

2020 to 2070 and Beyond: Transitioning from Production to Post-Production Coal Ash Use

By Bruce Sifton, P. Eng., and Brad MacKenzie

Over the last 50+ years, production coal ash has successfully transitioned from a “resisted use” product to a “required component” in cement mixtures to be used in infrastructure material. The next 50+ years will require an extension of that effort. It will necessitate the specification of coal ash to include the use of post-production coal ash from the vast reserves stored

in impounded coal ash sites around the world. To initiate this transition, a new approach is needed to create a fungible market for this 21st century material supply.

The Journey

The market is now witnessing the beginning of the end of one era and the genesis of a new economic reality. The “21st century commercial paradigm” of the construction and building products industry is already evident in regional production coal ash supply shortages around North America, the United Kingdom, and Europe. The results are longer transportation distances and the rising costs associated with moving the appropriate materials to address increasingly regional market demand. Additional demand is forecast over the next 20 years with the significant infrastructure upgrades required in most countries. Combined with new infrastructure requirements in fast-growing countries like China and India, this will create significant pressures on the collective coal ash market’s future.

Nowhere is the problem more acute than in the United Kingdom. The UK leads the global charge toward zero-coal power generation, with plans to close all remaining coal plants by 2025 (see Figure 1). As recently as 2012, the UK generated 6 million tons of fly ash. Last year, that figure dropped to roughly 1.6 million tons¹ following further reductions in the use of coal. These trends portend a new era in the domestic cement market.

Gone are the days of readily available excess, compliant production coal ash. For Britain, the timing could not be worse. The additional complication for the UK, in the form of Brexit, creates cost uncertainty on materials exclusively imported from Europe. As a result, the domestic building products industry is now faced with a significant problem. Where will it source new EN-450 (European ATSM C-618 equivalent) compliant materials?

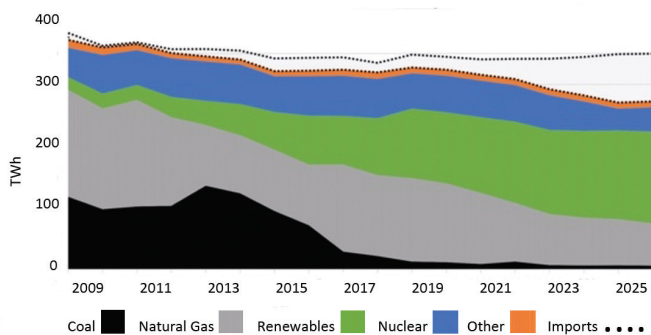


Figure 1. Historical and projected UK electricity generation by fuel type, 2008–2025 (TWh).
SOURCE: 2008–2016 actuals from BEIS; figures are approximated using BEIS’ quarterly figures and National Grid data. 2018 forecast from BEIS, corrected to make historical and forecast data consistent.

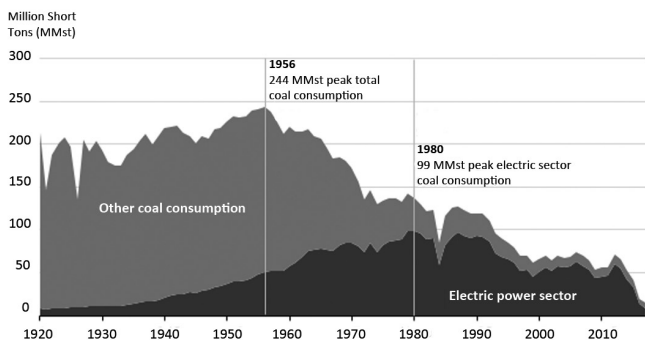


Figure 2. United Kingdom coal consumption, 1920–2017 (MMst).
SOURCE: U.S. Energy Information Administration.

The answer is in the country's vast supplies of impounded and landfilled coal ash. The United Kingdom Quality Ash Association (UKQAA) has been studying this issue since 2014. UKQAA has stated that the country's stockpiled ash, estimated at 50 million tons,² should be designated as future "pozzolanic" reserves. However, this sort of initiative will require multi-level government support. In the meantime, the UK will have to continue to import its coal ash from the rest of Europe. While that might be a solution for the short term, Europe is also moving away from coal as a fuel. So whatever relief the industry can gain through those imports will only delay the inevitable.

The UK's situation represents the "canary in the coal mine" for the industry structure around the world. In all major markets, coal is being displaced in favor of lower-cost and less-carbon-emissions-intensive fuels. The UK and an increasing number of EU member states will eliminate coal by 2025 (see Figure 3), and Canada will follow by 2030. It is further evident that the U.S. will continue to see accelerated, ahead-of-schedule coal plant retirements. Even in emerging markets such as China, India, and other Asian countries, coal is falling out of favor. All these factors are compounding a worldwide supply shortage of compliant production coal ash.

Furthermore, many jurisdictions around the world are implementing some version of carbon pricing, either through a tax or cap-and-trade system. Carbon policies focused on coal power generation and the cement industry require a reduction of carbon emissions. The impact of these policies on power generation is reducing the use of coal as a fuel. The impacts on cement producers are process adjustments in current cement formulas.

