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Resource and Energy Economics 26 (2004) 295–315
RESOURCE and ENERGY ECONOMICS
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Determining the cost-effective size of an emission trading region for achieving an ambient standard

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Received 3 December 2002; received in revised form 17 June 2003; accepted 15 August 2003

Available online 23 December 2004

Abstract

Little effort has been devoted to determining the cost-effective trading region for emission permits that achieve an ambient standard. With regional expansion, control by more distant, lower marginal cost sources supplants control by higher marginal cost sources in the original region. However, the impact of more distant source emissions on ambient receptors will typically decline. The aggregate effect on costs of this tradeoff depends crucially on the standard's stringency. Since a rule-of-thumb for the effect of regional expansion requires overly-restrictive assumptions, we model nitrogen oxide permits subject to nitrogen loading standards for Chesapeake Bay. Regional expansion substantially reduces cost only when the standard is stringent.
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JEL classification: Q25

Keywords: Tradable emission permits; Nitrogen oxide; Trading region; Permit market size; Chesapeake Bay

1. Introduction

Even though the US has carried out the most extensive and diverse experimentation with systems of tradable emission permits of any country, the systems in use share a fundamental characteristic: they make minimal or no use of the differential ambient impacts of sources to optimize system design. Thus, permits must be purchased for source emissions rather than their degradation of air quality as measured by ambient monitors. Emission-based

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doi:10.1016/j.reseneeco.2003.08.001

systems are used to improve air quality even when the location of an emissions source is known to cause significant and non-uniform ambient degradation, in particular, tropospheric ozone and acid deposition. Momentum will likely produce efforts to employ emission-based systems to address important remaining regional air pollution problems in the US: fine particulate matter, regional haze (which also is caused by fine particulate matter), and the 8 h standard for tropospheric ozone.

In a few cases, emission-based systems partially incorporate the differential ambient impacts of emissions by restricting trades to specific geographical regions. Such restrictions are present in, for example, the Federal non-attainment new source review program and the RECLAIM program in southern California. The Clean Air Act ((AA) requires compensating emission reductions (offsets) for increased emissions from new or modified "major" stationary sources in non-attainment areas (42 USC, Section 7503). Offsets may be obtained from other sources in the same non-attainment area, and, in general, states may allow offsets to be obtained from sources in another non-attainment area if "the other area has an equal or higher non-attainment classification than the area in which the source is located" and "emissions from such other area contribute to a violation of the national ambient air quality standard in the non-attainment area in which the source is located" (42 USC, Section 7503(c)). For emissions of volatile organic compounds and oxides of nitrogen (NO_x), the related "Emission Offset Interpretive Ruling" conveys the Environmental Protection Agency (EPA)'s recommendation that the compensating emission reduction should exceed the emission increase from the new or modified source (40 CFR 51, Appendix S IV(D)).[1] This recommendation goes even further by stating that except when provided by adjacent facilities, offsets of sulfur dioxide (SO_2), particulate matter, and carbon monoxide should be justified on the basis of "atmospheric simulation modeling to ensure that the emission offsets provide a positive net air quality benefit" (40 CFR 51, Appendix S IV(D)).

The RECLAIM program, which comprises two separate emission trading programs for NO_x and oxides of sulfur (SO_x), divides the South Coast Air Quality Management District into two trading zones for the purpose of new source review. The cities on and nearest the coast are in Trading Zone 1. Inland, downwind cities are in Trading Zone 2. All emissions from a new or relocated facility in Trading Zone 1 must be offset by emission reductions (RECLAIM Trading Credits) occurring at facilities that also are in Trading Zone 1; a new or relocated facility in Trading Zone 2 may obtain offsets from facilities in either zone (Rule 2005, Section (e)).

The geographical restriction on trades that is present in the RECLAIM program is atypical of the "second generation" emission trading systems, i.e., the regional and national cap-and-trade systems that were created after the Federal new source review program. For example, neither the Federal "Acid Rain" SO_2 emission trading program (created by the 1990 amendments to the Clean Air Act) nor the Ozone Transport Commission's summertime NO_x emission trading program (created in the mid-1990s) contain any geographical restrictions on trades.

Many aspects of emissions trading regions or zones have been examined empirically with simulation models, where trading is allowed within but not between zones. Atkinson (1983)

[1] The oxides of nitrogen are nitric oxide (NO) and nitrogen dioxide (NO_2), which react with volatile organic compounds (non-methane organic gases) to form tropospheric (ground-level) ozone.

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