sulfur oxide and NO_x emissions. In CFB plants, the temperature of combustion is 800°–900°C, compared to 1200°–1450°C in pc plants. Limestone is added to the CFB fuel to capture SO_2, producing a highly alkaline CFB ash. During combustion, the limestone is burned to calcium oxide, which forms $CaSO_3$ and $CaSO_4$ by combining with SO_2. The particles of CFB fuel are fed at a 1-cm size, compared with 74 µm at a pc plant. The ash particles circulate or are captured and recirculated in the CFB furnace for minutes to hours, compared with combustion in a few seconds in the pc process. The trace elements in the CFB ash are strongly bound because of annealing due to the lower temperature in the furnace and longer time in the furnace (Rose and others, 2001); (Dalberto and others, 2004).

The state's CFB plants offer an ideal opportunity to remine abandoned coal refuse piles, use the recovered coal refuse as a fuel, and return the resulting alkaline CFB ash often to the original site for reclamation. This is a classic recycling success story. As an added benefit, this process only uses private funding and thus preserves the AML funds for other sites.

Key 4: PennDOT Regulations Allow CCP Use in Concrete and Flowable Backfill Applications

PennDOT is the largest purchaser of concrete in the state. It does not track statistics on how much concrete it purchases but estimates that approximately 80% of PennDOT projects are asphalt and 20% are concrete. There are no records or documents on the quantity of CCPs used in PennDOT projects.

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[6] As further discussed in Barrier 4, the interpretation of PA DEP regulations can vary among district offices.

In order for CCPs to be used in PennDOT projects, they must be preapproved. Bulletin 14 lists all approved bottom ash sources, and Bulletin 15 lists all approved fly ash sources that can be used on PennDOT projects. To get on an approved list, one must fill out an application and provide a quality control plan. Usually an ash marketer approaches PennDOT to get a material approved, but sometimes a specific unit or plant manager will make a request. PennDOT has Class F and Class C fly ashes on its list from many states, including Illinois, Indiana, Maryland, Massachusetts, Missouri, New Jersey, New York, North Carolina, Ohio, Pennsylvania, and West Virginia. Fly ash is often imported because most fly ash sources in Pennsylvania do not meet specifications for use in concrete because of high unburned carbon content.

Most Class F fly ashes are approved by PennDOT for alkali silica reactivity (ASR) mitigation. Class F fly ash plays an important role in PennDOT projects because about 70% of its aggregate sources are reactive. ASR occurs when reactive aggregates chemically react with alkaline components of portland cement, forming ASR gel. The gel adsorbs water and expands, damaging the concrete. Class F fly ash is effective in controlling expansion due to ASR, but Class C fly ash and other materials can also be used in certain applications. PennDOT specifications allow the portland cement portion of concrete to be reduced by 15% of fly ash and by 25% of ground granulated blast furnace slag for ASR mitigation.

PennDOT has material specifications for fly ash utilization which include:

1. Fly ash used with lime for soil stabilization. Fly ash must be tested in accordance with AASHTO T 135 (Wetting-and-Drying Test of Compacted Soil-Cement). Physical requirements for fly ash are also established in ASTM C 593 (Standard Specification for Fly Ash and Other Pozzolans for Use with Lime for Soil Stabilization) (Publication 408, Section 724.2).

2. Fly ash used as a pozzolan in portland cement concrete mixtures. Fly ash must be tested in accordance with ASTM C 311 (Standards and Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland-Cement Concrete). According to Publication 408, Section 724.2, fly ash must meet specifications set forth in AASHTO M 295 (Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete). Loss on ignition is limited to 6%.

3. Fly ash used to mitigate the effects of reactive aggregate associated with ASR in concrete. Fly ash must conform to the optional chemical requirements of AASHTO M 295 (Publication 408, Section 704.1[g]3.c).

Fly ash, slag, and bottom ash meeting material specifications set by PennDOT can be used for the following types of flowable backfill applications as long as they come from approved sources (Publication 408, Section 220):

- Where future excavation of the backfill may be necessary, such as at utility trenches, pipe trenches, bridge abutments, and around box or arch culverts.

- Where excavation of backfills is not anticipated, including replacing unsuitable soils below structure foundations; filling abandoned conduits, tunnels, and mines; and backfilling around pipe culverts where extra strength is required.

- In construction areas requiring low-density backfill material as in abutments over highly deformable soils, backfilling retaining walls, filling vaults, and backfilling on top of buried structures.

PennDOT allows the use of ground granulated blast furnace slag as a pozzolan (Publication 408, Section 724.3). Ground granulated blast furnace slag must be tested in accordance with AASHTO M 302/ASTM C 989 (Ground Granulated Blast Furnace Slag for Use in Concrete and Mortars). In addition, bottom ash and ground granulated blast furnace slag are allowed for use as an antiskid material and are often mixed with salt.

Materials not meeting the specifications or standards covered in Publication 408 will require testing in accordance with PennDOT's Product Evaluation (PE) process. This process can take years because it is a case-by-case review.

PennDOT looks first to AASHTO and then to ASTM for guidance on developing its own specifications. PennDOT's specifications set the bar for other coal ash users in the state because industry sees the specifications as cautious and stringent, thus lessening the potential for failure. Contractors are also familiar with PennDOT specifications and are more willing to accept a practice that has been approved by PennDOT. For example, the Turnpike Commission typically defers to PennDOT specifications.

Key 5: Nearly All Poured Concrete for Commercial and Residential Construction Contains Class F Fly Ash, Which Helps Mitigate ASR

According to the National Ready Mixed Concrete Association (2006), Pennsylvania ready-mixed suppliers produced over 12 million cubic yards of concrete in 2005. This ranks Pennsylvania seventh in the nation with regard to ready-mixed concrete production.

Nearly all concrete poured for commercial and residential construction in Pennsylvania contains 10%–20% Class F fly ash. This percentage tends to work best for ASR mitigation and does not interfere with set time. The exception to this percentage is if a slow strength gain or other special conditions are required for a particular project. A nominal amount of Class C fly ash is imported, but most ready-mixed suppliers exclusively use Class F fly ash. Particularly in the western part of the state, Pennsylvania has very reactive aggregate and needs Class F fly ash to mitigate ASR. Although other nonash materials may also mitigate ASR, they are generally more expensive than fly ash.

In general, commercial and residential consumers do not know or care if their concrete contains fly ash. More savvy ready-mixed consumers understand that fly ash produces better concrete and is an environmentally friendly material, but for the most part, end users are unaware of the benefits of using fly ash in concrete. This lack of knowledge does not appear to impact the concrete market in Pennsylvania. The market is using as much concrete-grade Class F fly ash as

it can when taking into account current market conditions. Fly ash demand is expected to continue to parallel that of cement.

Key 6: PA DEP Presents Its Research and Monitoring Data in a Readable Format

The use of CCPs in mine applications is a contentious issue on local, state, and national levels. PA DEP believes it has a responsibility to make its monitoring data and related research available in a readable form for scrutiny and use by the scientific community, government agencies, environmental groups, and the general public. As a result of this philosophy, the PA DEP published a book titled *Coal Ash Beneficial Use in Mine Reclamation and Mine Drainage Remediation in Pennsylvania* in 2004. The publication is an in-depth, peer-reviewed analysis on the use of CCPs for mine reclamation and contains over 20 years of research and data.

