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New Source Review and coal plant efficiency gains: How new and forthcoming air regulations affect outcomes

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HIGHLIGHTS

- We explore the status of the U.S. coal-fired fleet relative to New Source Review (NSR) requirements.
- Modifications to improve thermal efficiency can trigger NSR.
- Thermal efficiency gains may also be an important strategy for forthcoming CO_2 regulation.
- 80% Of non-retiring coal-fired units are projected not to meet minimum NSR requirements.
- NSR is an important consideration for the design of CO_2 regulations for existing plants.

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ABSTRACT

Forthcoming carbon dioxide (CO_2) regulations for existing power plants in the United States have heightened interest in thermal efficiency gains for coal-fired power plants. Plant modifications to improve thermal efficiency can trigger New Source Review (NSR), a Clean Air Act requirement to adopt of state-of-the-art pollution controls. This article explores whether existing coal plants would likely face additional pollution control requirements if they undertake modifications that trigger NSR. Despite emissions controls that are or will be installed under the Mercury and Air Toxics Standards (MATS) and Clean Air Interstate Rule (CAIR) or its replacement, 80% of coal units (76% of capacity) that are expected to remain in operation are not projected to meet the minimum NSR requirements for at least one pollutant: nitrogen oxides or sulfur dioxide. This is an important consideration for the U.S. Environmental Protection Agency and state policymakers as they determine the extent to which CO_2 regulation will rely on unit-by-unit thermal efficiency gains versus potential flexible compliance strategies such as averaging, trading, energy efficiency, and renewable energy. NSR would likely delay and add cost to thermal efficiency projects at a majority of coal units, including projects undertaken to comply with forthcoming CO_2 regulation.

1. Introduction

Forthcoming carbon dioxide (CO_2) regulations for existing power plants in the United States have heightened interest in thermal efficiency gains for coal-fired power plants. Plant modifications to improve thermal efficiency can trigger New Source Review (NSR), a Clean Air Act permitting requirement to ensure adoption of state-of-the-art pollution controls (42 USC §7475; 42 USC §7503). NSR ensures that modifications and new construction do not hinder attainment of air quality standards, but its permitting process can delay and add to the cost of plant modifications (e.g. by requiring installation of or upgrades to pollution controls). Power plant operators will, therefore, assess the likelihood of additional pollution control requirements resulting from NSR review before deciding to undertake thermal efficiency upgrades at existing power plants.

On the whole, the current fleet of U.S. coal-fired power plants does not achieve technically obtainable efficiencies and is inefficient relative to newer coal generation technology (Eisenhauer and Scheer, 2009). A power plant's thermal efficiency is commonly expressed as its "heat rate," or the amount of fuel-bound energy that is required to produce one unit of electrical power. A lower heat rate indicates a more efficient unit, which can produce a

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given amount of electricity with less fuel than would be required by a less efficient (higher heat rate) plant (Sargent, 2009).

Coal-fired units of all vintages display a wide range of heat rates after controlling for factors that affect efficiency potential such as elevation, temperature, and steam system type (GAO (Government Accountability Office), 2012; Linn et al., 2013; Nichols et al., 2008). Efficiency gains are technically feasible at even the most efficient plants (e.g. with adjustments to boilers, turbines, flue gas, water treatment, and other systems) (Eisenhauer and Scheer, 2009). The U.S. Environmental Protection Agency (EPA) put forth in its advanced notice of proposed rulemaking for greenhouse gases that heat rate reductions of up to 10% may be feasible for existing coal-fired units, with a potential fleet wide average improvement of up to 5% due to variation across plants (EPA, 2008).

Market, regulatory, and technical factors contribute to variation in opportunity to improve heat rate across plants. Opportunities to technically improve thermal efficiency are site-specific, requiring significant expertise and analysis to optimize efficiency for a particular unit (Nichols et al., 2008; Sargent, 2009). Market and regulatory factors can also limit economically available opportunities to improve thermal efficiency. For example, low fuel prices discourage investment in thermal efficiency (Nichols et al., 2008). The industry generally views NSR as a barrier to efficiency upgrades (EPA, 2002a).

By reducing the amount of fuel required per unit of electricity output, efficiency improvements lower emission rates (Eisenhauer and Scheer, 2009). Increasing efficiency also lowers fuel costs, thereby reducing the unit's marginal cost of generating electricity (Linn et al., 2013). Efficiency improvements may therefore lead to higher annual emissions if units operate at a higher capacity factor after the modification. Because NSR regulates annual emissions rather than emission rates, the EPA has determined that thermal efficiency improvements are major modifications that can trigger NSR (EPA, 2002b; Nichols et al., 2008).

