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The benefits and costs of reducing emissions from the electricity sector

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Abstract

Recent federal policy proposals to reduce emissions of sulfur dioxide (SO_2), nitrogen oxides (NO_x), and mercury from the US electricity sector promise important improvements in air quality and reductions in acid deposition. The cost of achieving these reductions depends on the form and stringency of the regulation. In this research, we analyze the economic benefits and costs of the US Environmental Protection Agency's (EPA's) Clean Air Interstate Rule (CAIR) as characterized in the supplemental rule proposed in June 2004, and the Clean Air Mercury Rule (CAMR) as proposed in February 2004. The assessment integrates a model of the electricity sector, two models of atmospheric transport of air pollutants, and a model of environmental and public health endpoints affected by pollution. We model explicitly the emissions of SO_2, NO_x, mercury and carbon dioxide (CO_2) and the effects of changes in emissions of SO_2 and NO_x on environmental and public health. The manner in which mercury emissions are regulated will have important implications not only for the cost of the regulation, but also for emission levels for SO_2 and NO_x and where those emissions are located. We find the economic benefits of CAIR and CAMR are far greater than the costs. Recent estimates of benefits of reductions in mercury and acidification indicate that our model captures the lion's share of quantifiable benefits. We also find that the EPA would have been justified on economic grounds in pursuing additional SO_2 emissions reductions beyond the requirements of CAIR.

Keywords: Emissions trading; Air pollution; Multipollutant; Electricity

1. Introduction

The electricity sector is a major source of several air pollutants including sulfur dioxide (SO_2), which contributes to acid rain and fine particle concentrations in the atmosphere, nitrogen oxides (NO_x) which contribute to both of these pollution problems and to ground-level ozone, mercury, which is a toxic substance linked to neurological and other health problems, and carbon dioxide (CO_2), which contributes to global warming. The electricity sector contributes roughly 68% of national emissions of SO_2 emissions, 22% of NO_x, 40% of mercury, and 40% of CO_2. The environmental effects of SO_2 and NO_x emissions are particularly strong in the northeast, which is downwind of the large number of coal-fired generators located in the Mid-Atlantic States and the Ohio Valley.

Recent federal policy proposals to reduce emissions of SO_2, NO_x, and mercury from the electricity sector promise important improvements in air quality and reductions in acid deposition. The cost of achieving these reductions depends on the form as well as the stringency of the regulation. In particular, the fact that technologies designed to reduce SO_2 and NO_x can reduce mercury emissions as well has important implications for how producers respond to different types of mercury regulation and for the cost of multipollutant policies aimed at all three pollutants.

In this research, we analyze alternatives for federal policy to examine how well they will protect the environment and public health. We analyze the economic costs and benefits of the Environmental Protection Agency's (EPA's) Clean Air Interstate Rule (CAIR) as characterized in the supplemental rule proposed in June 2004 and the Clean Air Mercury Rule (CAMR) as proposed in February 2004,

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which differ in only small ways from the final rules issued in March 2005. Our assessment integrates a model of the electricity sector, two models of atmospheric transport of air pollutants, and a model of environmental and public health endpoints affected by pollution. We model explicitly the emissions of SO_2, NO_x, mercury and CO_2 and the effects of changes in emissions of SO_2 and NO_x on public health. We do not model directly the effects of acidification or of mercury emissions, but we augment the modeling with estimates from other recent studies.[1]

We find the economic benefits of CAIR and CAMR are far greater than the costs, even under cautious assumptions that yield low estimates of the benefits of SO_2 and NO_x emission reductions relative to assumptions usually used by EPA.[2] Moreover, our analysis of important sources of uncertainty indicates the finding of benefits in excess of costs holds up in virtually every scenario we consider. The policy that most closely resembles the EPA final rules for SO_2, NO_x, and mercury and that maintains the seasonal NO_x policy produces greater net benefits than the EPA rules as originally proposed. Unfortunately, this finding does not translate into an endorsement of the EPA final rules because our modeling indicates that additional SO_2 emissions reductions beyond those called for by the EPA would yield further benefits substantially in excess of the additional cost. That is, our research indicates the EPA would have been justified on economic grounds in pursuing additional SO_2 emissions reductions beyond the requirements of CAIR.