The information presented in the report demonstrates that PA DEP is effectively regulating the use of CCPs in mine sites, while ensuring that the opportunities for beneficial use are not unduly restricted. The report documents numerous case studies of successful applications in great detail. In particular, it shows how coal ash is successfully being used to alleviate AMD problems by removing refuse coal from the environment, a key source of AMD.

By providing easy access to its research and monitoring data, PA DEP has been able to provide information to environmental groups and government agencies demonstrating that no environmental damages have occurred as a result of putting CCPs in mine sites.[7]

REPORTED BARRIERS TO INCREASING CCP UTILIZATION IN PENNSYLVANIA

The following barriers were identified during the Pennsylvania state review process. The barriers or "weaknesses" detract from a CCP stakeholder's ability to increase CCP utilization. The authors believe the barriers are listed in order of significance.

Barrier 1: FGD Material Is Not Included in the Definition of Coal Ash Under the Solid Waste Management Act

When Pennsylvania's solid waste regulations were put into place by an act in 1986, the coal ash beneficial use regulations did not include FGD material because FGD material was not available for beneficial use. Since that time, electric generating companies have installed or are planning to install FGD systems and are marketing their FGD material. Managing FGD materials under the current regulatory framework has become problematic because it is not afforded the same permit-by-rule beneficial use applications given to coal ash. Therefore, FGD material must be managed as a residual waste and can only be beneficially used under a specially issued permit, such as a general permit. Industry does not want to be required to apply for a general permit for each beneficial use because it is a lengthy process.

[7] The McDermott site was a damage case because of AMD. CCPs were used in the backfill, but it was not a damage case because of the ash. The damage was caused from past mining practices in the area, additional remining and partial reclamation.

This barrier is an immediate concern to the state's electric generating companies because of the expected surplus of more than 4 million short tons of FGD gypsum per year in Pennsylvania alone. Nationally, Bruce (2004) predicts that over the next 20 years the North American supply of FGD gypsum is going to exceed the demand by a wide margin, with a surplus of 10–15 million tons a year by 2015. Electric generating companies do not want to be dependent on wallboard and cement plants to use all of their FGD gypsum because plants may shut down temporarily or close and the markets for wallboard and cement fluctuate based on building trends. Also, the wallboard and cement markets may soon be oversupplied with synthetic gypsum. In addition, the potential for mercury captured in FGD gypsum to be released during wallboard production is still unknown. There is also some concern that mercury contained in FGD gypsum wallboard may leach into the groundwater at municipal landfills once the wallboard reaches the end of its life cycle and is disposed of.

This predicted surplus suggests a need to develop new markets for FGD gypsum and for PA DEP to write new regulations that would include FGD gypsum in its definition of coal ash and designate new beneficial use applications for the material. This would require a revision to the Solid Waste Management Act.

Through EPGA, industry started working with PA DEP in 2004 to find uses for the anticipated surplus of FGD gypsum. Industry would like to be able to use FGD gypsum in mining, structural fill, and agriculture applications. Mine applications are preferred because there is a local need for reclamation materials, and it is a large-volume application. Electric generating companies are also concerned that PA DEP may require a lined landfill for the disposal of FGD gypsum, making it even more important to secure a beneficial use for the material.

PA DEP cannot approve FGD gypsum for use in coal or non-coal mine sites under current regulations (287.611 [e] [3]) unless it is combined with fly ash. PA DEP is working on combining the municipal and residual waste regulations into one regulatory package. PA DEP is also reviewing a general permit application submitted by EPGA for the beneficial use of FGD gypsum in a coal ash–lime mixture for use in mine reclamation. At the time of the review meetings, this process was expected to take approximately 2 years, from the initial proposal to implementation. EPGA proposed a number of different blends to PA DEP. It originally proposed 100% FGD gypsum, next 90% FGD gypsum–10% fly ash, and then 74% FGD gypsum–24% fly ash–2% lime. After repeated laboratory tests on a variety of blends, PA DEP stated at one point it would like a 50% FGD gypsum–45% fly ash–5% lime blend and encouraged industry to use less FGD gypsum, more fly ash, and more hydrated lime. PA DEP is concerned about the hydraulic conductivity and solubility of FGD gypsum, which could result in high concentrations of calcium and sulfate and, possibly, boron and result in the development of karstlike features. Electric generating companies do not want to blend concrete-grade fly ash with FGD gypsum because it does not make economic sense, and they do not want to contaminate pure FGD gypsum with fly ash in case it could be recovered again for future use. Also, some electric generating companies would have to import fly ash from external sources.

Following the review meetings in December 2006, PA DEP, with cooperation from industry, agreed that a performance-based standard would be the best option, rather than dictating the exact mixture of FGD gypsum, fly ash, and alkaline fixative. PA DEP requested

that industry achieve a hydraulic conductivity of no more than 10^{-6} cm/sec within 56 days of placement to reduce leachate generation. EPGA provided testing information to PA DEP showing that a 3:1 ratio of FGD gypsum to fly ash with 4% alkaline additive (lime) will produce this permeability and result in a compressive strength of more than 1400 pounds per square inch. This information along with the FGD gypsum/fly ash/alkaline agent testing, groundwater quarterly monitoring, and appropriate placement methods are incorporated in the draft general permit that was issued in February 2007.

Barrier 2: Lack of Internal Communication at Government Agencies

Internal communication and technology transfer among departments within state agencies are limited. At PA DEP, BWM and BMR/DMO communicate regularly and work together to develop rules, guidance, and special conditions needed for the coal ash beneficial use program. However, BWM, the Bureau of Air Quality, and the Bureau of Water Standards and Facility Regulation do not appear to communicate as effectively. Similarly, at PennDOT, the 14 bureaus did not appear to be familiar with each other's activities. These communication barriers appeared to be due to a lack of formal mechanisms to facilitate such communication with departments or districts and are not due to lack of interest among departments to work together.

The lack of communication between bureaus is a barrier because, instead of developing a cohesive approach to issues, these bureaus may be duplicating efforts or have contradicting opinions.

Barrier 3: Costly Long-Term Field Studies May Be Needed to Get New Beneficial Use Applications Approved

PA DEP is sometimes perceived as being overly conservative in accepting new beneficial uses and wanting long-term field studies to alleviate any concerns it may have about the environmental appropriateness of using CCPs over time. Although the need for long-term field studies is often valid, these studies can be costly, may result in substantial project delays, and are not always cost-effective for industry to conduct (i.e., the cost of the study is more than the avoided disposal cost or the potential revenue to be earned via the beneficial use).

Unfortunately, Pennsylvania does not have a governmental entity or state-derived R&D funds to help fund these studies like other coal-mining states, such as North Dakota (Lignite Energy Council), Ohio (Ohio Coal Development Office), and Illinois (Illinois Clean Coal Institute). These R&D organizations provide funding for projects that preserve and enhance the development of their states' coal resources, which include projects focused on CCP utilization.

