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Would including more source species enhance the cost-effectiveness of climate policy?

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Sammendrag:.
Ved å ta med utslepp av gassar som dannar ozon og utslepp av partiklar som fører til oppvarming av atmosfæren kan kostnadseffektiviteten til framtidige klimaavtaler bli betre, men samstundes vil kompleksiteten auke og forhandlingane, rapportering av utslepp, og gjennomføring av avtalene bli meir komplisert. For å vurdere potensialet for kostnadssparing blir Noreg brukt som eit eksempel. Berre NMVOC og NO_x er med sidan data for dei andre gassane og partiklane manglar. Det viser seg at potensialet for å redusere desse gassane er avgrensa - mellom 4 og 12 % av potensialet til dei seks gassane som er inkludert i Kyotoprotokollen. Ein må vere forsiktig med å generalisere resultata frå Noreg til andre land.

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Abstract:
Incorporating ozone precursors and particle emissions in future climate policy agreements could improve the level of cost-effectiveness, but would also add complexity and complications to negotiation, reporting and implementation. To assess the cost saving potential, a case study of Norway is carried out. Only NMVOC and NO_x are included, since data for the other species are not available. It turns out that the potential for reducing emissions of these gases is limited, and in the range of 4 to12 % of the potential of the six gases included in the Kyoto Protocol. One must be careful when trying to generalize the results from Norway to other countries

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1 Introduction

Including ozone precursors and particle emissions in future climate policy agreements could improve the cost-effectiveness and comprehensiveness of greenhouse gas mitigation policies, as requested by United Nation's Framework Convention on Climate Change (UNFCCC). The Kyoto Protocol (to the Convention), adopted in 1997 but not yet entered into force, covers CO_2 and five other greenhouse gases. Reductions in air pollution and damages to human health and environment are important side-effects, or co-benefits, of including these substances in future climate agreements. These co-benefits could induce greater participation in future climate policy agreements and possibly make more ambitious targets politically feasible. In this regard, the participation of the USA and major developing countries is vital. On the other hand, the added complexity with regard to reporting and accounting of emissions could make the negotiation process more complicated and implementation more costly.

At the national level as well as the global level, the social cost of achieving an emission reduction or limitation target could be reduced if ozone precursors and particles are included because the portfolio of options is expanded. One provision for increasing cost-effectiveness in this way is that the costs of measures to reduce emissions of ozone precursors and particles, measured as cost per ton of CO_2 equivalent, are lower than the costs of measures to reduce emissions of the gases included in the Kyoto Protocol. A second provision is that measures and investments which are least expensive per ton of CO_2 equivalent are carried out first. Furthermore, to have a significant cost-saving effect, the emission reduction volume for the additional gases and particles must be sizeable compared to the large emission reduction volume of the six Kyoto gases, in particular for CO_2.

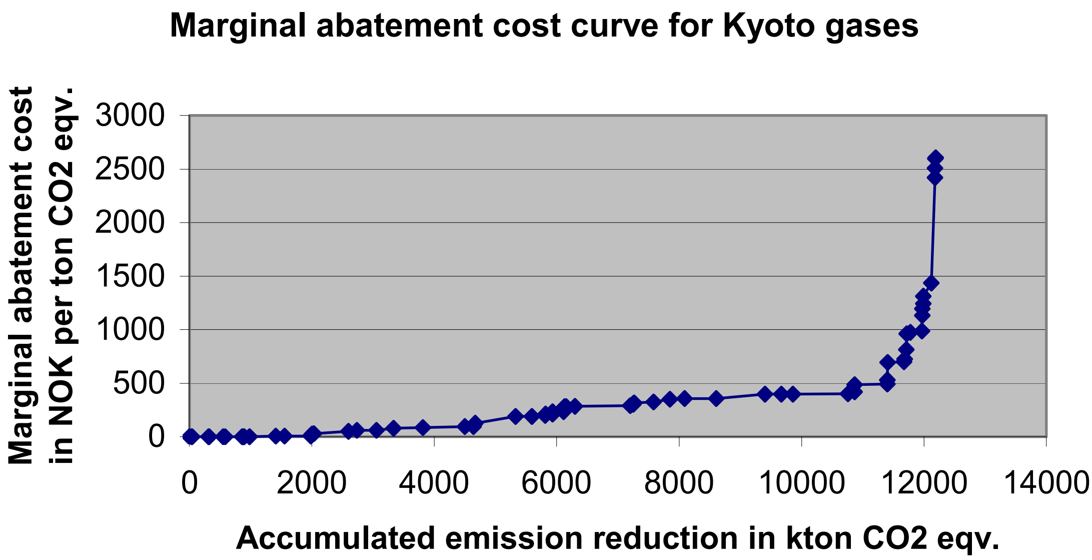
There are few studies that estimate the cost-saving potential of developing a mitigation strategy that would integrate the Kyoto gases, ozone precursors and particles. A study by van Harmelen et al. (2002) can give an indication of the relative importance of measures that affect both Kyoto gases and ozone precursors and particles (and thus give us a lead on the significance of category c below). They have estimated the costs of controlling regional air pollution in Europe given that a climate policy is also in force, and find that mitigation costs for SO_2 and NO_x in Europe can be reduced by 50-70% for SO_2 and about 50 % for NO_x by climate measures. In some scenarios the costs of integrated mitigation of SO_2, NO_x, and CO_2 can be even smaller than mitigation of SO_2 and NO_x alone by add-on technologies (end of pipe).

