Executive Summary

Aims and scope

The aims of the European Auto-Oil II Programme (AOPII) were to make an assessment of the future trends in emissions and air quality and establish a consistent framework within which different policy options to reduce emissions can be assessed using the principles of cost-effectiveness, sound science and transparency; and to provide a foundation (in terms of data and modelling tools) for the transition towards longer term air quality studies covering all emission sources.

The scope of AOPII included all the main "conventional" pollutants (effects on CO_2 emissions were also tracked); the period 1990-2020 but with the focus on introducing measures in 2005 which might help meet air quality objectives by 2010; the EU15 but with a focus on ten "auto-oil" cities and their nine host countries; air quality modelling at regional, urban and local scale; a detailed assessment of the full range of potential road transport measures, including "non-technical" measures; comparison with other sources than road transport; and an evaluation of the benefits of reducing emissions.

The programme ran from spring 1997 to early 2000 and is reported in a series of working group and consultants reports and this overview report from the services of the European Commission. Further detail is available from the Commission's and related web sites. The Commission's services grateful acknowledge the considerable contributions from the many stakeholders and other experts who have participated and assisted throughout the programme.

A draft of this report and a set of preliminary draft conclusions was presented to the stakeholder contact group on 26 November 1999; conclusions from the integrated assessment modelling were also discussed at the last Working Group 7 meeting in May 2000. Their comments and suggestions are reflected as far as possible in the final version.

Approach

The approach in AOPII broadly followed that of the first programme, i.e. to identify environmental objectives for air quality; forecast future emissions and air quality; establish emission reduction targets (or appropriate functional relationships); collect input data on costs and effects of potential measures to reduce emissions; and carry out a cost-effectiveness assessment as a basis for a future air quality strategy.

There were, however, several important differences between the two programmes. First, the participation in AOPII working groups was extended to all interested stakeholders including Member States and non-governmental organisations and, through the contact group and other briefings, the European Parliament. Second, more extensive work was carried out on the emissions base case and the air quality modelling, including the use of reactive and street canyon models and an empirical assessment of future air quality in most large European cities. Third, the development of the TREMOVE model enabled the analysis of technical and market-based solutions in the transport sector on an equal footing.

On the other hand, the agreement reached in 1998 by the Council and Parliament on the "auto-oil I" directives meant that the range of remaining potential measures on the "technical" side (notably emission standards for cars and heavy duty vehicles and several of the fuel quality parameters) narrowed the scope of the programme.

Management of the programme was carried out by an ad hoc inter-service group which reported progress to the contact group of all stakeholders. Responsibility for carrying out the various activities was delegated to seven working groups, each chaired by a Commission service but with wide participation from stakeholders and other experts.

Environmental objectives

Air quality objectives in AOPII were derived mainly from recently proposed or adopted "daughter" directives which set limit or target values for air quality to be achieved in 2005 or 2010.

In addition, the Commission's proposed national emission ceilings for nitrogen oxides and volatile organic compounds were taken as emission reduction targets for "regional" ozone.

Some stakeholders considered a number of non-regulated pollutants also to be of importance, including $PM_{2.5}$, 1,3 butadiene and polycyclic aromatic hydrocarbons. For all these pollutants there was insufficient data to enable detailed air quality modelling to take place. Nonetheless, a brief assessment of their significance is discussed in the air quality report.

CO_2 was not treated as a policy driver in the analysis but it was generally recognised that it was important to look for any potential synergies in the assessment of both technical and non-technical measures.

The AOPII base case

The overall AOPII base case, essentially a "business-as-usual" scenario, covered the EU15 and the period 1990-2020, six conventional pollutants plus CO_2 and all emission sources.

It predicted significant reductions in emissions of all the conventional pollutants over the period, typically between approximately 40 and 50 per cent. The reductions were expected to occur predominantly in the combustion in energy and road transport sectors.

Within the overall base case, a more detailed base case for road transport was developed covering the nine Member States containing the ten auto-oil cities. This base case included historic and projected data for transport demand, activity levels and transport system costs in order to be able to model the effects of potential policy measures on demand, modal choice etc.

The road transport base case incorporated the estimated effects of the "auto-oil I" legislation as well as the voluntary agreement on CO_2 emissions reached with the car industries. It projected that in broad terms, emissions from road transport would fall by 70-80%

between 1995 and 2010 and indeed fall further beyond that as new EURO IV technologies continued to penetrate the market from 2005 onwards. Road transport emissions were expected to take a diminishing share of total EU and national emissions.

In the absence of the “auto-oil I” measures, road transport emissions would have been 50-100% higher by 2010 and, with continued traffic growth, would have begun to increase again by that point.

