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Economic impactmodules for the EUROS model

Final Report Summary

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Summary

The project 'Economic Impactmodules for the EUROS-model' was worked out by VITO – Flemish Institute for Technological Research – in cooperation with ECONOTEC – a private consultancy company with a strong specialisation in environmental subjects.

In summertime, there are often high ozone concentrations. Because of its oxidising character, ozone is damaging for public health and vegetation. The formation of ozone results from the oxidation of volatile organic compounds (VOCs) in the presence of nitrogen oxides (NOx) and sunlight. If the ozone concentration is higher than 180µg/m³, the government warns the public for negative impacts on health. To reduce the ozone concentrations, both long-term and short-term measures have to be taken by the government. The Göteborg Protocol to the Convention on Long-Range Transboundary Atmospheric Pollution (CLRTAP) of the UN/ECE prescribes emission ceilings for the emissions of NOx, NMVOC, SOx and NH_3 in 2010. The European directive on National Emission Ceilings (NEC) is even stricter.

EUROS is a atmosferic dispersion model developed by RIVM (Netherlands) and adapted for Belgium by Vito, calculating ozone concentrations as a function of NMVOC and NOx emissions as well as meteorological and geographical data. The aim of the present project was to built a module for evaluation of costs and benefits of emission reduction scenario's and hence of emission reduction policy measures.

An inventory of all available emission data was made up. All emissions were aggregated and the totals were compared with the totals registered by EMEP[1], the European Emission Inventory. A lot of attention was given to the inventorying of emissions.

In a study by J. Duerinck (article added) an analysis is made on the robustness of emissions reduction cost functions. A national emission reduction cost function for VOC emissions and the Monte Carlo Method are used to demonstrate the high degree of uncertainty in the global cost estimations due to uncertainties in volume components of the emission reduction cost function. It is demonstrated as well that uncertainties in the price components are less critical although a small downward bias is observed.

Also emission reduction technologies were inventoried. Emission reduction measures can be split up into primary and secondary measures. Primary measures prevent emissions, secondary measures abate emissions. The necessary information to be able to link the technology with the installations were abatement efficiency, investment and operation costs and technical information.

A model was set up with the collected emission and technology data. In total 85% of the NOx-emissions from stationary resources are imported in the model. For each

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[1] EMEP: Co-operative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe

installation responsible for those emissions, technologies for emission reduction were identified. For NMVOC 65% of the emissions was identified in the model. All emissions in the model can be located geographically. They are divided into two categories: point sources and area sources. For NOx the greatest part of the stationary emissions are point sources.

The model allows to calculate for a certain year in the future the emissions in a business as usual scenario, the possible emission reduction for this year and the costs linked to this reduction. The model calculates also the mean and marginal costs for each combination. These data are used to calculate total costs and draw cost curves.

For the projection of the mobile sources, the results from the study of I. De Vlieger (VITO) et al. (2001) "Measures in the transportsector for the reduction of CO_2 and troposferical ozone" were used. These mobile emissions were considered as line sources. In the framework of the present study, they were split out over the belgian transport infrastructure (roads, railways & waterways).

In the following table an overview is given of the results of the different scenarios that are calculated. 1997 served as the reference year. All the collected data are for this year. For the business as usual (BAU)-scenario 2010, the data from 1997 are projected with sector evolution factors, taking into account the current legislation and known end-of-life replacements till 2010. The sector evolution factors used are from the MIRA-S scenarios (Flemish environmental report), calculated by the Federal Planing Agency and from the EPM model of ECONOTEC. Based on the data for 2010 the maximal reduction scenario is calculated. Because the hypothesis 'the emissions grow as fast as the sector' is contestable, we calculated a BAU-scenario with the hypothesis that the emission growth stands still and only reduction is possible.

Although the business as usual (BAU) scenario 2010 does not reduce enough to satisfy the Göteborg Protocol ceilings and the European directive on National Emission Ceilings (NEC), extra emission reduction measures could be found to satisfy the emission ceilings for the NOx-emissions, but not for the NMVOC-emissions. The volume of the NMVOC-emissions are not well known, nor costs and effectiveness of NMVOC-emissions reduction measures. Further research on this subject could reveal new reduction potentials.