As a result, what is old becomes new again. As with the formulas developed during the Roman Empire circa 312 BC

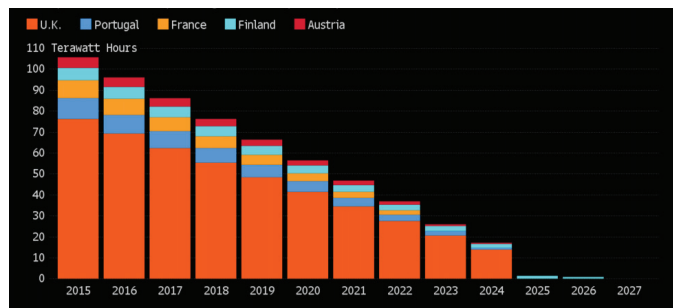


Figure 3. European countries phasing out coal power plants, 2015–2027. SOURCE: Bloomberg New Energy Finance.

The Pantheon in Rome is an example of Roman concrete construction built in 113–125 AD. SOURCE: Jean-Christophe BENOIST, CC BY 2.5, <https://commons.wikimedia.org/w/index.php?curid=2532901>



to 500 AD—which used volcanic ash as a natural pozzolan in the construction of some of its most durable structures—new formulas will need to be considered in the search for a low-carbon reality for the 21st century’s infrastructure build-out and refresh.

Impounded Coal Ash Is Key to Looming Shortages

The easiest answer to the looming worldwide supply shortage exists in the billions of tons of “waste” coal ash in storage around the world. Collectively, the industry will need to embrace the concept of impounded coal ash as a viable ingredient when engineered to a certain specification. It has the potential to replace cement as the primary active cementitious ingredient.

John Ward, Chairman of the American Coal Ash Association’s Government Relations Committee, stated in this very magazine (Issue 2, 2018): “However...if you want to invent the machine/pixie dust that eliminates performance variability among ash types and sources, that would be a true breakthrough—enabling the CCP world to shift from a series of local markets to a single fungible commodity market.”

The authors agree completely with this statement; it is the key to unlocking the 21st century opportunity.

Applying this new 21st century thinking together with the appropriate innovative technology converts coal ash impoundments to resource-rich “above-ground ore bodies.” The opportunity paradigm in this new reality is the additional high-value product matrix available in coal ash impoundments. This product matrix includes engineered pozzolanic material (high-performance cement), cenospheres, silica flour, rare earth elements, strategic metals, carbon offsets, and proppants.

The coal power industry and related associations have made excellent progress in quantifying and mitigating the perception of risk associated with production coal ash as a high-quality pozzolanic material. This can be seen in the dramatic rise in the use of production coal ash in North America, as the product application utilization rate has nearly doubled over the last decade to almost 45% even while the share of coal in the global energy mix has declined.

But the decline in coal use has reduced the volumes of reliable, uniform high-quality production coal ash available to the concrete and construction industries, as measured by consistent loss on ignition (LOI) and impurities (such as sulfur and nuisance heavy metals). Key concrete parameters like workability and ASTM C-618 (EN-450)-grade material particle size are often assumed to be consistent in the marketplace but are not. Both of these production coal ash components have highly empirical correlations with one another relating to high-performance and LEED-eligible applications, where reuse has significant value-add upside. Ensuring both workability and uniform particle size will be essential to making reclaimed coal ash a fungible market

material in the 21st century marketplace and useful for future concrete applications.

New Beneficiation Method

The “first mover” coal ash supply challenges facing the United Kingdom have been particularly interesting to SonoAsh. SonoAsh has developed a sustainable, modular, and patented solution for production and impounded coal ash. The technology creates new pathways to make impounded and production coal ash streams into a consistent manufactured product designed to meet regional and individual customer specifications.

The SonoAsh Sonicator reactor can process a broad range of coal ash samples. This manufactured coal ash meets ASTM C-618 (AASHTO M295 and European EN-450) requirements for high-value ordinary portland cement (OPC) displacement. The process creates <1% LOI from variable coal ash sources at more than 15% LOI at definable particle size specifications, typically 25-100 µm.

The SonoAsh outcome represents a genuine market opportunity, producing a scalable, regional, and economical OPC supplement with negligible greenhouse gas (GHG) emissions. This creates relevance from a risk mitigation and marketing perspective even where GHG/carbon discussions are unmeasured, untaxed, or not currently recognized. This is significant for a global market demanding major infrastructure expansion with challenging high-performance cement applications.

The world is transitioning to post-production ash realities at an accelerating rate. How the United Kingdom and Western European countries respond legislatively and in practice will become teaching moments for the industry in the rest of world.

References

1. Cooke, Nigel, Dr. “Utilizing the UK’s Vast Landfilled Fly Ash Deposits.” *Ash at Work*. Issue 1, 2018, p 8.
2. Ibid.

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