Barrier 4: Interpretation of PA DEP Regulations Varies Among Districts/Regions

The PA DEP DMO has five surface mining and one refuse district offices, and the BWM has six regional offices. The PA DEP central office has general oversight on beneficial use and provides technical support to the district/regional offices. The districts/regions issue permits.

An example of a difference in the interpretation of regulations among DMOs is for the amount of growing medium required after a mine has been filled in. The regulations call for 1 foot of growing medium for planting grass and 3 feet for planting trees. If coal ash placement occurs, 4 feet of growing medium is required. The districts indicated that each district has exclusive geographic conditions and that the growing medium required is dependent on what the land is intended to be used for in the future. Although industry generally agrees that site-specific exceptions are needed, they contend that the requirements are not consistent, making it difficult to plan and budget for these projects.

Barrier 5: Government Agencies Did Not Appear to View CCPs as a Means for Achieving Sustainability

The government agency representatives interviewed did not appear to consider the environmental sustainability associated with the beneficial use of CCPs when making their rules, regulations, or policies regarding coal ash management. There are some noteworthy exceptions to this statement:

- The environmental benefits of using CCPs for mine reclamation were very well understood and promoted by PA DEP BMR.

- The state requires all new government buildings to be LEED®-certified, which could indirectly encourage the use of CCP-containing products.

- The PA DEP in conjunction with the Environmental Technology Evaluation Center at the Civil Engineering Research Foundation in Washington, D.C., has established a national program to increase the use of innovative cement technologies, which includes the increased use of fly ash. An initial outcome of this work is the acceptance of the ASTM performance specification within the commonwealth.

Despite these exceptions and potentially others that were not revealed during this review process, the discussion groups did not relieve a green movement (whether that be from the development of legislation on green building or sustainable development groups approaching state agencies) that was making a major impact on directly encouraging the increased use of CCPs.

To illustrate this barrier, the use of fly ash as a mineral admixture in concrete should be considered (generally at 15%–35% replacement for portland cement nationwide). This practice offers significant engineering, economic, and environmental benefits. Engineering benefits include improved performance for placement and in the final product. Electric generating companies and end consumers realize economic benefits by avoiding fly ash disposal costs and saving money by using fly ash as a supplementary cementitious material. Environmental benefits include reduced greenhouse gas emissions (approximately 1 ton of carbon dioxide saved for every 1 ton of fly ash used to replace portland cement), reduced need for landfills, and conservation of virgin resources. The environmental benefits associated with using CCPs in concrete applications were not considered by Pennsylvania government agencies. The coal ash beneficial use section of the solid waste regulations set forth by PA DEP were included mainly

because PA DEP believes it is environmentally safe to use CCPs in certain applications. The PennDOT specifications were in place primarily because Class F fly ash is effective in mitigating ASR. PennDOT's specifications, in particular, are focused on the physical benefits of using CCPs and did not place value on the environmental benefits of using CCPs.

As an other example, government agencies interviewed have programs that encourage using recycled materials, but they do not focus on CCPs. Since 1998, PennDOT and PA DEP have operated under a MOU to promote and support recycled materials in state highway construction and maintenance projects. PennDOT's Strategic Environmental Management Program focuses on recycled material use in maintenance projects, and the Strategic Recycling Program evaluates and helps implement recycling opportunities for new projects. These programs are spearheaded by PennDOT, with support from PA DEP. Both of these programs consider CCPs to be recycled materials; however, they are not actively encouraging the use of CCPs. In order for these programs to look more closely at CCPs, they would likely need to be approached by industry.

Barrier 6: Advocacy Groups Can Be Effective in Delaying or Terminating Beneficial Use Applications

National and local advocacy groups such as the Clean Air Task Force, Hoosier Environmental Council, and the Army for a Clean Environment representing the people of Tamaqua, Pennsylvania, have attacked the beneficial use of CCPs in Pennsylvania. Advocacy groups such as these have stated that they believe that government agencies fail to protect humans by caving to political pressure and that the people are left to defend themselves against what they see as dirty coal-burning power plants.

CCP industry stakeholders interviewed believe these advocacy groups attack mine reclamation with CCPs in an indirect way to stop the burning of coal to produce electricity. Those interviewed believe that these groups understand that if they can prevent a coal-fired power plant from hauling its CCPs back to a mine site for reclamation, they will be hurting the power plant, thereby protecting the public from the pollution (air and water) they perceive to be associated with the plant. Advocacy groups have cited outliers in monitoring data provided by PA DEP or the presence of AMD-related contaminants as evidence of environmental damage, even though the alleged environmental damage cannot be linked to the placement of CCPs.

Despite the efforts of these advocacy groups, the general public seems to accept the beneficial use of CCPs in mine sites and understands the logic that the land is better off with reclamation than without. In particular, the general public understands that AML represent a physical safety hazard and are pleased when the land is returned to a productive and safe state. Nevertheless, these groups are still effective in delaying or terminating some beneficial use applications, simply because potential project proponents may wish to avoid the hassle of dealing with these groups.

It is important to note the advocacy groups named in this report were not invited to participate in this review. The opinions reflected in this barrier were brought forth by those who participated in the discussion group sessions.

Barrier 7: Although the NAS Report Was Not Damaging, It Was a Missed Opportunity to Showcase Success Stories

In recent years, the beneficial use of coal ash on mine sites has become a controversial topic on local, state, and national levels. As a result, EPA was tasked to review the adequacy of coal ash beneficial use programs nationwide to determine if federal regulation, guidelines, or other requirements are needed to help ensure that the beneficial use of coal ash on mine sites does not cause groundwater contamination. NAS was commissioned to perform this evaluation and published a report titled *Managing Coal Combustion Residues in Mines* (2006).

Everyone interviewed in the discussion groups stated that the NAS report was "middle of the road." They felt that although the report contained no information that would prohibit the use of CCPs in mines, it was a missed opportunity to showcase the benefits of using CCPs in mines.

No damage cases were reported by NAS about the use of CCPs in mine applications. Some of the sites identified as alleged damage cases by critics of coal ash beneficial use were Pennsylvania sites. In reviewing the concerns over the Pennsylvania sites, it became apparent to those who participated in the discussion groups that many of them were generated by misinterpretation of data and a lack of in-depth analysis of the sites. Industry and PA DEP defended these allegations of damage cases.

PA DEP is considering making the following minor modifications to its monitoring requirements based on recommendations in the NAS report:

- Broaden the parameters it monitors in groundwater and leachate.
- Require the recording of landowner consent forms. These were only recommended to be recorded in the past.
- Increase monitoring of heavy metals quarterly instead of annually in order to provide information on seasonal information and to allow for more rigorous analysis and interpretation of the data.
- Require more conditions in permits.
- Investigate specific compaction techniques and fugitive dust issues.
- Require risk assessments.