The projections suggested that, as far as the objectives for air quality were concerned (but not necessarily all other objectives), it is possible to break the link between economic growth and environmental damage from transport and other sources. Improvements in technology above all else appeared to be capable of staying ahead of the effects of traffic growth.

Similar reductions could not be expected for CO_2 emissions from road transport, which were expected to be 10-15% higher in 2010 than in 1995.

Air quality

Though a key pollutant for future air quality policy, regional ozone was not modelled in detail in AOPII since the parallel ozone strategy already provided a full evaluation of predicted ozone levels in 2010 and the Commission had already proposed a set of national emission ceilings to be met by that date.

The principal focus of the air quality modelling in AOPII was therefore on urban air quality in the ten AOPII cities (Athens, Berlin, Cologne, Dublin, Helsinki, London, Lyons, Madrid, Milan (including Reggio D’ell Emilia), and Utrecht) led by the Joint Research Centre of the Commission. The modelling provided results for benzene, carbon monoxide, nitrogen dioxide and particulate matter in eight cities. The modelling of PM_{10} was subject to a variety of important uncertainties including the emission inventories, concentration measurements, and modelling of secondary as well as primary particulate matter.

In order to have an idea of the effects of the predicted emission reductions on air quality at the very local scale, street canyon modelling was carried out for Berlin and Milan.

The results of the modelling of air quality in 2010 suggested that of the targeted pollutants, neither carbon monoxide nor benzene would pose challenges in any of the AOPII cities. Exceedences of the objective for nitrogen dioxide were predicted only for two cities. Exceedences of the PM_{10} objective would be more widespread, affecting possibly half of the cities.

These conclusions were broadly supported by the generalised empirical approach applied by the European Environment Agency to a large sample of European cities.

Further scenario analysis by the JRC demonstrated that road transport would still have a major influence on urban air quality in those cases where exceedences were predicted. Another major obstacle to improving air quality was, however, the local climatic conditions which could impair the effectiveness of emission reductions for the reactive pollutants.

In relation to the objectives set in AOPII, therefore, the remaining air quality challenges would appear to be:

- Meeting the PM_{10} objectives for 2010 in around half of the AOPII cities;
- Tackling remaining but rather limited exceedences of the NO_2 objectives.
- Closing the gap between the AOPII base case emissions projections and the proposed national emission ceilings for ozone precursor emissions of NOx and VOCs;

In terms of urban pollution problems, continued widespread exceedences of the PM_{10} objective would suggest the need for action at the European as well as national/local scales in order to bring down concentrations; in contrast, it would seem likely that city-based or even more targeted measures to tackle remaining NO_2 problems could be sufficient; exceedences of the benzene objective at background levels would appear to be very slight and may be eliminated as a side-effect of measures to meet other problems.

Potential measures to reduce emissions

The scope of the assessment of measures aimed at improving vehicle technology in particular was limited as a result of the agreement on the "auto-oil I" directives and the setting of most emission limit values for 2005. The successful agreement also meant that much further progress towards meeting the air quality objectives had been achieved than was originally anticipated. This also served to change the nature and extent of the remaining air quality gaps.

Data on the costs and effects of measures in the road transport sector was collected through a number of studies, questionnaires, and literature surveys. Some measures could be considered to be applicable at the European scale; others were more likely to be applied at national or city level. In order to make them comparable, data on all the measures was fed into the TREMOVE model, which was developed to support the AOP-II cost-effectiveness analysis.

Input scenarios were developed for the following:

- Tighter emission standards for motorcycles;
- Promotion of enhanced environmentally friendly (EEV) passenger cars;
- Changes in fuel specifications for gasoline and diesel (though not for sulphur or aromatics in gasoline which had already been fixed for 2005);
- Promotion of alternative fuels in captive fleets;
- Promotion of a city fuel to reduce PM emissions;
- More sophisticated dynamometer testing of catalyst-equipped cars for inspection and maintenance;
- Local measures, including parking charges, differentiated road pricing, improved infrastructure, public transport priority, improved logistics for freight;

- National scrappage schemes;
- Fiscal instruments, including fuel duty increases or replacement of registration or circulation taxes with fuel duty increases.

Integrated assessment of measures

The TREMOVE model provided a consistent framework for the comparison of measures in the transport sector. Outputs from TREMOVE included not only the impact on emissions and costs but also the size and composition of the vehicle stock and vehicle usage. Impacts on changing costs could also be decomposed between transport users, transport producers and Government.

