Regulating Greenhouse Gases from Coal Power Plants under the Clean Air Act

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Abstract

Until recently, most attention to U.S. climate policy has focused on legislative efforts to introduce a price on carbon through cap and trade. Since that policy has stalled the Clean Air Act has assumed the central role in the development of regulations that will reduce greenhouse gas (GHG) emissions. The EPA has announced its intent to issue performance standards for GHG emissions for steam boilers at power plants fuelled with coal, oil and natural gas. These sources represent one-third of GHG emissions in the United States.Initial surveys of the operating efficiency of existing power plants indicate substantial variation across these facilities. The focus of this analysis is to explain the variation in the operating efficiency and emissions rates of existing coal-fired power plants. Second, we estimate the potential magnitude of emissions reductions that could be achieved through efficiency improvements and fuel substitution at these facilities, and at what marginal abatement cost.

The analysis is performed using a unique panel data set of coal-fired generation units that cover the years 1985-2008, including monthly fuel input, generation, and coal prices by generation unit, and which account for 97 percent of total coal generation. We use a generation unit's heat rate (the ratio of heat input to electricity generated) to measure performance. For example, in 2005 we observe an average heat rate of about 11,367 Btu/kWh with a standard deviation of 2,051 Btu/kWh. Although heat rates vary more for small units than for large ones, there is substantial variation across all types of units. A percentage improvement in heat rate is nearly equivalent to an equal percentage improvement in the emissions rate. The difference stems from slight variation in carbon per Btu in varieties of coals. Since fuel substitution is one possible way to change the emissions rate from a plant, we also account for fuel choice.

In the absence of GHG regulation, improving the operating efficiency of a generation unit reduces fuel costs per unit of electricity generation. Reduced fuel costs thus constitute a benefit of improving operating efficiency that should already be reflected in the operational decisions of firms under conventional assumptions. Hence, to understand the potential influence and costs of regulation, it is important to investigate and try to explain currently observed heterogeneity. We do so by controlling for technical, economic and regulatory factors that may affect managerial incentives. For example, we hypothesize that the presence of a scrubber reduces operating efficiency, and that certain types of boilers may have lower efficiency than others. We also investigate whether ownership type (investor-owned, municipal, etc.), vintage, utilization rate, coal type, the delivered price of coal, and regulatory regime affect operating efficiency. These factors may affect baseline (unregulated) emissions, and cause there to be heterogeneity in marginal abatement costs across generation units. Finally, we use the results to assess the cost and magnitude of potential emissions reductions from setting emissions rate standards for existing coal-fired units.

Importantly, when the price of coal is higher, the benefit of improving operating efficiency is also higher. We assume that in equilibrium a firm equates the marginal benefit of improving operating efficiency with the marginal cost. Under this assumption, we can use time series and cross sectional variation in operating efficiency and coal prices to estimate the marginal cost of improving operating efficiency. With such a long time series and extensive geographic coverage, there is substantial variation in unit-level coal prices and heat rates. Because an improvement in operating efficiency translates directly to a reduction in the

GHG emission rate, we can use this result to estimate the marginal abatement cost for GHG emissions. Thus, because fuel costs and a GHG emission price create similar incentives to improve operating efficiency, it is possible to estimate marginal abatement costs despite the fact that GHGs have not been regulated.

Preliminary results indicate that technical factors help to explain observed heterogeneity across units. These include fixed attributes of generating units such as boiler design, vintage, location, and features such as pollution control equipment and cogeneration. Another economic explanation is the variation in the way units are run. In some instances units provide ancillary services or vary utilization in response to changes in load that erode the observed performance of facilities.

Nonetheless after controlling for these fixed attributes and economic justifications, we find remaining differences in operational efficiency of nearly 20 percent for facilities that share common attributes and are utilized in similar ways. We explore institutional features that may explain what are apparently unrealized opportunities for efficiency improvements. We find evidence that in different cases, the ownership structure of a facility and its market and regulatory environment affect its operation and associated emissions rate. We find evidence consistent with the hypothesis that factors such as fuel cost pass through provisions and the possibility that boiler modifications would trigger new source review that would raise costs at the facility affect the operation of facilities.

References

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