Industry is generally accepting of these increased monitoring requirements, although some industry representatives indicated that the increase in monitoring may be more costly but would not preclude the practice of placing CCPs in mines. In addition to the monitoring requirements, PA DEP is trying to make its monitoring data easier to review by providing it in an electronic format. It will use forums such as ASTSWMO, Interstate Mining Compact Commission (IMCC), and Solid Waste Alliance Communities (SWAC) to exchange information with other states. On a federal level, EPA plans to begin regional state calls for industrial material reuse/recycling,

which will include CCP use for mine filling. These should be considered positive outcomes of the NAS report.

The "barrier" of the NAS report is that it did not recognize the vast differences between the highly alkaline CCPs produced by CFB plants and the less alkaline fly ash produced by pc-fired plants. The CFB ash generators believed their success story was missed by the NAS report because this distinction was not made and the beneficial use of CFB ash in particular should have been prominently showcased. For example, the NAS report indicated that coal ash should not be placed in direct contact with standing water or groundwater. However, the Big Gorilla project demonstrated the engineering and environmental appropriateness of placing fly ash and bed ash from a CFB plant directly into a surface mine pool.[8] This was a demonstration project with closely monitored groundwater proving the successful reclamation for a nearly 15-acre mine pit containing 135 million gallons of acidic water. Such highly beneficial reclamation projects could be prohibited in the future if regulatory agencies blindly adhere to the NAS report's suggestions in this regard.

POTENTIAL THREATS THAT COULD IMPACT FUTURE CCP UTILIZATION IN PENNSYLVANIA

The following potential threats could hinder the future of CCP beneficial use in Pennsylvania. For the purpose of this report, a threat is defined as an external challenge that could negatively impact the use of CCPs. Because threats are external – CCP stakeholders have no direct control over them, but may benefit by having contingency plans to address them should they occur. The threats are based on information gathered at the discussion groups and the authors believe the threats are listed in order of importance.

Threat 1: Industry Is Concerned about the Impact Federal and State Air Emission Rules Will Have on CCP Management

In March 2005, EPA announced new clean air regulations that will reduce emissions of NO_x, SO_2, and mercury from coal-fired power plants. These regulations seek to lower levels using a cap-and-trade mechanism by which power plants are assigned emission limits but can exceed those limits by purchasing credits from companies whose emissions are below their assigned limits. EPA lists both of these rules as a part of the Clean Air Rules of 2004:

- The Clean Air Interstate Rule (CAIR) applies to SO_2 and NO_x emissions in 28 eastern states and Washington, D.C. (this includes Pennsylvania). CAIR calls for selected states to have a 70% reduction of SO_2 emissions and a 60% reduction of NO_x emissions compared to 2003 levels by the year 2015.

[8] More information about the Big Gorilla demonstration project can be found in *Coal Ash Beneficial Use in Mine Reclamation and Mine Drainage Remediation in Pennsylvania;* Pennsylvania Department of Environmental Protection, 5600-UK-DEP3132, 2004.

- The Clean Air Mercury Rule (CAMR) is the first federal rule to limit mercury emissions from coal-fired power plants. This rule calls for a 70% reduction of mercury emissions by 2018.

In addition to federal regulations, the PA DEP submitted its own proposed rulemaking to EPA to reduce mercury emissions from coal-fired power plants in November 2006. The proposed rule stated that new and existing coal-fired power plants in Pennsylvania will meet an annual mercury budget of 1.779 tons per year for Phase 1, which begins January 1, 2010. The Phase 2 requirements will begin January 1, 2015, and will require an annual mercury budget of 0.702 tons per year and each year thereafter. PA DEP's proposed rule does not allow participation in the CAMR cap-and-trade program. The regulation will be codified in 25 PA Code 123.201–123.215.

Industry is concerned about the Pennsylvania mercury regulation because it:

- Does not allow for cap-and-trade.

- Reduces mercury emission by more than 95%, which will force electric power generators to consider switching to low-mercury (non-Pennsylvania) coal.

- Forces controls on all units regardless of cost–benefit. For many units, it is believed that the incremental environmental and health benefits are not proportional to the increased cost of mercury control, which will be borne by either utility shareholders or consumers (Davis, 2006).

Some concerns brought forth by industry related to the impact these federal and state air emission regulations will have on CCP management include the following:

1. CFB plants burn coal refuse with a high sulfur content. To achieve the SO_2 emission levels designated by CAIR, CFB plants would have to add a considerable amount of limestone, resulting in additional costs and an ash with an even higher pH.

2. Bituminous coals burned by Pennsylvania's pc-fired power plants tend to produce high proportions of soluble, oxidized mercury in the flue gas; thus the primary technology for reducing mercury emissions is wet FGD systems. This allows mercury removal to be achieved as a "cobenefit" of compliance with CAIR; however, the amount of mercury removal achievable with wet FGD systems varies from plant to plant. There is great concern that some units, even after wet FGD systems are installed, may not be able to achieve the high levels of mercury removal required by the Pennsylvania law. The inability to trade mercury reduction credits in Pennsylvania could force such units to install additional mercury controls, which will increase cost and could have negative impacts on the quality of CCPs. Other options include adding more limestone to the boiler but since most boilers can only handle a defined amount of material; there is an inability to add limestone to reduce SO_2 emissions while maintaining the level of generation mandated. Plants could also switch to a higher-Btu/lower-sulfur coal; however, the availability of this type of coal is uncertain.

3. Other than wet FGD systems, the leading technology to comply with CAMR and/or the Pennsylvania mercury rule is activated carbon injection (ACI). ACI may lead to increased concentrations of mercury-containing sorbents and higher carbon contents in fly ash. Fly ash will likely no longer be able to be used in concrete because ACI impacts air-entraining admixtures (AEAs). Both industry and PennDOT are concerned that their mix designs rely on fly ash as an admixture and changes in the chemical and physical properties of the fly ash could adversely impact its effectiveness. More specifically, they are concerned about the impact of the AC on AEAs in concrete. They are also concerned about any changes that influence the material's ability to increase strength and reduce permeability. Units that choose to burn lower-sulfur coal as a means of complying with CAIR may also produce fly ashes that are less advantageous as a concrete admixture than current Class F ashes. PennDOT may also not be able to list fly ash sources contaminated with AC on Bulletin 15. In order for it to approve contaminated fly ash, it would need long-term data indicating that the fly ash works over time and is a consistent material. These data would need to come from an independent source. PennDOT does not have the monetary or personnel resources to conduct its own testing.

4. Fly ash from units using sorbent injection for mercury control may no longer be able to be used in cement manufacture unless the manufacturer demonstrates that the use of such ash will not lead to increased mercury emissions from the cement kiln (National Emission Standards for Hazardous Air Pollutants From the Portland Cement Manufacturing Industry, 2006). EPA has voluntarily taken reconsideration on the ban on fly ash where sorbent injection for mercury control is practiced and has been petitioned (Pew, 2007) to reconsider its decision not to place restrictions on the current use of fly ash. EPA plans to complete these reconsiderations by the end of 2007.

