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MEASURES IN TRANSPORT TO REDUCE CO_2 AND TROPOSPHERIC OZONE

SUMMARY

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Within the national programme 'Sustainable Mobility' (1996-2001) Vito has been working on the project 'Measures in transport to reduce CO_2 and tropospheric ozone'. At Vito three research teams were involved in this study: (1) Integral environmental studies, (2) Energy technology and (3) Remote sensing and atmospheric processes. The Free University of Brussels (Centre of Business Informatics) was involved, as subcontractor to give methodological support for the multiple criteria analysis. There Mr W. De Keyser and Mr P. Peeters paid heed to the problem.

General context

An efficient and flexible transport system is essential to our economy and quality of life. There is a need for efficient and reasonably prised mobility for work, education, leisure activities, and of course also for the transportation of goods. The rise in the demand of transportation was enormously during the last decades. In 1999 the amount of vehicle kilometres driven on Belgian roads increased by 30 % compared to 1990. This is a tripling compared to 1970. [1]. All these activities in transportation have a negative influence on the environment and public health.

In 1999 transport was responsible for about 22 % of the carbon dioxide (CO_2) emission, which still is the most import greenhouse gas. The contribution of traffic to the main precursors of ozone, in particular nitrogen oxides (NO_x) and non-methane volatile organic compounds (NMVOC), was respectively 53 % and 31 % [2].

This study focussed on the reduction of CO_2 and tropospheric ozone from transport. It is interesting to evaluate the opportunities within transport to help fulfil the international agreements on above mentioned environmental problems, in particular the Kyoto Protocol and the Gothenburg Protocol, as agreed by Belgium.
The Kyoto Protocol aimed at the reduction of emissions of greenhouse gases. Belgium agreed to reduce the emission of greenhouse gases by 7,5 % averaged over the period 2008-2012 compared to 1990 (year of reference). No objectives for the different sectors were formulated, so neither for transport.
The Gothenburg Protocol sets national emission limits on NO_x, SO_2 (sulphur dioxide) and VOC for 2010. In Belgium those limits were translated to emission limits for transport: 68 kton NO_x, 2 kton SO_2 and 35,6 kton VOC. For transport these limits are analogous to those mentioned in the European NEC (National Emission Ceilings) directive in preparation. In 2004 this directive foresees to amend the emission limits.

In this perspective, it is essential to inform policy makers about the possible policy options within transport to work out emission reduction strategies for CO_2 and tropospheric ozone.

Structure of the study

The aim of the project was to make a targeted study of existing and potential policy measures within transport, that fall in the framework of a sustainable mobility policy and contribute to reducing CO_2 and tropospheric ozone. Various policy options in the transport sector were investigated for their effectivity for reducing CO_2 and tropospheric ozone, and for their techno-economic and social feasibility. The outcome of this multidisciplinary study led to scientific well-founded policy recommendations. Figure 1 shows an overview of the different tasks within the study.

