Repairing the Damage

Cleaning Up Hazardous Coal Ash Can Create Jobs and Improve the Environment

Appendix C: Coal Ash Reuse

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The Scale of Coal Ash Reuse

Coal ash disposal—but not its reuse—is subject to regulation under the Resource Conservation and Recovery Act (Federal Register 2015; Seidler and Malloy 2020;[1]). For this reason, the 2015 Coal Combustion Residuals (CCR) rule distinguishes between coal ash disposal and reuse, and provides a method for assessing whether an application qualifies as reuse (Seidler and Malloy 2020; ORCR and OLEM 2016). Coal ash has been reused to some extent for decades—and specific coal combustion residuals are more common in certain reuse applications. Research on coal ash reuse stretches back to 1937, and by 1949 coal ash was used as a cement replacement in the construction of the Hungry Horse Dam in Montana (Seidler and Malloy 2020).

The American Coal Ash Association (ACAA) is a trade organization dedicated to the reuse of coal ash, and its members include many of the largest electric utilities in the country. ACAA conducts an annual voluntary survey among utilities to gather data on national coal ash production and reuse. Typically, the respondents to the survey represent only a portion of the total power capacity nationally. For example, ACAA reports that in 2009 respondents represented 59 percent of total generating capacity nationwide; in 2019 respondents represented 64 percent (ACAA 2021a).

QUANTITIES OF COAL ASH REUSED

According to ACAA, approximately 52 percent of coal ash waste was reused in 2019, and 34 percent of coal ash has been reused in total since 1966 (ACAA 2021a). These estimates include both encapsulated and unencapsulated reuse applications. All of these applications are considered "beneficial" according to ACAA, but, as discussed below, some are controversial. Figure 1 shows the production and reuse of coal ash since 1966, the first year for which these data are available. The annual volume of coal ash produced has grown dramatically over the past half century: production in 2019 was over 2 times larger than in 1966.

The *portion* of coal ash that is reused annually also increased sharply over time. As of 2019, 52 percent of coal ash was reused—significantly higher than the 12 percent in 1966 and slightly lower than the 2017 peak of 64 percent. The combination of higher production and a higher reuse rate resulted in a 2019 reuse tonnage that was more than 12 times larger than in 1966 (37 million metric tons compared with 2.8 million metric tons). If we look at the entire 1966–2019 period in total, 4.3 billion metric tons of coal ash were produced. Only 34 percent (1.4 billion

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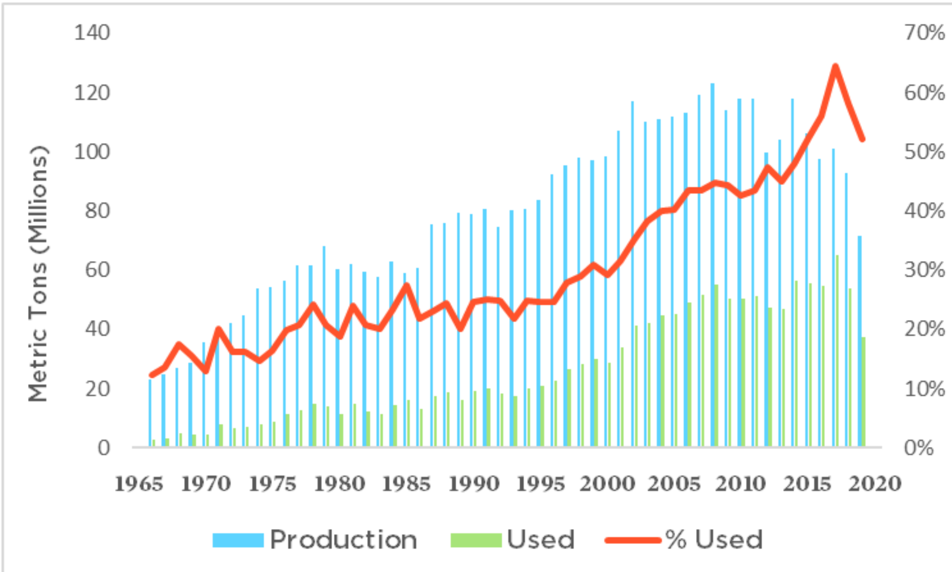
[1] See pages 4 and 62 in Seidler and Malloy (2020): "Beneficial uses of coal ash, however, are not subject to regulation by [the Environmental Protection Agency] under [the Resource Conservation and Recovery Act]. Although [the act] was designed to 'conserve valuable material and energy resources by [promoting] . . . new and improved methods of collection, separation, and recovery, and recycling of solid wastes,' conservation activities are exempt from direct regulation. Consequently, in promulgating national minimum criteria for coal ash disposal, [the Environmental Protection Agency] promulgated a definition of beneficial use to differentiate those use activities that would not be classified as disposal from regulated disposal activities."

metric tons) were reused, meaning that in the past 54 years at least 2.8 billion metric tons of coal ash were disposed of.

