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National Inventory of Coal Ash Quality in Reserve at Major Electric Power Facilities in the United States

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Coal combustion residuals such as fly ash and bottom ash are widely utilized as a replacement of Portland cement that lowers the carbon intensity of concrete manufacturing. Coal ash has also been proposed as a potential feedstock for critical metals that could be co-products of ash re-processing. While freshly generated coal ash has been the focus of such recycling efforts, a truly decarbonized application would utilize legacy coal ash residuals (wastes of past coal combustion) rather than freshly generated ash from ongoing and future coal energy. In the United States multiple decades of coal energy have yielded more than 2 Gt of coal ash stored at several hundred disposal units at coal fired power plants. Recent federal regulations mandate the closure or retrofitting of most coal ash impoundments, presenting significant challenges for waste management. These regulatory pressures also present opportunities to reuse the coal ash. However, the quality and quantity of discarded coal ash across the U.S. is not well known, even though this information is crucial for spurring its reuse for conventional and new material applications. This study describes a predictive model for major element composition of coal ash in reserve at disposal sites of major U.S. coal fired power plants. This model was constructed from coal purchase records of 705 power stations from 1973-2022 and was trained on coal ash composition data showing that coal ash elemental composition is strongly associated with the source of feedstock coal. The model showed regional shifts in the major element contents of ash produced by power plants in the last 50 years, particularly for calcium and iron (expressed as %CaO and %Fe_2O_3), as coal-fired power stations changed their source of coal over this time frame. Our approach enables an estimation of coal ash chemical composition for wastes stored in disposal sites at individual power stations. Such information can help delineate the regional market resource potential of supplementary cements for concrete and other material innovations that would utilize coal ash harvested from disposal sites across the U.S.