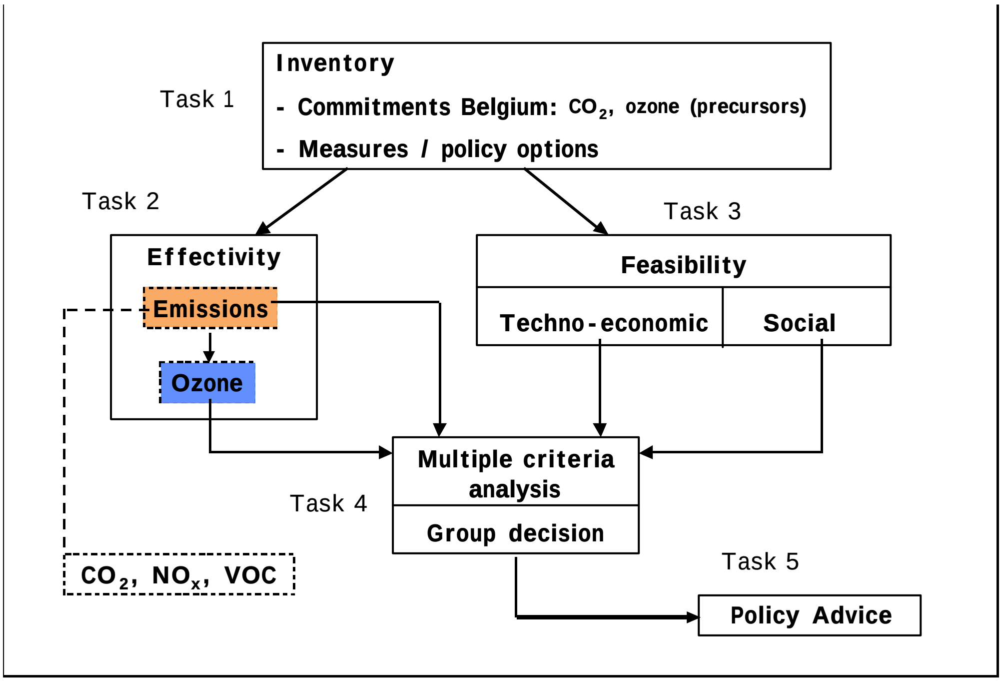

Figure 1: Global structure of the project.

In Task 1 an inventory of commitments and obligations made by Belgium in international context in relation to the CO_2 and ozone problem was compiled. Also the objectives for ozone precursors NO_x and VOC were integrated. Furthermore, an overview of measures for the transport sector to manage above-mentioned commitments was given. On the basis of this inventory of measures, 12 policy options were defined, see Table 1. It was decided to work on a higher abstraction level, policy options instead of measures, to keep the project feasible and to be able to formulate clear lines of force for mobility and environmental policy later on in the project.

In Task 2 the effectivity of the different policy options for reducing the emissions of CO_2-, NO_x- and VOC from traffic (road, railway, inland shipping) was evaluated. Next their effect on ozone concentrations in the atmosphere was assessed.

Table 1: Overview of the 12 policy options.

	Evaluated policy options
1	Advanced introduction of environmental-friendly conventional vehicles
2	Advanced introduction of environmental-friendly alternative vehicles
3	Enhanced replacement of old passenger cars
4	Conversion of vehicles to more environment friendly alternatives: retrofit
5	Introduction of electric vehicles
6	Enhanced inspection and maintenance
7	More environmental-friendly driving style
8	Reduce passenger car use through more car pooling and Tele-working
9	Reduce passenger car use through more public transport
10	Reduce passenger car use through more cycling and walking
11	Reduce road freight traffic through rail transport
12	Reduce road freight traffic through inland shipping

In Task 3 the techno-economic and social feasibility of the policy options were studied. In the economic part, assessments were made for the costs and benefits at national level of the different policy options. In the social part, the policy options were evaluated on their social desirability and political feasibility.

The results of Task 2 and 3 were the basis for the multiple criteria analysis (MCA) performed in Task 4. Within this MCA several decision-makers were involved, by means of the organisation of two consultation workshops. For each decision-maker the ranking of the policy options was determined. Subsequently, the individual ranking was processed to the 'best' group ranking. The eight criteria used within the evaluation and ranking of the policy options are given in Table 2. With cumulative emission reduction is meant the total emission reduction during the period 2001-2012.

Table 2: Overview of criteria used within the MCA-exercise.

N°	Criterion
1	Cumulative CO_2 (carbon dioxide) emission reduction
2	Cumulative NO_x (nitrogen oxides) emission reduction
3	Cumulative VOC (vol. org. comp.) emission reduction
4	AOT40* – vegetation
5	AOT60* – public health
6	Social (~ national) cost
7	Social desirability
8	Political feasibility

* AOT = Accumulated (ozone) exposure Over a Threshold of 40 or 60 ppb.

The policy recommendations formulated in Task 5 are based on the group ranking of the different policy options, as well as on the specific findings resulting from the individual disciplines. Also the feasibility of the policy options to fulfil international commitments concerning CO_2, NO_x and VOC was taken into account.