As an illustration I calculate the potential saving for Norway for some source species. Data on emissions, measures and costs for some ozone precursors and the six Kyoto gases are available from the Norwegian Pollution Control Authority (SFT). Thus the idea is to explore how the marginal abatement cost (MAC) curve may shift when including ozone precursors and particles. The curve will shift downwards when including new inexpensive measures, and in addition the optimal sequence of measures may change so that the slope of the curve changes. Lack of data availability means that calculations can only be carried out for NMVOC and NO_x. Due to large variations in relative emissions from various sources and source species in different countries, the relative importance of ozone precursors and particles is also likely to vary substantially. Therefore one must be careful when trying to generalize the results from Norway to other countries.

2 Analytical approach

The analytical approach is based on a MAC curve for emission reductions. The MAC curve shows the cost of implementing one more measure at the time to reduce emissions when measures are ranked according to rising cost. The vertical axis measures the cost per ton of CO_2 equivalent, whereas the accumulated volume of emission reductions in tons of CO_2 equivalents is measured along the horizontal axis. Figure 1 shows a well-known MAC curve for Norway taken from a report from the Norwegian Pollution Control Authority in 2000. The MAC curve is based on the six greenhouse gases (of which two are groups of gases) included in the Kyoto Protocol. Measures up to a cost of around 2700 NOK per ton of CO_2 equivalent are included.

Figure 1. Marginal abatement cost curve for the six Kyoto Protocol gases in Norway (SFT 2000).



To find the cost-effectiveness consequences of including ozone precursors and particles, cost and volume data on relevant measures must be transferred to the same format, that is, tons of CO_2 equivalents, so that these measures can be inserted among the Kyoto gas measures in the MAC curve in Figure 1. This requires Global Warming Potential (GWP) values for ozone precursors and particles. The larger the downward shift of the MAC curve, the larger the gain in cost-effectiveness of including the new gases and particles.

In terms of the Kyoto gases, ozone precursors, and particles, there are three categories of measures to mitigate emissions:

a) measures that only affect the six Kyoto gases;

b) measures that only affect ozone precursors and particles; and

c) measures that affect both Kyoto gases and ozone precursors and particles.

A large number of measures are likely to be in category c, even if the mitigation share probably is dominated by the Kyoto gases in most cases. Due to limited data availability we simplify this by only comparing measures in categories a and b, without considering that some share of the measures are in category c.

Since measures to reduce greenhouse gas emissions in many cases reduce emissions of local (and regional) pollutants, the ancillary benefits in terms of improved local environmental conditions should be accounted for. Important benefits are reduced health problems and reduced corrosion of materials. This could be done by subtracting the local environmental benefits from the cost of the measures when considering the greenhouse gas mitigation cost. The ancillary benefits associated with ozone precursors and particles can be handled in the same manner. However, due to methodological and data reasons, ancillary benefits have not been accounted for in this study.

For some ozone precursors and particles (such as SO_2) the GWP could be negative. The simplest approach to such as a case is to say that the GWP is equal to zero. The alternative is to account for a negative GWP, which is problematic in the analytical framework we are operating in. If one were only concerned with the climate effect, activities releasing such gases or particles to the atmosphere should in principle be stimulated (subsidized). However, it might well be that the negative local environmental impacts of these emissions outweigh the positive climate effect.

3 Data

The ozone precursors are NMVOC, NO_x, SO_2 and CO. Particles are divided into organic carbon (OC) and black carbon (BC).