Numerous beneficiation technologies have been developed to address these ash management concerns; however, the applicability of beneficiation technologies is very site-specific to each power plant, and there is limited information available on the potential rerelease of ACI-captured mercury from ash beneficiation operations. There is not a one-size-fits-all technology, and in many instances, it is not economically advantageous to employ beneficiation technologies because the plant has low-cost disposal options. Some Pennsylvania electric generating companies are in the process of installing or are considering installing beneficiation technologies to improve CCP quality.

Threat 2: OSM Is Developing New Rules Which May Require Modifications to PA DEP Regulations

The U.S. Department of the Interior OSM sets standards for the operation of surface coal mines and reclamation of the land following mining. Currently, OSM is developing national rules for active Surface Mining Control and Reclamation Act (SMCRA) coal mines and abandoned mines that receive federal funding for reclamation. The new rules will utilize existing SMCRA authorities. The current schedule is to have a proposed rule during 2007, with a final rule during 2008, although OSM stated this is an optimistic time line. OSM will publish an advance notice of proposed rulemaking in the Federal Register formalizing its intentions. Once

these rules become final, OSM will write Part 732 notification letters to each of the mining states (including Pennsylvania) telling them that if they want to continue permitting CCP placement under SMCRA, they must adopt rules that are equivalent to the federal rules. The OSM rules will not be modeled after Pennsylvania residual waste beneficial use coal ash rules but will designate all of the existing SMCRA rules which must be complied with in order to conduct CCP placement at a SMCRA mine. Some new rules may be necessary such as addition of a definition of terms. These rules will not apply to AML sites where no federal funding is involved (Vories, 2007). In Pennsylvania, the ARIPPA program to reclaim AMLs does not receive funding from the federal SMCRA AML program and, therefore, does not fall under SMCRA regulatory authority.

Threat 3: EPA Could Prohibit the Use of FGD Gypsum in Cement Production

With the predicted surplus of FGD gypsum, cement manufacturers are expecting to get FGD gypsum at a lower price and, subsequently, will be using more FGD gypsum. FGD gypsum requires special handling equipment; however, this will not be cost-prohibitive. Given the potential EPA ban on the use of fly ash from sorbent injection for mercury control as a cement kiln feed (see Threat 1 above), there is some concern that EPA will also prohibit the use of FGD gypsum produced at coal-fired power plants using sorbents for mercury control. EPA understands that FGD gypsum is generally not used in the high-temperature portion of the cement-manufacturing process that would be conducive to mercury release but is investigating worker safety and mercury emission information that may influence such future restrictions.

ACTIONS THAT COULD INCREASE CCP USE IN PENNSYLVANIA

The following actions are suggested by the authors as methods for overcoming barriers and threats identified in this report by taking advantage of the opportunities for increasing CCP utilization. The proposed actions are to be implemented by a variety of CCP stakeholders, including government at the federal, state, and local level; electric generating companies; ash marketers; ready-mix producers; academia; and industry groups. The actions are listed in order of significance.

Action 1: Develop Regulations and Find New Markets for FGD Material

Several high-volume applications could use FGD gypsum and take advantage of its inherent chemical properties. One of the most promising high-volume applications is the low-cost production of alpha hemihydrate/gypsum cement (otherwise known as high-strength plaster). Other end uses that are expected to be economically viable are fertilizers and fillers (Bruce, 2004). Although the amount of FGD gypsum required as fertilizer at any one site may be somewhat limited, the collective agricultural market is quite large and appears to be worthy of further investigation. In fact, the U.S. Department of Agriculture is currently working with Pennsylvania State University to develop uses for FGD gypsum in agricultural uses. Pennsylvania also has several high-volume mining application opportunities.

In order to facilitate the development of regulations that are conducive to large-volume uses of FGD gypsum, both PA DEP and industry should seek out the advice and experience of

persons and agencies in other states (e.g., Tennessee Valley Authority) that are familiar with large-volume FGD gypsum placement in monofills. Real-world data from existing FGD gypsum monofills would provide PA DEP with evidence it needs to determine whether or not solution channeling within the FGD gypsum is or is not likely to occur and provide some insight as to how to design structural fills containing high volumes of FGD gypsum.

Action 2: Improve Lines of Communication Between Industry and Government Agencies

Government agencies, legislators, and industry generally agree that making modifications to current regulations or writing new regulations is a lengthy process. Government agencies indicated this process could be expedited if industry would provide them with the information/data they need up-front; whereas, industry indicated that the government agencies should say what information/data they need and then industry will provide it. Industry further indicated that, in some instances, government agency staff do not have the technical knowledge base needed to completely understand the issues. These roadblocks can delay the regulation process for years.

The PA DEP representatives interviewed indicated that their primary job is to protect the public, not to represent the interests of industry. PA DEP stated that industry should take a proactive, not reactive, approach to providing information/data. For example, if industry wants the PA DEP to consider including FGD gypsum in its definition of CCPs, it needs to do its part in providing PA DEP with the information/data it needs to make that determination. Likewise, industry indicated the PA DEP needs to do a better job of deciding up-front what information/data it needs.

A potential solution to this issue is for industry and government to work together toward advancing the beneficial use of coal through a research consortium. For example, the EERC's Coal Ash Resources Research Consortium® (CARRC®) has offered a forum for industry to work with DOE NETL on a multitude of coal-ash related issues. Government participation on a state level could also be incorporated into consortium efforts such as CARRC. Industry support groups, such as EPGA, also offer an excellent forum for industry to pool its intellectual and monetary resources and collectively approach state agencies as one unified voice for the mutual benefit of all parties involved.

Action 3: Import Fly Ash from States with High Disposal Costs and Limited Beneficial Use Options

Several fly ash-marketing companies contacted to participate in the discussion groups were not currently selling fly ash in Pennsylvania but were interested in getting into the market. To do so, they would likely have to import fly ash into Pennsylvania. Some are already doing so, but there is opportunity to import more for beneficial use. In some instances, it is economically feasible to import fly ash from states where landfill costs are high. Transportation costs may be limiting in some areas; however, some marketing companies have managed to import ash for high-volume, low-value applications such as mine reclamation. It is anticipated that more fly ash

will be imported into the Pennsylvania market for use in concrete (if the concrete market continues to grow) and mine reclamation projects.

It should be noted, however, that the import of fly ash from other states may be perceived by local citizens and environmental groups as problematic. Pennsylvania has had instances in the past where local groups have tried to stop the transportation of coal ash in their townships/cities and could look at the import of coal ash for beneficial use applications as a way for other states to use their "waste material" elsewhere. These potential negative perceptions could spill over into the regulatory and legislative arena. In addition, the import of fly ash from other states will not directly benefit Pennsylvania coal ash producers but will benefit the coal ash industry as a whole.

Action 4: Industry Could Approach PennDOT to Encourage CCP Use

As previously mentioned, PennDOT's specifications set the bar for other coal ash users in the state because industry sees the specifications as cautious and stringent, thus lessening the potential for failure. Thus new PennDOT specifications that encourage CCP use have the potential to have a large impact on all coal ash users in the state.