The landscape of electricity generation in the United States has changed in recent years, suggesting that some portion of the existing fleet may meet the minimum NSR requirements with already- or soon-to-be-installed controls. A combination of low natural gas prices and recent federal air quality regulations have led many of the most inefficient coal-fired power plants to retire rather than retrofit to comply with MATS and other regulations (Pratson et al., 2013). The Mercury and Air Toxics Standards (MATS) rule requires that coal-fired units remaining in operation after April 16, 2015 comply with new limits on hazardous air emissions (EPA, 2012a), and many of those facilities will also take action to meet anticipated restrictions on sulfur dioxide (SO_2) and nitrogen oxide (NO_X) emissions as the EPA revises the Clean Air Interstate Rule (CAIR) (EPA, 2005).

This article explores the impact of NSR on the fleet of existing coal-fired power plants projected to remain in operation after units will have complied with MATS and CAIR or its replacement (approximately 2016). For facilities that already meet the most current air quality standards, NSR may add costs associated with the permitting process but potentially no requirements to install additional control technologies. For facilities that do not meet one or more of the current air quality standards and that are undergoing a modification to improve unit efficiency, the NSR process could result in significant additional costs for marginal decreases in conventional air pollutants. Cohan and Douglass (2011), for example, estimate that implementation of the Cross State Air Pollution Rule (CSAPR) would likely achieve most of the NO_X and SO_2 reductions that would result from requiring existing coal-fired power plants to meet emissions standards for new plants.

This article uses data from the EPA's analysis of the MATS rule to assess the degree to which coal-fired power plants undergoing a modification to improve thermal efficiency (or for any reason) would trigger additional pollution control requirements under the NSR program. Despite new air quality standards for existing coal-fired units, the analysis shows approximately three-quarters of coal-fired capacity that is not expected to retire will not meet the minimum standards to comply with NSR. In the context of greenhouse gas regulations currently under development, this is an important consideration for the EPA and state policymakers as they determine the extent to which CO_2 regulation will rely on unit-by-unit thermal efficiency gains versus potential flexible compliance strategies such as averaging, trading, energy efficiency, and renewable energy. NSR would likely delay and add cost to thermal efficiency projects at a majority of units, including projects undertaken to comply with forthcoming CO_2 regulation.

1.1. Previous studies of New Source Review

Researchers have examined the potential for vintage differentiated regulations – such as the Clean Air Act's varying requirements for new, modified, and existing sources – to extend the life of older, dirtier plants. For example, Maloney and Brady (1988) and Nelson et al. (1993) find that capital turnover among electricity generating facilities decreased following implementation of the Clean Air Act. Heutel (2011) develops a structural dynamic model that reveals facilities' decisions to scrap or update capital investment under various policy scenarios and shows that increased stringency of performance standards for new sources would have decreased investment in new boilers.

Others have examined the potential for NSR – which requires modified facilities to meet new source standards – to limit investment in existing facilities. List et al. (2004) compare manufacturing facilities in air quality attainment and nonattainment areas of New York State and find a reduction in modifications among facilities located in nonattainment areas—which are likely to face more costly NSR requirements. Bushnell and Wolfram (2012) find that heightened enforcement of NSR reduced capital investments in existing plants.

Concern that NSR is a disincentive to power plant modifications that could improve efficiency prompted the EPA to promulgate a controversial set of NSR reforms in 2002, some of which did not survive judicial review (New York v. EPA, 2005). For example, the EPA proposed (1) an exemption for modifications if the primary purpose is pollution control, (2) a clean unit designation that would allow qualifying facilities to modify without triggering NSR for a period of ten years, and (3) plant-wide-applicability limits that would allow sources to make changes to facilities for a ten-year period so long as it remains below the plant-wide emissions limit (New York v. EPA, 2005). In New York v. EPA (2005), the D.C. Circuit vacated the NSR exemptions for pollution control projects and designated clean units, holding that EPA lacks the authority to exclude modifications that result in actual emissions increases. The court upheld the plant-wide applicability limits provision, however, finding that the Clean Air Act grants the EPA discretion to establish the method of calculating emissions increases. An independent review of NSR and the 2002 reforms by the National Research Council (2006) cites a lack of data on the effects of reform and encourages that future changes to the NSR program be accompanied by comprehensive retrospective and prospective analysis. Nash and Revesz (2007) find that, contrary to the EPA's position in 2002, reforms to relax the NSR requirement would have led to degradation of environmental quality.

Potts (2007) discusses the political, economic, and public health tradeoffs of vintage-differentiated regulations and proposes alternatives to the NSR program for addressing emissions from existing coal power plants. However, the authors are not aware of studies that have analyzed how recent EPA rules requiring existing coal-fired power plants to adopt state-of-the-art pollution controls could affect potential NSR hurdles to plant modification.