Our analysis cannot provide economic advice regarding mercury emission targets because the modeling reflects inadequate links between models of emissions, physical science, public health and social science. We model the costs of mercury reductions in detail and we account for ancillary changes in concentrations of particulate matter that result from mercury reductions; but we do not provide a direct accounting of the benefits of reduced mercury emissions. How mercury benefits are accounted for could change the net benefits assessment of the four policy scenarios we model, but it is unlikely to change the main results. Inclusion of recent estimates of benefits from mercury reductions indicates that our model captures the lion's share of quantifiable benefits. The overarching finding is that the reductions in emissions that would be achieved under the EPA final rules or any of the alternatives we investigate offer important economic benefits far in excess of costs.

[1]We also do not analyze the implications of mercury trading for the creation of mercury hot spots, or local concentrations of mercury that lead to particularly adverse effects and that some believe could offset substantially the cost savings from allowing mercury trading.

[2]To identify the efficient policy one would seek to maximize net benefits by equating marginal costs and marginal benefits. In this analysis, we evaluate specific policy proposals and thus we focus on the total costs and benefits of each policy proposal, and the size of the difference between benefits and costs across the different policies.

2. Policy background

Significant reductions in emissions from power plants have been achieved under the 1990 Clean Air Act Amendments and under various other state and federal regulations. However, it is widely recognized that further emission reductions are necessary in order to achieve compliance with the 8-h ozone standard and with new air quality standards for fine particulates with a size of 2.5 μm in diameter and smaller ($PM_{2.5}$), and to reduce emissions of mercury.

For several years congress has weighed proposals suggesting a coordinated environmental policy to reduce emissions of multiple pollutants from the electricity sector. It makes sense to coordinate policies for multiple pollutants because of the interaction of compliance investments at power plants. Efforts to reduce one pollutant have an effect on the cost of reducing other pollutants. However, with the inability of Congress to reach agreement, the EPA initiated a regulatory process that culminated in two new rules announced in March 2005 that together address SO_2, NO_x, and mercury emissions from the electricity sector.

In its CAIR, EPA caps emissions of SO_2 and NO_x in a large multistate region mostly east of the Mississippi. This regulation allows for emissions trading and emission reductions are imposed in two phases with the first beginning in 2010 and the second beginning in 2015. In the first phase, the program allocates 3.7 million tons of SO_2 allowances and 1.6 million tons of NO_x allowances to electricity generators within 25 states and the District of Columbia. In 2015, the total allocations for annual emissions drop to 2.6 million tons for SO_2 and 1.3 million tons for NO_x. Actual emissions are expected to exceed these targets for some years beyond 2015 due to the opportunity to bank emission allowances distributed in earlier years for use in later years. The percent reductions in emissions within the CAIR region are comparable to those that would be required nationwide under the Clear Skies Initiative under consideration in the 108th and 109th Congresses, except they happen on a somewhat accelerated schedule. The final regulation also preserves a cap on seasonal summertime emissions of NO_x in a region with a slightly different boundary.

In the second new rule, the CAMR, EPA adopts a national plan to reduce emissions of mercury from electricity generators using a cap-and-trade approach. The rule distributes allowances for 38 tons of emissions from all coal and oil-fired electricity generators beginning in 2010 and 15 tons beginning in 2018. The rule allows for emission allowance banking. According to the EPA actual emissions are expected to exceed 15 tons for many years beyond 2018 due to the role of banking. In the final rule, the cap-and-trade approach to reducing mercury was selected over a maximum achievable control technology (MACT) approach, which was also included as an option for consideration in the proposed rule.