Table 1: Total emissions for the different scenarios

kton	NOx	NMVOC
Göteborg	184	144
NEC	176	139
IIASA MFR 2010[2]	127	102
1997	305	292
2010 BAU	227	196
2010 BAU 0% growth emissions	204	179
2010 BAU MAX	159	174
2010 BAU 0% MAX	147	160

[2] Maximum Feasible Reduction scenario, as calculated by IIASA (International Institute for Applied System Analysis) in preparation of the Göteborg protocol

The emissions of the reference year, the BAU scenario 2010 and BAU 2010 maximal reduction were geographically split out and converted to a grid with square cells of 15 by 15 kilometers. Those grids were used by the EUROS model (EURopean Operational Smog Model) which calculates the ozone concentrations given the emissions. The ozone concentrations are used to calculate the benefits from ozone reduction. The emission data from the BAU-scenario with growth rate 0% are not imported in EUROS given the long calculation time of the EUROS model.

For the cost calculation, the emission reduction costs borne to satisfy current legislation or end-of-life replacements are not taken into consideration. Only the cost for extra reduction were calculated. Cost curves were set up based on the emissions for the BAU 2010 scenario. The BAU 2010 scenario was also calculated with 0% growth of the emissions to simulate a stand still of the emissions. Based on these emissions, cost curves for NOx and NMVOC were set up. The maximal reduction that could be reached by cost curves can be seen in the table above. The costs associated with it can be found in the table below. In an exercise was shown that the cost associated with a policy implementing norms for burners, based on the fuels used, are higher than the costs in the cost-effective case.

Table 2: Maximal reduction (kton) and costs (MEURO) associated

	NOx		NMVOC	
	kton reduction	MEURO	kton reduction	MEURO
2010 BAU MAX	68	392	22	372
2010 BAU 0% MAX	57	435	18.3	353

The benefits are calculated by a model that was set up. The model uses the ozone concentrations of ten points distributed over Belgium, generated by the EUROS model. Based on the difference between the ozone concentrations of two scenarios, the model calculates the benefits of NOx and NMVOC reduction. Benefits can be a direct or indirect effect of ozone reduction. With the direct effects is meant the change in health effects and agricultural effects caused by a change in ozone concentrations. Lower ozone concentrations gives lower health or agricultural effects, thus benefits, higher ozone concentrations means negative benefits or costs.

Indirect effects are effects caused by NOx in the formation of nitrates. The reduction of those effects is not a direct consequence of the reduction of the ozone concentration, but of the reduction of NOx.

Table 3: Comparison between costs and benefits

	Reduction (kton)		**Costs (MEURO)**		**Benefits (MEURO)**			
	NOx	NMVOC	NOx	NMVOC	Direct		Indirect	Total
					Health	Agriculture		
1997 – BAU 2010	78	96	-	-	7,5	12	236,9	256,4
BAU 2010 – BAU 2010 MAX	68	22	392	372	-5,1	5	334,1	334,0

In table 3, the costs and benefits of the transition from one scenario to another are put together. As mentioned before, the costs for satisfying current legislation or End-Of-Life replacements are not taken into account.

Based on the direct effects, benefits in health and agricultural effects, there appear to be no benefits from NOx and NMVOC reduction in BAU 2010 MAX.

This result is due to the fact that NOx-emissions can create and delete ozone. The relation between the amount of NOx-emissions and the ozone concentrations is non-linear. Till a certain point, ozone concentrations are increasing with lower NOx concentrations, after this point ozone concentrations are lowering. In this study, it was not possible to indicate how much NOx reduction gives lower ozone concentrations. The calculation time limited the number of scenarios that could be worked out. The only conclusion that can be drawn is that BAU 2010 Max creates no direct benefits in comparison with BAU 2010.

On the other hand, the indirect effects of NOx reduction, health effects from the reduction of nitrates, are more important then the direct effects, even taking into account the uncertainty of the benefits of the indirect effects. The indirect effects could make further NOx reduction profitable.

The estimations for the different scenarios were made with constant emissions for foreign countries. The effect from emission reductions abroad were not taken into account. The effect abroad from emission reductions in Belgium were also not calculated. Further research taking into account foreign countries, on this subject could be interesting.

It must be stressed that a complete cost-benefit analysis is an ambitious task because of the long calculation times of the EUROS model and the extensive work in making data compatible. However the cost and benefit modules could be used independently. The cost module could be applied to generate emission reduction cost curves in detail (sector, region, technology,...). The benefit module could be used to evaluate output of the EUROS model.