TREMOVE could be used to analyse scenarios with or without the use of optimisation tools. However, the limited number of emission reduction targets and transport scenarios tended to mean that less use of the optimisation model (LEUVEN-II) was required than originally anticipated. In the case of some remaining air quality problems (notably nitrogen dioxide in Athens and PM generally) it was unlikely that sufficient measures could be identified to close the air quality gap.

The structure of the TREMOVE model and the base cases (covering the auto-oil cities and countries) also meant that the potential of measures could be evaluated at all political scales, from European down to the urban scale (though not street canyons).

Among the scenarios studied there were few remaining measures in the road transport sector which could on their own have a major impact on emissions.

Nonetheless, technical measures could still be justified in view of the ~~very~~ low costs per kilometre or litre associated with them.. In particular, the analysis tended to support the application of more stringent standards for motorcycles not least because they are some way behind those applied to other vehicles .

The broadly based fiscal measures studied, including moderate changes in fuel duty rates, were not expected to have much impact on overall transport demand due to its relative inelasticity. On the other hand, the modelling assumptions used led to a predicted large net societal benefit on the assumption that increased revenue will be used to reduce more distorting forms of taxation. In all cases, results of broad based tax increase scenarios can differ significantly across countries as important differences exist between the general tax structure and levels of countries. Considerable analytical work would be needed to design budget-neutral fiscal packages.

Limited work carried out to date suggests that differentiated fiscal instruments can be more effective in reducing emissions by influencing consumer choice on type of fuel or vehicle.

Locally targeted measures could provide highly cost-effective solutions to a number of remaining air quality problems. These measures can often target the cost per kilometre for certain modes significantly and therefore effectively influence modal choices. Promising individual measures included the application of parking charges and differentiated road pricing. Generally, when local measures are aimed at shifting passenger transport to public transport they often generate "negative costs" (i.e. benefits) to society provided that sufficient alternative transport modes are available. These benefits are mainly a function of travel time, which remains more or less constant for those shifting (away from highly congested roads) to faster metro or bus systems and significantly improves for those remaining on the road (in particular freight transport). Impacts on emissions depend on how much additional traffic is attracted to the roads and the environmental performance of public transport that is operating at higher capacities. When demand for public transport increases such that additional vehicles are required, complementary technical vehicle and/or fuel measures are imperative in order to avoid that overall emissions going up rather than down due to the higher emission factors of city buses (e.g. PM).

Scrappage schemes introduced in the short-term and focussing for example on pre-catalyst vehicles could bring benefits in the period before 2010 but trade-offs may exist with climate change objectives**.** In the long-term, however, they offer little attraction as the pre-catalyst vehicles will soon disappear from the fleets and the newer catalyst vehicles are becoming more durable. Well-designed scrappage schemes targeting "gross polluters" (e.g. remaining pre-catalyst vehicles or malfunctioning catalyst vehicles) are potentially very cost-effective, in particular when combined with enhanced inspection & maintenance (I&M) schemes.

The gradual phasing out of pre-catalyst and the early generation of catalyst means that increased testing only has advantages in the near future. On the other hand, the current trend in I&M regulation to focus in particular on gross polluters (see also above) is likely to be very cost-effective and warrants the introduction of more sophisticated dynamometer testing.

Relatively few fuel and vehicle options were analysed that offered much potential to reduce PM and NOx emissions, although the diesel fuel packages studied have the potential to achieve modest reductions of PM. A number of promising new after-treatment systems are also appearing such as the deNOx catalysts and the so-called PM-traps. However, considering the stringent vehicle emission limit values imposed by the AOP-I directives by 2005 in combination with the commitment of the car manufacturers to significantly improve the fuel efficiency of new cars as contained in the so called ACEA agreement, it is likely that these technologies will be implemented even in the absence of additional regulation, although it is not clear to what extent.

Local retrofit schemes could provide cost-effective alternatives for combating local air quality problems. Further work is needed to estimate the cost of such solutions and to see to what extent the introduction of these technologies could be promoted through, for example, fiscal incentive or local retrofit schemes in particular in an urban context. Similarly, the introduction of alternative fuels in certain polluted areas could potentially provide a cost-effective solution for achieving air quality standards in the remaining problem areas.

None of the scenarios investigated had a significant benefit for CO_2, although information on the effects of some technologies on the fuel consumption was often lacking. Whilst it should be emphasised that none of the scenarios was specifically designed with this objective, the difficulty in reducing overall transport demand is nonetheless noteworthy. As with the conventional emissions the biggest reductions in CO_2 might still need to be found through technical innovation, improved efficiency and the development of renewable fuels. The AOPII analysis would, however, argue at least for the potential to reduce traffic and encourage modal shifts in those urban areas where viable alternatives exist and to invest in alternatives where it is currently lacking.