If industry approached PennDOT to request changes to current specifications or write new specifications, PennDOT would be compelled to respond, although it noted this process takes time. PennDOT seemed to be rarely approached by industry to try new beneficial use applications or to make changes to its current specifications. It also did not seem to be proactive in developing its own specifications to increase the use of CCPs in highway projects. It is important to note, however, that PennDOT is currently investigating high-performance concrete and self-consolidating concrete applications. Some of these mix designs rely on fly ash as an admixture. Fly ash is being considered because it may be advantageous from an engineering standpoint.

To make modifications or write new specifications, industry would need to provide PennDOT with a PE, which would be considered a research project by PennDOT. PennDOT would not be agreeable to evaluating a material itself, but may check data internally. A demonstration process could also be considered, but industry should ask PennDOT prior to the processes so that any of its questions or concerns could be answered during the demonstration process.

A possible reason why Pennsylvania electric generating companies do not appear to be approaching PennDOT to increase CCP use is because all concrete-grade fly ash produced in Pennsylvania is being used, and many companies are producing a fly ash that is not suitable for concrete because of high unburned carbon contents. Electric generating companies need research, beneficiation technologies, and operational changes that will help to produce fly ash that is suitable for the concrete market. Nonetheless, fly ash not meeting concrete specifications could be used in other applications such as flowable fills and embankments. These high-volume uses provide an opportunity to use non-concrete-grade fly ash; however, they are low-value applications and it may be more cost-effective for some electric generating companies to dispose of the material than to find uses.

Action 5: Reclassify CCPs as a Product

Some pc-fired power plant representatives indicated that they would be able to use more CCPs in nontraditional applications if PA DEP classified CCPs as a product and subsequently granted CCP producers the authority to market CCPs as products. The current classification system limits the beneficial use options for CCPs. CCP producers would like PA DEP to simplify the process to qualify CCPs for use. In some instances, the process is too lengthy for CCP producers to bother with a low-value, low-volume use, and it is easier and cheaper to dispose of the material.

Action 6: Increase Awareness of C^2P^2 and the Green Highways Partnership

Most participants in the discussion groups were not aware of the Green Highways Partnership or C^2P^2. Some had heard of the programs but did not think they could be members if they were not doing something significant with CCP utilization and did not understand what was expected of members. In addition, they did not know who at their company/organization had the authority to sign the registration form.

Both of these programs offer a method of promoting beneficial use success stories and earn national recognition for those successes. Those interviewed indicated that these programs could offer a means of educating the general public about these success stories, so that they hear about the positive aspects of CCP utilization. These programs would likely be perceived by the general public as more credible than industry. Also, more outreach needs to be done by these programs to get industry involved.

Action 7: Build Off of LEED's Success in Government-Funded Projects

The LEED® program has been successful in the United States for many reasons, but perhaps its greatest accomplishment thus far was to simply define what it means to "build green" and offer recognition to those who build green. LEED® is gaining popularity in Pennsylvania, particularly with government-funded projects. All government buildings now require some level (gold, silver, or platinum) of certification from LEED®. Using coal ash-containing products in LEED® projects can help earn points toward achieving LEED® certification. Pennsylvania concrete producers do make a "green" mix with 40%–50% slag to help projects earn LEED® credits. Other green concrete mixes are gaining popularity in Pennsylvania. One example is pervious concrete used to construct parking lots which uses supplementary cementitious materials such as silica fume, fly ash, and slag in the mix design. Pervious concrete offers several advantages: reducing the level of pollution contained in runoff, reducing the overall runoff from an area, reducing the need for large detention ponds, and improving driving safety during wet weather conditions.

Although LEED® is encouraging CCP use in government-funded projects, LEED® is not as popular for other construction projects. Most contractors in Pennsylvania are driven by price and performance, and fly ash helps them meet both of those requirements. Contractors are typically not concerned and/or aware of the environmental benefits associated with using fly ash.

In order for LEED® to become more accepted for residential and commercial construction, thus potentially increasing the amount of coal ash-containing products in construction projects, it was suggested that the coal ash industry should do more to become involved in the LEED® program.

CONCLUSIONS

Pennsylvania's estimated 60%–70% CCP utilization rate is due largely to the fact that CCP use in mining applications is defined as a beneficial use in Pennsylvania, unlike many other states that consider it to be disposal. PA DEP residual waste coal ash beneficial use regulations and program implementation policies are perhaps the most comprehensive and dependable in the country, particularly for abandoned mine reclamation. These regulations coupled with the state's 14 CFB power plants successfully using CCPs in mine applications make Pennsylvania a model state for the use of CCPs in mine applications.

PA DEP BWM excludes coal ash used for beneficial use from the definition of solid waste and establishes provisions for the beneficial use of coal ash. The eleven approved beneficial uses are generally accepted by industry and have cleared the way for CCP use in those applications. The exception to this is FGD material because it was not readily available as a product when the regulations were put in place. Through EPGA, industry is working with PA DEP to find approved beneficial uses for the expected 4-million-ton surplus of FGD gypsum which will be produced as more Pennsylvania electric generating companies install wet FGD systems.

PennDOT has specifications for the use of CCPs in concrete and flowable backfill applications. Class F fly ash plays an important role in mitigating ASR because about 70% of PennDOT's aggregate sources are reactive. PennDOT's specifications set the bar for other concrete users in the state because industry sees the specifications as cautious and stringent, thus lessening the potential for failure. Although PennDOT has approved beneficial uses for CCPs, PennDOT's specifications would not be considered progressive compared to other states with regard to encouraging CCP use.

Industry is concerned about the effect that pending federal and state air emission rules will have on CCP management. CFB plants are concerned that they will have to add a considerable amount of limestone to reduce sulfur emissions, resulting in an ash with an even higher pH. Pulverized-coal-fired plants are primarily concerned that ACI for mercury control may lead to increased concentrations of mercury-containing sorbents and higher carbon contents in fly ash, thus prohibiting fly ash beneficial use in cement and concrete applications.

The action items presented are methods for overcoming barriers and threats identified in this report. The most pressing action item is to develop regulations for the beneficial use of FGD material. Significant progress was made on this action item following the state review discussion group sessions and the release of this report in draft format to project participants.

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APPENDIX A

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* Indicates that this participant did not attend a group discussion session but contributed to the state review either by submitting written comments or participating in a telephone conversation with the administrative team.

APPENDIX B

REVIEW GUIDE

REVIEW OF PENNSYLVANIA REGULATIONS, STANDARDS, AND PRACTICES RELATED TO THE USE OF COAL COMBUSTION PRODUCTS
Review Guide
December 13–15, 2006

Background

The University of North Dakota Energy & Environmental Research Center (EERC), in cooperation with the U.S. Environmental Protection Agency, the U.S. Department of Energy, and the American Coal Ash Association, is conducting a third review of state regulations, standards, and practices related to the use of coal combustion products (CCPs). Previous reviews were conducted in Texas and Florida. The final report from those reviews can be accessed online at www.undeerc.org/carrc/html/review.html.

Purpose

The purpose of this review is to highlight successes and identify barriers to increased utilization in Pennsylvania.