Figure 1. Coal Ash Production and Use, 1966–2019.



Note: The production and use values for 1966 through 2015 are from the U.S. Geological Survey (USGS 2014), which relied on ACAA for the period 1966 through 1993, its own data for 1994 through 2001, and ACAA data for 2002 through 2015. The production and use values for 2016 through 2019 are from the annual ACAA survey. See USGS 2014 for notes on this data, including regarding early years when data for certain CCRs was unavailable and excluded.
Sources: USGS (2014); ACAA (2021a).

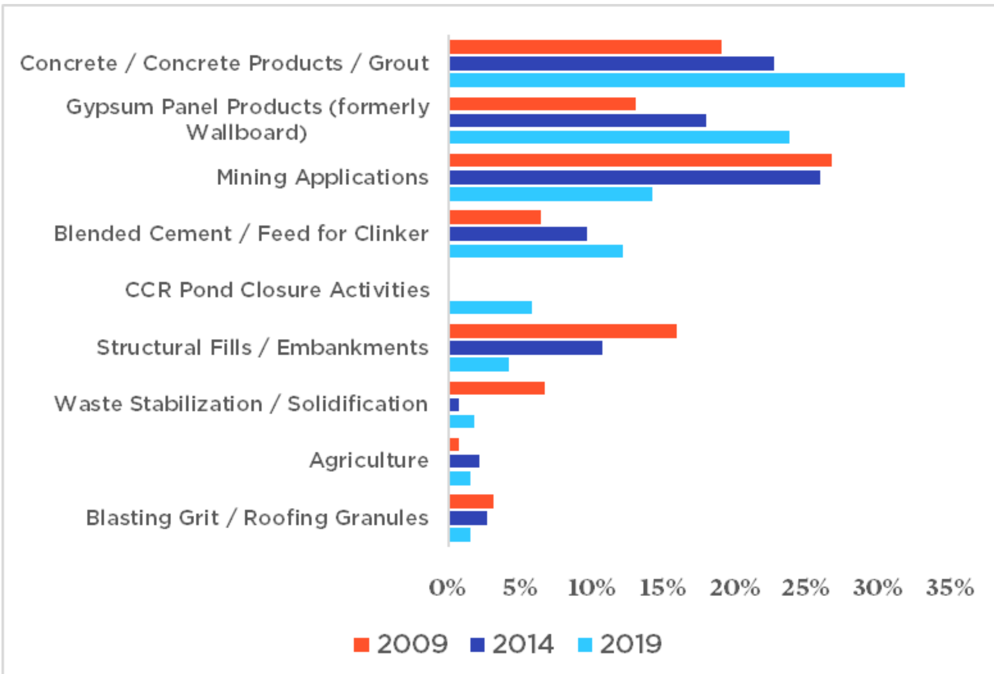
REUSE OF ENCAPSULATED COAL ASH

Figure 2 outlines the top nine reuse categories as of 2019, which represented 97 percent of total coal ash reused (by tonnage). About one-third of total coal ash that was reused in 2019 was reused in concrete products. Almost a quarter of total coal ash reused in 2019 was reused in wallboard, or drywall, as synthetic gypsum; the use of synthetic gypsum in wallboard avoids mining virgin gypsum (Seidler and Malloy 2020). It is common for wallboard manufacturers to locate adjacent to power plants in order to utilize directly the synthetic gypsum from coal ash (Seidler and Malloy 2020). These two reuse applications are the most common, and their use is growing. In 2019, these two categories represented 56 percent of total coal ash reused, up from 32 percent in 2009. Though, in 2019 the tonnage of coal ash reused in concrete products and wallboard was only 29% of total coal ash *production* (ACAA 2021a) Both applications are encapsulated and considered beneficial uses of coal ash according to the EPA.

In addition to improving the performance of materials, reusing coal ash instead of mining or producing virgin materials can yield considerable emissions reductions. According to ACAA, reusing a ton of fly ash[2] in concrete avoids roughly a ton of CO_2 emissions (Seidler and Malloy 2020). ACAA claims that 250 million tons of greenhouse gases have been avoided by reusing coal ash in cement production since 2000 (ACAA 2021b).

However, fly ash often has to undergo a "beneficiation" step to make it chemically suitable for use in concrete (Gardner and Greenwood 2017), which can increase the global warming emissions associated with this type of coal ash reuse. For example, typically there is too high a percentage of combustible content remaining in coal ash and it must undergo additional processing which utilizes energy (Gardner and Greenwood 2017). Beneficiation processes, as well as transporting the fly ash, require energy and thus emissions, and a full analysis of the lifecycle of reuse and its benefits should weigh the environmental impacts of beneficiation as well.

