

**When a Negative Externality Turns Positive:  
An Analysis of Flue-gas Desulfurization By-products**

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*PRELIMINARY DRAFT:  
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*Abstract:*

Energy and environmental regulations often result in the generation of unforeseen marketable by-products that can reduce costs of compliance. This research evaluates a unique case in which the marketability of by-products produces positive external benefits. Specifically, this paper focuses on flue-gas desulfurization (FGD) gypsum by-product produced by coal-fired electric plants using sulfur dioxide (SO<sub>2</sub>) scrubbing technology to comply with the emission standards set by the 1990 Clean Air Act Amendment (CAAA). Intuitively, the ability to market FGD gypsum provides incentives for electricity generating plants to operate their scrubbers more efficiently by providing gypsum revenues, and lowering gypsum disposal costs. Increased operating efficiency creates external benefits attributed to reduced SO<sub>2</sub> emissions that would otherwise not have occurred. In order to estimate the impact of FGD gypsum marketability on SO<sub>2</sub> emissions, a unique longitudinal database is constructed that merges electricity plants' boiler-level SO<sub>2</sub> emissions data from the U.S. Environmental Protection Agency (EPA) with data on scrubber operations and coal quality available from the U.S. Energy Information Administration (EIA). Boiler fixed-effect estimations suggest annual SO<sub>2</sub> emissions decline by 3,494 tons as a result of gypsum marketing. This corresponds with a 39% average reduction in SO<sub>2</sub> emissions at boilers marketing FGD gypsum. The total benefits associated with the reduced SO<sub>2</sub> emissions are estimated between \$147.1 billion and \$350.6 billion (2011\$), or between 0.9% and 2.1% of the total benefits of the U.S. CAA from 1990 to 2010.

Keywords: by-products, sulfur dioxide (SO<sub>2</sub>) emissions, scrubber, gypsum, Clean Air Act  
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