Goal

The primary goal is to review factors related to the use of CCPs in Pennsylvania and develop recommendations that may help Pennsylvania and other states increase the use of CCPs. Pennsylvania was selected because of its capacity to generate coal-based electricity, northern location, established CCP regulations, diversified beneficial use markets, and use of CCPs in mining applications.

Process

The review team will travel to Pennsylvania to visit state agencies and other key stakeholders involved in CCP utilization. Five discussion groups will be formed to answer questions posed by the review team. The discussion groups include the following:

- Government agencies – directors and other key personnel of state or regional transportation and environmental agencies
- CCP generators – utility environmental and ash managers
- Concrete and Other Engineering Applications – CCP marketers, engineering/consulting firms, ready-mix concrete suppliers
- Wallboard – users of synthetic gypsum for wallboard production
- Mining – Bureau of Abandoned Mine Reclamation officials and engineering/consulting firms

Separate telephone interviews may also take place with individuals unable to attend their scheduled session or those who have expertise outside of the major discussion groups.

Instructions

Please come to the review prepared to answer the following list of questions, and assemble all applicable information prior to the review. Answer the questions as completely as is reasonably possible without stating proprietary information. Written responses to the questions are greatly appreciated but not expected. Any written documentation you can provide will ensure that exact citations are included in the final report. Please provide written comments to Tera Buckley at tbuckley@undeerc.org before December 31, 2006.

Reporting

A draft final report will be prepared and distributed to all interviewees on or before February 1, 2007. You will be given a 30-day review period to review the report and provide comments to the EERC. A final report will be published April 2007. Following the completion of the Pennsylvania review, a synthesis report will be prepared that translates the results from the three in-depth state reviews into a national perspective.

AGENDA

Wednesday, December 13, 2006

8:30 – 10:15 a.m.	Pennsylvania Department of Environmental Protection Bureau of Mining and Reclamation *Location: Pennsylvania Department of Environmental Protection*
10: 30 – 12:00 p.m.	Pennsylvania Department of Environmental Protection Bureau of Waste Management *Location: Pennsylvania Department of Environmental Protection*
1:30 – 4:00 p.m.	Electric Power Generation Association (EPGA) Members *Location: EPGA Offices*
4:15 – 5:00 p.m.	Review Team Meeting

Thursday, December 14, 2006

9:30 a.m. – 12:00 p.m.	Concrete and Other Engineering Applications *Location: EPGA Offices*
1:30 – 4:00 p.m.	Mining *Location: EPGA Offices*
4:15 – 5:00 p.m.	Review Team Meeting

Friday, December 15, 2006

9:00 – 11:30 a.m.	Pennsylvania Department of Transportation and District Federal Highway Administration *Location: Pennsylvania Department of Transportation*
1:00 – 3:30 p.m.	ARIPPA (Anthracite Region Independent Power Producers Association) Member Utilities *Location: EPGA Offices*

NOTE: Other sessions may be scheduled via conference call.

If you are unable to attend your scheduled session, please contact Tera Buckley at (701) 777-5296 or tbuckley@undeerc.org.

GOVERNMENT AGENCIES

1. What is your agency's role in the management (use and disposal) of CCPs?

2. What type of infrastructure (i.e., employees, programs) has your agency dedicated to CCP management? How does the state headquarters interact with local, regional, and federal offices?

3. For which of the following CCPs does your agency have guidelines, guidance documents, material specifications, regulations, orders, or statutes? How were they developed and adopted? If applicable, provide references for, and dates of, the specific guidelines, guidance documents, material specifications, regulations, orders, or statutes related to CCPs.

   a. Fly ash

   b. Bottom ash

   c. Flue gas desulfurization material

   d. Boiler slag

   e. Fluidized-bed combustor ash

   f. Other _____

4. How would changes to the chemical or physical composition of CCPs impact your agency's role in the use or disposal of CCPs? For example, new air pollution control requirements may increase the carbon and mercury content of CCPs.

5. Are there any plans to implement any new policies, rules, or regulations regarding CCPs currently in process or expected in the near future?

6. What process does your agency undergo to make changes to its policies, rules, or regulations? Has this process ever changed over time?

7. Please list and explain any successful projects/applications using CCPs. Why were they successful?

8. Please list and explain any problematic projects/applications using CCPs. Explain the problems encountered and any instances where the use of CCPs was precluded in a project.

9. Please list and explain any cases in Pennsylvania where the use of CCPs has caused environmental damage or resulted in violations of environmental requirements. Describe any corrective actions, monitoring, and follow-up employed to address the issues.

10. In your opinion, what are the biggest obstacles hindering the increased use of CCPs in Pennsylvania? How could these obstacles be addressed?

11. Which of the following sources of information does your agency rely on in approving the use of CCPs in particular applications?

    a. Surveys of current practices (federal or state)

    b. Demonstration projects

    c. Internal (agency) testing and evaluations

    d. Technical reports submitted by qualified consultants

    e. Research projects or reports by other agencies, research institutions, or consultants

    f. Other _____

12. What further research, laboratory work, or policy initiatives would be necessary to assist your agency in overcoming barriers?

13. In general, how do you perceive the position that Pennsylvania has taken toward CCPs in comparison to other states?

CCP GENERATORS

1. Please describe or provide written documentation on the type, amount, and current management practices employed for all CCPs produced at your facility.

2. How is coal ash utilization handled and perceived at your company? For example, at some utilities, CCP utilization is a priority for upper management but not for plant operators.

3. What types of quality assurance/quality control procedures are employed at your company with regard to CCPs? Are efforts taken to ensure a consistent-quality product?

4. How would changes to the chemical or physical properties of CCPs impact your company's role in the generation, use, or disposal of CCPs? For example, new air pollution control requirements may increase the carbon and mercury content of CCPs.

5. Please indicate your thoughts on the current CCP specifications or guidelines that you are aware of in the state of Pennsylvania. Are there any environmental policies, permits, regulations, or statutes that impact the way you process and handle CCPs? What specifications or guidelines do you feel promote or restrict CCP utilization? What changes would you like to see made to the current specifications and guidelines?

6. Are you or your CCP users (marketers/contractors) provided with the flexibility to make the decision to utilize CCPs when the material meets standard specification requirements, or does the state require additional approvals and testing?

7. Please list and explain any successful projects/applications using CCPs. Why were they successful?

8. Please list and explain any problematic projects/applications using CCPs. Explain the problems encountered and any instances where the use of CCPs was precluded in a project. Describe any corrective actions, monitoring, and follow-up employed to address the issues.

9. Provide details of any ongoing or completed research and demonstration projects regarding CCPs.

10. In your opinion, what are the biggest obstacles hindering the increased use of CCPs in Pennsylvania? How could these obstacles be addressed? Would any changes to state or federal regulations help you address these obstacles?

11. What barriers has your company overcome to increase the use of CCPs? How?

12. What further research, laboratory work, or policy initiatives would be necessary to assist your company in overcoming barriers?