Results

Scientific evaluation-tools

In this study on one hand existing tools were adopted and on the other hand some additional tools were developed and made operational:

- TEMAT model: Transport Emission Model to Analyse (non-) Technological measures. With this model emission assessments for road transport can be made for non-technological as well as technological measures. This model was made operational for Belgium (previously only operational for the Flemish Region). Furthermore, input data were updated and refinements to the model were fitted;

- Ozon94 model: a simplified and fast model for policy support with regard to the ozone problematic. Assessments of the long-term effects of emission reductions on the ozone concentrations can be made. This model has been extended and made operational for Belgium;

- Ozone working tables: generally usable (also for the government) working tables were compiled for estimating the ozone effectivity (AOT40, AOT60 en NET60[1]) of measures and policy options;

- ARGUS-software: the software was adapted and made operational to comply with needs of the project. Analogous for the GDSS (Group Decision Support System) software, which was made operational to come from individual rankings to a group ranking.

The used methodology and available tools could be applied in future studies concerning sustainable evaluation of transport or of other sectors.

Ranking of the 12 policy options

Table 3 gives an overview of the values of the different criteria for the 12 policy options. Those values are the results of the activities within the different disciplines in the project.

Table 3: Values of the criteria for the different policy options.

Option	Crit 1: CO_2 [kton]	Crit 2: NO_x [kton]	Crit 3: VOC [kton]	Crit. 4: AOT40 [ppm*h]	Crit 5: AOT60 [ppm*h]	Crit 6: Nat. cost[1]	Crit 7: Social desirability [2]	Crit 8: Political feasibility [3]
1	1200	47,4	18,6	7,22	0,982	[]	+	[]
2	1060	36,2	13,9	7,23	0,985	--	+	[]
3	150	9,3	16,7	7,23	0,975	--	-	-
4	0	42,4	25,3	7,24	0,991	-	+	[]
5	800	~0	3,9	7,25	0,984	--	-	[]
6	0	39,6	39,3	7,19	0,962	--	+	[]
7	1620	18,7	4,7	7,25	0,984	[]	+	[]
8	10700	12,9	6,0	7,24	0,978	+	+	[]
9	9190	0,2	3,9	7,25	0,984	+ , --	++	+
10	3680	9,9	5,3	7,25	0,984	+	+	+
11	9470	16,9	7,5	7,24	0,982	[] , --	+	[]
12	8220	10,8	8,2	7,24	0,978	[] , --	+	[]

Legend of Table 3, see next page.

[1] NET60 = Number of Exceedances of Treshold of 60 ppb

Legend of Table 3:

[1] '--' stands for very expensive (> 500 million euro); '-'stands for expensive (> 50 million euro); '[]' stands for not expensive, moderate benefits; '+' stands for significant benefits.
Due to the big uncertainty on the capital outlay for rail transport and inland shipping, an assessment of the lowest and highest value has been integrated. A sensitivity analysis has been done to evaluate the effect of the capital outlay and the ranking of the policy options.

[2] '-' stands for moderate; '+' stands for high '++' stands for very high.

[3] '-' stands for unlikely; '[]' stands for probable; '+' stands for very probable.

Taking into account all eight criteria, the integrated evaluation of the policy options lead up to the following ranking:

☞ *Policy options which scored good:*
- Advanced introduction of environmental-friendly conventional vehicles;
- Enhanced inspection and maintenance;
- Reduce passenger car use through more car pooling and Tele-working.

☞ *Policy options which scored moderate to good:*
- Reduce passenger car use through more public transport;
- Reduce road freight traffic through rail transport;
- Reduce road freight traffic through inland shipping.

☞ *Policy options which scored very moderate to moderate:*
- Conversion of vehicles to more environmental friendly alternatives: retrofit
- More environmental-friendly driving style;
- Reduce passenger car use through more cycling and walking;
- Advanced introduction of environmental-friendly alternative vehicles.

☞ *The two worst scoring policy options, were:*
- Enhanced replacement of old passenger cars;
- Introduction of electric passenger cars in city traffic.

The low order in ranking for the option 'retrofit' can be explained by the fact that this option has no or only little influence on the CO_2 emissions. Note that the evaluation of the effectivity to reduce particulate matter fell outside the scope of this study. However particles seem to be the most important impact factor of traffic on public health [3]. So retrofitting of diesel vehicles may not be excluded.

