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Local air pollution and global climate change: A combined cost-benefit analysis

Johannes Bollen [a,*], Bob van der Zwaan [b,c], Corjan Brink [a], Hans Eerens [a]

[a] PBL, Netherlands Environmental Assessment Agency, P.O. Box 303, 3720 AH, Bilthoven, The Netherlands
[b] ECN, Energy Research Centre of the Netherlands, Policy Studies Department, P.O. Box 56890, 1040 AW, Amsterdam, The Netherlands
[c] Columbia University, Lenfest Center for Sustainable Energy, Earth Institute, NY, USA

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ABSTRACT

This article presents the findings of a combined cost-benefit analysis of local air pollution and global climate change, two subjects that are usually studied separately. Yet these distinct environmental problems are closely related, since they are both driven by the nature of present energy production and consumption patterns. Our study demonstrates the mutual relevance of, and interaction between, policies designed to address these two environmental challenges individually. Given the many dimensions air pollution control and climate change management have in common, it is surprising that they have only little been analyzed in combination so far. We attempt to cover at least part of the existing gap in the literature by assessing how costs and benefits of technologies and strategies that jointly tackle these two environmental problems can best be balanced. By using specific technological options that cut down local air pollution, e.g. related to particulate emissions, one may concurrently reduce CO_2 emissions and thus contribute to diminishing global climate change. Inversely, some of the long-term climate change strategies simultaneously improve the quality of air in the short run. We have extended the well-established MERGE model by including emissions of particulate matter, and show that integrated environmental policies generate net global welfare benefits. We also demonstrate that the discounted benefits of local air pollution reduction significantly outweigh those of global climate change mitigation, at least by a factor of 2, but in most cases of our sensitivity analysis much more. Still, we do not argue to only restrict energy policy today to what should be our first priority, local air pollution control, and wait with

* Corresponding author.
E-mail address: Johannes.Bollen@pbl.nl (J. Bollen).

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the reduction of greenhouse gas emissions. Instead, we propose to design policies that simultaneously address these issues, as their combination creates an additional climate change bonus. As such, climate change mitigation proves an ancillary benefit of air pollution reduction, rather than the other way around.

1. Introduction

Two interrelated environmental policy problems are global climate change (GCC) and local air pollution (LAP). Both are discussed in the political arena: the first notably in the United Nations Framework Convention on Climate Change (UNFCCC) and the second in, e.g. the United Nations Economic Commission for Europe's task-force on Long-Range Transboundary Air Pollution (UNECE-LRTAP). Emissions from the combustion of fossil fuels contribute to both GCC and LAP. Options to mitigate these problems are typically chosen to address each exclusively. For example, to reduce the emissions of SO_2, NO_x, or particulates, one often uses end-of-pipe abatement techniques specifically dedicated to these respective effluents, but not to CO_2. Their application thus only contributes to diminishing LAP, not GCC. Alternatively, one of the ways to cut down emissions of CO_2 is to equip fossil-fired power plants with CO_2 Capture and Storage (CCS) technology, which in principle only addresses this greenhouse gas, and not the emissions of air pollutants. CCS equipment installed in isolation therefore alleviates GCC, not LAP. Still, options exist capable of simultaneously addressing both environmental problems, such as the substitution of fossil fuels by various types of renewables or nuclear energy. This paper investigates, through an integrated cost-benefit analysis of GCC and LAP, to what extent synergies between solutions for these environmental challenges can be created by using technologies that are beneficial to both at once.

Nordhaus became one of the early protagonists in the cost-benefit analysis of GCC by deriving an analytical solution to a simple climate change maximization problem (Nordhaus, 1977, 1982). The answer to the problem involved an optimal time-profile for the concentration of CO_2 in the atmosphere. Nordhaus later developed a numerical model (DICE) that simulated a rudimentary world climate–economy system (Nordhaus, 1993). Estimates for climate change damage costs, however, fundamentally determined his modeling results, like those of others who meanwhile had undertaken similar research (see, for example, Fankhauser, 1995; Manne and Richels, 1995; Tol, 1999; Rabl et al., 2005). The reason was a very incomplete scientific understanding of potential climate change impacts, resulting in large cost uncertainties. Another shortcoming of this type of work was, and still is, that none of the GCC cost-benefit analyses cover the LAP problem, even while these two issues are closely linked. Indeed, they are both much driven by current energy production and consumption patterns. This paper attempts to correct for this, by presenting a single model that includes detailed descriptions of the costs and benefits of both GCC and LAP control strategies.

In 1999, the EU adopted the *Gothenburg Protocol to Abate Acidification, Eutrophication and Ground-level Ozone*. This protocol set emission ceilings for the year 2010 for SO_2, NO_x, NH_3, and VOC (volatile organic components). A few years later, the EU developed the *National Emission Ceiling Directive* that stipulated more stringent targets for these pollutants. The multi-national negotiations, leading to the agreement of these targets, used insights from scientific assessments and estimates for the economic costs of pollutant abatement options obtained with the LAP model RAINS (Amann et al., 2004a,b). Recently, results from RAINS have been used for restricted cost-benefit analyses of LAP, notably to serve the Clean Air For Europe program (CAFE, see Holland et al., 2005). Other studies of costs and benefits of air pollution policy packages have been performed that focused on isolated environmental problems or single pollutants (such as RIVM, 2000). All these analyses conclude that the monetary benefits of air pollution policies can be much larger than their costs. They all imply that the benefits are dominated by the avoided number of premature deaths from the chronic exposure of the population to concentrations of particulate matter (PM). A few studies merely signal potential LAP benefits resulting from GCC policies (Criqui et al., 2003; van Vuuren et al., 2006). They typically fix the