13. In general, how do you perceive the position that Pennsylvania has taken toward CCPs in comparison to other states?

CONCRETE AND OTHER ENGINEERING APPLICATIONS

1. Provide a general description of the CCP market in Pennsylvania, including supply and demand, and identify the major use applications. Are any CCPs being imported or exported? How much concrete is being used in various segments of the market (i.e., residential, commercial, highway construction)? How much fly ash or FGD gypsum is being used for cement and concrete manufacture?

2. What is the general feeling toward CCPs in your industry? How would you describe the competition between fly ash and portland cement? Are there any product acceptance issues among consumers with concrete containing fly ash?

3. Please indicate your thoughts on the current specifications or guidelines that you are aware of in the state of Pennsylvania related to CCPs. Are there any environmental policies, permits, regulations, or statutes that impact the way you process and handle CCPs? What specifications or guidelines do you feel promote or restrict CCP utilization? What changes would you like to see made to the current specifications and guidelines?

4. Please list and explain any successful projects/applications using CCPs. Why were they successful?

5. Please list and explain any problematic projects/applications using CCPs. Explain the problem encountered and any instances where the use of CCPs was precluded in a project. Describe any corrective actions, monitoring, and follow-up employed to address the issues.

6. What role do other alternative materials (i.e., foundry sand) play in your business?

7. How would changes to the chemical or physical composition of CCPs impact your company's role in the use of CCPs? For example, new air pollution control requirements may increase the carbon and mercury content of CCPs. Do you foresee beneficiation technologies as a new trend to deal with these changes?

8. In your opinion, what are the biggest obstacles hindering the increased use of CCPs in Pennsylvania? How could these obstacles be addressed? Would any changes to state or federal regulations help you address these obstacles? Could utilities do something to overcome these obstacles?

9. What further research or laboratory work would be necessary to overcome barriers to CCP utilization?

10. In general, how do you perceive the position Pennsylvania has taken toward CCPs in comparison to other states?

WALLBOARD

1. Provide a general description of the wallboard market in Pennsylvania. Is supply meeting demand? How much FGD gypsum is being used for wallboard manufacture? Is any FGD gypsum being imported or exported?

2. What is the general feeling toward FGD gypsum in your industry? How would you describe the competition between natural gypsum and FGD gypsum? Does the wallboard industry encounter any product acceptance issues with regard to purchasing wallboard made from FGD gypsum vs. natural gypsum?

3. Please indicate your thoughts on the current specifications or guidelines that you are aware of in the state of Pennsylvania related to CCPs. Are there any environmental policies, permits, regulations, or statutes that impact the way you utilize FGD gypsum? What specifications or guidelines do you feel promote or restrict FGD gypsum utilization? What changes would you like to see made to the current specifications and guidelines?

4. As the government continues to reduce SO_2 emissions and thereby increase FGD gypsum production, how will these changes impact they way your company does business?

5. Research is under way to determine if mercury contained in FGD gypsum will be released during wallboard production or disposal. What approach is your company taking to deal with this issue?

6. Can you offer any advice to utilities looking to utilize their FGD gypsum?

7. In your opinion, what is the biggest obstacle hindering the increased use of CCPs in Pennsylvania? How could this obstacle be addressed? What state or federal regulations could be implemented to overcome these obstacles?

8. What further research, laboratory work, or policy initiatives would be necessary to overcome barriers to CCP utilization?

9. In general, how do you perceive the position Pennsylvania has taken toward CCPs in comparison to other states?

BUREAU OF MINING AND RECLAMATION

1. What type of infrastructure (i.e., employees, programs) has your agency dedicated to CCP use in mining applications? How does the state headquarters interact with district, regional, and federal offices?

2. The 2003 U.S. Environmental Protection Agency Site Visit Report titled "Coal Combustion Waste Minefill Management Practices – Pennsylvania" described the requirements for using CCPs in mine settings set forth by the Bureau. Have any changes or modifications been made to these requirements since the EPA report was published? How were the current requirements adopted?

3. Would changes to the chemical or physical composition of CCPs impact the requirements for CCP use in mining applications? For example, new air pollution control requirements may increase the carbon and mercury content of CCPs.

4. Are there any plans to implement any new policies, rules, or regulations regarding CCPs currently in process or expected in the near future?

5. What process does your agency undergo to make changes to its policies, rules, or regulations? Has this process ever changed over time?

6. Please list and explain any successful projects/applications using CCPs. Why were they successful?

7. Please list and explain any problematic projects/applications using CCPs. Explain the problems encountered and any instances where the use of CCPs was precluded in a project.

8. The U.S. EPA report indicated that, at the time, there were no damage cases related to the use of CCPs in mining applications. Have there been any damage cases since that report was published?

9. How does the general public perceive CCP use in mining applications?

10. The National Academy of Sciences recently published a report titled "Managing Coal Combustion Residues in Mines." What is your opinion of that report? Do you think the report will have an impact on the way CCPs are used in mines in Pennsylvania?

11. In your opinion, what are the biggest obstacles hindering the increased use of CCPs in Pennsylvania? How could these obstacles be addressed?

12. Which of the following sources of information does your agency rely on in approving the use of CCPs in particular applications?

    a. Surveys of current practices (federal or state)

    b. Demonstration projects

    c. Internal (agency) testing and evaluations
    d. Technical reports submitted by qualified consultants

    e. Research projects or reports by other agencies, research institutions, or consultants

    f. Other _____

13. What further research, laboratory work, or policy initiatives would be necessary to assist your agency in overcoming barriers?

14. In general, how do you perceive the position that Pennsylvania has taken toward CCP use in mining applications in comparison to other states?

MINING

1. Provide a general description of how CCPs are being used in mine settings in Pennsylvania. How much material is being used in mining applications and for what purpose?

2. What is the general feeling toward CCPs used in mine settings? Have you experienced, or know of, opposition to the use?

3. Please indicate your thoughts on the current specifications or guidelines that you are aware of in the state of Pennsylvania related to CCP use in mine settings. What regulations or statutes do you feel promote or restrict CCP utilization? What changes would you like to see made to the current regulations and statutes?

4. The National Academy of Sciences recently published a report entitled "Managing Coal Combustion Residues in Mines." What is your opinion of that report? Do you think the report will have an impact on the way CCPs are used in mines in Pennsylvania?

5. Please list and explain any successful projects/applications using CCPs. Why were they successful?

6. Please list and explain any problematic projects/applications using CCPs. Explain the problem encountered and any instances where the use of CCPs was precluded in a project. Describe any corrective actions, monitoring, and follow-up employed to address the issues.

7. How would changes to the chemical or physical composition of CCPs impact your company's role in the use of CCPs? For example, new air pollution control requirements may increase the carbon and mercury content of CCPs.

8. If CCPs were no longer available for use in mine settings (i.e., the marketplace changed and CCPs were sold to high-value applications), how would that impact reclamation plans?

9. In your opinion, what are the biggest obstacles hindering the increased use of CCPs in Pennsylvania? How could these obstacles be addressed? Would any changes to state or federal regulations help you address these obstacles? Could utilities do something to overcome these obstacles?

10. What further research or laboratory work would be necessary to overcome barriers to CCP utilization?

11. In general, how do you perceive the position Pennsylvania has taken toward CCPs in comparison to other states?