On the Use of Abatement Cost Curves in Integrated Assessment Modelling – Implications of Dealing with Multi-pollutant Multi-effect Problems

Stefan Reis[1] , Rainer Friedrich[1] and Steffen Nitter[1]

Abstract

This paper will critically review the current state-of-the-art of integrated assessment modelling of air pollution control strategies based upon abatement cost curves, and discuss the specific implications of multi-pollutant multi-effect analysis for their further use in modelling studies. Starting from this analysis, a new approach towards modelling emission control options will be discussed, which combines the concept of transparency and simplicity – among the most criticised aspects of current integrated assessment models – with a real-world modelling of abatement options, both technical and non-technical.

Scope

As air quality limit values have been becoming more stringent during the last 20 years, and with the need to reduce emissions of greenhouse gases beyond the scope of no-regret technologies to achieve the Kyoto commitments, the costs of emission control has constantly gained importance. In international negotiations such as e.g. the protocols to the UNECE Convention on Long-Range Transboundary Air Pollution (CLRTAP), the analysis of cost-effective ways to reduce emissions played a major role since the 1970s. Binding emission control targets for Sulfur Dixoide (SO_2) and Nitrogen Oxides (NO_x) were agreed upon with the backing of model calculations of the related costs of control strategies (*cf.* Amann et. al 1996, 1999; ApSimon 1994a,b, and 1996; Bailey 1996 as well as Gough et al. 1995, 1998). These models use(d) single abatement cost curves as input to their

[1] Institute of Energy Economics and the Rational Use of Energy, University of Stuttgart, Hessbruehlstrasse 49 a, D-70565 Stuttgart, Germany; Tel. +49 711 7806119; Stefan.Reis@ier.uni-stuttgart.de – http://www.ier.uni-stuttgart.de/merlin

optimisation tools, in order to identify the least-cost ways to achieve given reduction targets, and to assess the overall costs of strategies. Typically, the analysis focussed on a single pollutant (e.g. SO_2, NO_x) with a (usually) linear relationship between emissions and concentrations, respectively emissions and effects. The case of acid rain and acidification in general (Gough et. al. 1995) is one of the most prominent examples, where reductions of emissions of SO_2 and/or NO_x would usually lead to reduced deposition in the same order of magnitude. The assessment models had to take into account transport of pollutants through the air to some extent, in order to map the regional distribution of deposition changes, while chemical transformation of pollutants did not play a major role yet.

When air pollution by tropospheric ozone became the focus, the modelling task turned more difficult, as the relationship between the emissions of ozone precursor substances NO_x and Non-Methane Volatile Organic Compounds (NMVOCs), and to some extent Carbon Monxide (CO) as well as the the formation of groundlevel ozone is not linear. Thus, the assessment models needed to include more complex mechanisms to account for these non-linearities. At the same time, the results not only needed to address the question, which measures to take in order to achieve a cost-effective solution, but instead had to tell, which pollutant to be controlled, and where – thus making the optimisation task more complex (cf. Friedrich and Reis, 2000). But even apart from the modelling aspects, the case of two pollutants to be controlled introduced an issue that has not been properly solved up to date. While in a single pollutant case, the costs per unit of pollutant controlled by a specific measure are usually easy to pinpoint, given sufficient information about the activity rates, the technology and the economics of the respective installation. As soon as two pollutants were to be controlled, and measures existed, which would reduce the emissions of both pollutants when installed, usually with differing efficiency, the issue of allocating cost proportions to single pollutant cost curves was no longer trivial. In this paper, this particular problem shall be discussed, with a focus on the current development towards multi-pollutant multi-effect assessment models, where a robust and transparent methodology to solve this problem could prove to be vital. In the second part, a new methodology to model the application of technical and non-technical emission control measures and the respective costs of abatement will be introduced and discussed in detail. Finally, an outlook will be given with respect to the application of this new metholodogy in the European resarch project MERLIN.

Bibliography

Amann M et al, (1996) Cost-effective Control of Acidification and Ground-Level Ozone. First Interim Report to the European Commission, DG-XI, Laxenburg

Amann M et al (1999), Final report on work done under EU acidification and ozone strategy. International Institute for Applied Systems Analysis (IIASA), Laxenburg, Austria

ApSimon H M, Warren R F, Wilson J J N, (1994) The abatement strategies assessment model (ASAM): applications to reductions of sulphur dioxide emissions. Atmospheric environment 28 (4), 649–664

ApSimon H M and Warren R F (1996) Transboundary Air Pollution in Europe. Energy Policy 24 (7), 631–640

Bailey P D (1996) Emissions and Abatement Costs of Nitrogen Oxides for Use in Integrated Assessment Models. Report to the Working Group on Strategies and the Task Force on integrated Assessment Modelling, LRTAP Convention, UNECE, Stockholm Environment Institute at York, York

Friedrich R, Reis S (eds) (2000) Tropospheric Ozone Abatement – Developing Efficient Strategies for the Reduction of Ozone Precursor Emissions in Europe. Springer Publishers

Gough C A, Chadwick M J, Biewald B, Kylenstierna J, Bailey P D, Cinderby S (1995) Developing optimal abatement strategies for the effects of sulfur and nitrogen deposition on European scale. Water, Air and Soil Pollution 85, 2601–2606

Gough C, Castells N, Funtowicz S (1998) Integrated Assessment: an emerging methodology for complex issues. Environmental Modelling and Assessment 3, 19–29