Figure 2. Reuse Category as Percent of Total Reuse Tonnage, 2009—2019



Note: This chart only includes categories that were at least 1 percent of total reuse tonnage in 2019; the top nine of the 17 reuse categories listed by ACAA are included

REUSE OF UNENCAPSULATED COAL ASH

Other common reuse applications—for mine reclamation and for structural fills—are much more controversial. Both of these reuse applications use unencapsulated coal ash. Loose coal

[2] Fly ash is coal ash that is expelled from the boiler with flue gases and is captured by pollution control systems.

ash has been used as filler for mine pits, contouring landscapes, and leveling uneven surfaces for transportation or construction projects.

When coal ash is used as a filler, there is risk of contaminants leachinginto groundwater or surface water, and a concern that unencapsulated reuse as filler is a backdoor means of coal ash disposal that avoids regulation. In a 2011 report, the inspector general of the Environmental Protection Agency acknowledged that “sand and gravel pits as well as large-scale fill operations, represent disposal rather than beneficial use” (OIG 2011). As of 2015, the agency’s test for “beneficial reuse” requires unencapsulated non-roadway projects above 12,500 tons—that is, projects large enough to be landfills—to not result in more environmental releases than analogous material that does not contain coal ash (ORCR and OLEM 2016; Ward 2019). Any pollutant releases must be below relevant human health and ecological benchmarks (EPA 2014b; Seidler and Malloy 2020).

Trade groups like ACAA argue that these applications are safe, noting that unencapsulated use as structural filler has a history stretching back to the 1970s and is governed by extensive industry and engineering standards (Ward 2019). The engineering benefits of using coal ash as fill are evident; however, the concern is that these applications are not worth the risk of contamination. For example, the Environmental Protection Agency determined that coal ash used as fill for a golf course in Virginia did not qualify as beneficial reuse (Seidler and Malloy 2020). In the Town of Pines, Indiana, unencapsulated coal ash was used as filler throughout the town, resulting in the contamination of water wells and the eventual declaration of the entire community as a Superfund site (Gottlieb, Gilbert, and Evans 2010).

NEW REUSES

In addition to these common reuse applications, utilities and other stakeholders are exploring new end uses for coal ash. Georgia Power and the Electric Power Research Institute opened the Ash Beneficial Use Center in 2020 to pilot new methods of coal ash reuse (Gaffney 2021). Some researchers are exploring the potential of reusing coal ash for carbon nanomaterials, which could be used for many applications, including making stronger materials (Seidler and Malloy 2020). Cenospheres—light, hollow spheres that can be separated from coal ash by water and then coated with metals—are also being pursued for their potential use in lightweight car manufacturing, battery casings, and other applications (Seidler and Malloy 2020).

The specific elements in coal ash can vary based on the location of the mined coal and the emissions controls at the specific power plants, and this variety in coal ash composition impacts the feasibility of different reuse applications (Seidler and Malloy 2020). This is especially the case with the potential of extracting rare earth elements from coal ash. The company Optimus, an extension of the University of Kentucky, and the Asian Coal Ash Association are partnering to develop an eco-industrial park model that would theoretically reuse coal ash in various processes and applications in adjacent locations (Seidler and Malloy 2020).[3]

The Need for Proper Regulation

Coal ash, if unregulated, poses considerable risk of contaminating water sources and thus harming public health (OIG 2011). Historically, the reuse of coal ash—particularly unencapsulated reuse as fill—has been utilized to dispose of coal ash in an unregulated way and has been promoted by the Environmental Protection Agency without proper examination of the risks. In 2011, a report by the Environmental Protection Agency inspector general found that the agency had promoted the "beneficial reuse" of coal ash but "did not follow accepted and standard practices in determining the safety of the 15 categories of CCR beneficial uses it promoted" (OIG 2011).

Given the considerable public health risk, the precautionary principle should be utilized in assessing new and future coal ash reuse applications: policymakers should be cautious about allowing the reuse of coal ash and should place a reasonable burden of proof on industry in demonstrating that applications are safe prior to approving reuse (Gottlieb, Gilbert, and Evans 2010). The environmental benefits of reuse can be considerable, but policymakers should remain diligent about weighing these against the risks, particularly as many stakeholders will continue to pursue reuse for its economic benefits. As an example, the cost of fly ash is roughly half the cost of Portland cement, making fly ash reuse in concrete a billion-dollar industry (Gardner and Greenwood 2017). Coal ash reuse in other applications could be similarly lucrative.

Reuse of coal ash in unencapsulated applications should demonstrate, according to research specific to the application and across a range of cases, that such reuse poses no greater public health risk than analogous materials (Federal Register 2015; Gottlieb, Gilbert, and Evans 2010). Unencapsulated reuse, given the inherit risk of its physical form and the history of mistreatment as disposal, should be treated legally as disposal, with the appropriate regulatory and monitoring controls (Gottlieb, Gilbert, and Evans 2010).

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[3] See pages 55 and 56 of Seidler and Malloy (2020), who cite David Harris, *Coal Combustion Products and the Circular Economy*, Asian Coal Ash Association, Optimus Mgmt. Ltd., at slide 12 (2017), http://unia-ups.pl/wp-content/uploads/2016/03/Harris.pdf.

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