Though an adapted driving style has a large emission reduction potential, the option 'More environmental-friendly driving style' scored very moderate. Changing people's behaviour is difficult. Furthermore, this measure was only calculated for passenger cars. An extension to the other vehicle categories should result in higher emission reductions. If one wants to change driving style, this should most probably happen indirectly by technological measures, such as in-car devices (speed-limiting device, cruise control, black boxes) and ISA (Intelligent Speed Adaptation). However, the cost of those technological solutions is higher than for a driving course.
Attention given to advice for adapted driving style could decrease, especially some years after the training.

The moderate score for the option ‘Reduce passenger car use through more cycling and walking’ could be explained by the small amount of passenger car kilometres that could be substituted (max. 5 %).

The ‘Enhanced replacement of old passenger cars’ is not an interesting policy option. This option works only during a short period. Also, the economic and social feasibility of this option appeared to be very low.

Furthermore, the study has learned that within a global policy (on international, federal and regional level) with respect to the reduction in CO_2 and ozone from transport, introduction of electric vehicles is not a suitable policy option within a time horizon of 2010 or 2012. To what extend electrical vehicles on local level could contribute to other specific objectives (reduction noise, emissions of particles,…) was not studied, so no statements are pronounced.

Checking against the Kyoto and Gothenburg Protocol

With regard to the emission prognoses, current understandings show that especially the emission of CO_2 and in a smaller extend the emission of NO_x are alarming.

Today’s technological amelioration and voluntary commitment of the automobile manufacturers with the European Commission, to lower the CO_2 emissions of new passenger cars, are not sufficient to decrease or even stagnate CO_2 emissions from transport. But the increase in CO_2 emissions is less sharp. The steady growth in mobility demand compensates all accomplished and future (up to 2005) technological developments.
The study shows that it will be very difficult to comply with the Kyoto Protocol. Far-reaching measures and technological improvements for reducing fuel consumption (~ CO_2-emission) are urged. To comply with the Kyoto Protocol other sectors in Belgium will have to contribute for more then 7,5 % in the reduction of greenhouse gases in the period 1990-2010.

To fulfil the Gothenburg Protocol for the transport sector, efforts mainly will have to be concentrated on NO_x-emissions. The NO_x levels for the different individual policy options lie close by the emission ceiling. Taking into account the different uncertainties during emission calculation and the fact that the ceiling will be amended in 2004, big efforts would still have to be made for reducing NO_x.

At first view VOC emissions from transport do not seem to be a problem. The national VOC objective, taken into account all sectors, will be difficult to comply with though, as well as the objectives for air quality in general. Additional measures within transport will be welcome.

Policy advices

The most efficient way to reduce the negative effects of traffic on the environment and public health is to move and travel less with motorised vehicles. In accordance with policy, measures to control mobility demand are of primordial importance. The disconnection between economical growth and mobility demand has to be pursued. Policy has to pay attention to measures stimulating tele-working, an option that scored well within the study. At the same time measures have to be worked out to minimise the fill up of avoided kilometres.

If one has to move anyway, then this has to be done in the most environmental-friendly way: even better in the most sustainable way. Shifts in transport modes have to be stimulated. According to the study it seems that substitution of passenger traffic through public transport is the most social feasible. Furthermore, also technological measures could be taken, such as the promotion of more environmental-friendly vehicles and the draw up of an adapted inspection and maintenance programme for vehicles.

Moreover our personal perception according to how we deal with and act in traffic, plays an important role in the whole traffic business and its consequences. Policy initiatives also have to be directed towards changes in behaviour of drivers (purchasing behaviour, driving style, use of luxury accessories).

Obviously large policy efforts are required to achieve more sustainable mobility. The different policy levels have to focus their efforts on a common target. Starting from an European policy receiving maximal support from the member states, efforts at federal, regional and local level have to be well-tuned on one an other and be co-ordinated. Furthermore, there is a need for a policy that integrates environmental interests and other sustainable aspects to the decision-making regarding transport and related policy. There must be aimed for an optimal tuning of policy towards environment, mobility, town and country planning and infrastructure planning.

References

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