3.1 GWP

The GWP value for NMVOC is taken from Collins et al. (2002), where we take the average radiative forcing effect involving methane and ozone over the organic compounds contained in NMVOC, which is calculated at 3.7. If we have a fossil fuel NMVOC source, a CO_2 component at 3.0 must be added, making the total GWP value 6.7. The GWP value for NO_x is taken from Derwent et al. (2001). The value is 4.5 adding the cooling component, and 13 if the cooling component is left out. For SO_2, BC and OC, no GWP values are found in the published peer-reviewed literature due to various difficulties. GWP values for CO exist, but are not specified here due to missing data on measures and costs.

3.2 Measures and costs

The Norwegian Pollution Control Authority has produced catalogues of measures and costs for NMVOC (SFT 1998), NO_x (SFT 1999), and SO_2 (SFT 2001). These reports contain detailed description of measures/investments and the mitigation effect for all relevant industries, and also include total cost and marginal cost calculations. Furthermore they include a MAC curve for all industries/sectors and sources taken together. The emissions of these three gases are regulated in Norway, whereas CO, BC and OC are not regulated. The main NO_x source is combustion of fossil fuels, and thus there is a relation to CO_2 emissions. However, there may be a trade-off since increased energy efficiency and reduced CO_2 emissions can lead to higher NO_x emissions. The main SO_2 source is process industries, where metal ore and reduction agents (charcoal and coal) contain some sulphur. NMVOC and CO are by-products from combustion of fossil fuels and biomass combustion. Another main source for NMVOC and CO is loading of oil and gas tankers offshore.

4 An illustration of the case of Norway

The illustration of the case of Norway is based on including only NMVOC and NO_x since data and/or GWP values are not available for the other gases and particles. The MAC curves from these reports are employed to calculate the potential cost saving from adding NMVOC and NO_x to the MAC curve for the Kyoto gases shown in Figure 1. Assuming a marginal price limit of 1000 NOK per ton of CO_2 equivalent, the MAC curves show the percentage reduction in emissions from 1989 level (NMVOC) or 1990 level (NO_x) given that all measures at a lower cost than 1000 NOK are implemented. Since the price limit is in 1000 NOK per ton CO_2 equivalent, the cost figures per ton of NMVOC and NO_x are adjusted according to the relevant GWP values to find the cost per ton CO_2 equivalent. As explained above we have two GWP cases for each gas. Thereafter the emission reduction in kilotons for each gas is found by comparing with national emissions in 1989 and 1990. The next step is transforming the emission reduction in kilotons of each gas to kilotons CO_2 equivalents by multiplying by the relevant GWP values. Finally the potential emission reduction for each gas is compared to the equivalent potential for the six Kyoto gases shown in Figure 1, which is in 12 Mton CO_2 equivalents. The results are shown in Table 1. We assume that there is no overlapping or double-counting in terms of measures undertaken, neither between NMVOC and NO_x, nor between these gases and the Kyoto gases. Table 1 also shows the range for the potential mitigation effect of NMVOC and NO_x taken together, dependent on the GWP values chosen, and compared to the Kyoto gases.

Table 1. The cost-effectiveness potential for Norway of adding measures to reduce NMVOC and NOx emissions to measures to reduce emissions of the six Kyoto Protocol gases in the case of a price limit at 1000 NOK/ton CO_2 equivalent.

Gas (GWP value)	Reduction potential; Mt CO_2 eqv. below price limit at 1000 NOK/ton CO_2 eqv.	Reduction potential compared to Kyoto gases (12 Mt CO_2 eqv.); percentage
NMVOC (GWP 3.7)	0.270	2.3
NMVOC (GWP 6.7)	0.527	4.4
NO_x (GWP 4.5)	0.152	1.3
NO_x (GWP 13)	0.864	7.2
SUM	0.422 – 1.391	3.6 – 11.6

The results indicate that there is some effect on cost-effectiveness of including measures on NMVOC and NO_x, but that the effect is likely to be quite limited since the emission mitigation potential of these gases is only between 4 to 12% of the potential of the Kyoto gases.

5 Conclusions

There is no doubt that implementing a more comprehensive greenhouse gas policy strategy could increase cost-effectiveness. The question is how large this effect could be, and how much the negotiation and administrative costs could increase by doing so. An illustration from Norway, considering separate measures and including the ozone precursors NMVOC and NO_x indicates that the potential is limited since the mitigation potential is only in the range of 4-12 % of the mitigation potential for the Kyoto gases. If data on measures, costs and GWP values for more ozone precursors and particles become available, a more detailed and complete analysis could be undertaken. However, the study of Van Harmelen et al. (2002)

indicates that there may be strong economic arguments for developing joint policies to reduce air pollution and greenhouse gas emissions in Europe. The situation may be different in developing countries where marginal abatements costs and the composition of sources are different.

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