# Service contract for "ex-post" evaluation of short-term and local measures in the CAFE context

A report produced for European Commission, DG Environment

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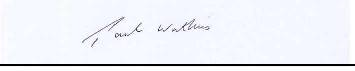
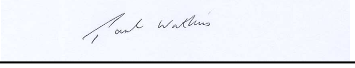
| **Reviewed by** | Paul Watkiss |  | 22/1/05 |
| **Approved by** | Paul Watkiss |  | 22/1/05 |

# Executive Summary


This report presents the findings of the service contract on *"Ex-post" evaluation of short-term and local measures in the CAFE context (DG Environment reference B4-3040/2003/366045/MAR/C1).*

The study is focused on measures to address short-term pollution peaks i.e. very high peak concentrations for short periods of time (such as during pollution episodes), and also measures to address local (permanent) air quality hot-spots. As far as possible the study evaluates these measures 'ex post', i.e. after their introduction, to consider the effectiveness of measures, their costs and benefits, and what this might mean for future policy.

The study has established a database of local or short-term emission reduction measures, by surveying completed or planned measures implemented by municipalities or regional authorities across Europe. This information has been reviewed and analysed to examine the potential for short-term or local measures. The study has then selected five schemes, which look of particular interest, and undertaken a more detailed analysis of their costs and benefits. Finally, the study has brought this information together to provide policy recommendations on the potential role of short-term and local measures for the thematic strategy.

***The database***

The study has collated information on short-term and local measures that address air pollution peaks and permanent hot-spots. Following an initial survey, more detailed survey work was undertaken to obtain data on measures.

The database has been built within an Access framework to provide a resource for future studies that is searchable and accessible from the internet. The data can be browsed easily and has a variety of search functions that will allow users to undertake searches of the following themes, 1) a pollutant-based search, 2) a geography-based search and 3) a measure-based search.

The database includes information on 91 different measures, from 22 different countries worldwide (mainly representative of urban areas), that have been used to address pollution peaks or hot spots. It covers a wide range of technical and non-technical measures, across most human activity sectors. An analysis has been made of the data. Key findings are that:

- 76% of the information received represents permanent local measures while only 24% represents short-term measures. To some extent this reflects the lower potential for short-term actions to significantly influence pollution peaks in many locations (because pollution peaks are often the result of regional pollution episodes).

- 76% of the measures focus on controlling road transport-based emissions. 18% of the responses focus on stationary sources. This demonstrates the extent to which road transport is generally the dominant source and sector to be controlled in the modern urban context. Site-specific issues determine whether other sectors such as domestic combustion of solid fuels are also significant contributors.

- $NO_2$, $O_3$ and $PM_{10}$ account for 64% of all of the pollution issues reported. For half of all reported issues the problem is experienced year-round, while the share of winter and summer episodic problems are 26% and 29% respectively. European respondents highlight that problems with these pollutants may result in exceedences of the air quality framework and daughter directives limit values in their location. In many cases they also highlight the inability for locally implemented measures on their own to achieve compliance with short and long term limit values.

- In 12% of cases, the pollution issue only affects a few streets of houses while in 28% of cases the whole authority area suffers from the problem. Other cases experience problems somewhere between these extremes. Where the geographical scale of the issue is greater than a few streets the effectiveness of single hot-spot -specific measures is diminished and much more stringent and widespread implementation of measures may be necessary.

- Most respondents and other data sources were unable to provide good quantitative data on the effectiveness and costs of the measures. This presents difficulties in evaluating local short term or permanent measures in comparison against those implemented at national or international scales.

The final point is one of the more important conclusions from the study, and leads to one of the main research recommendations. It is extremely difficult to find reliable and consistent data on the ex post costs, and the ex post benefits (particularly in relation to emissions and air quality), of local measures. Moreover, where data does exist, it is not disaggregated sufficiently, and does not account for the baseline conditions i.e. with a counter-factual analysis to separate out the effect from the measure from other policies or changes. Further work is needed to investigate the full costs and benefits, and the role toward meeting EU limit values, for such measures. We highlight the creation of the database in this study as an important starting point, but recommend that further effort is needed to maintain and improve the database, and more emphasis given on the consistent collection of ex post data on schemes across Europe. Member State compliance with duties to report results of "plans and programmes" under the air quality framework directive and daughter directives would be an important contributor to this. This will beneficial to improve the understanding of which measures are successful and their potential transferability.

***Case Studies***

The study has undertaken more detailed analysis on a number of major projects that have successfully managed short term or hot spot pollution problems. There is some evidence from the information collated for the database that local schemes that are directed at emissions improvements, such as low emission zones, motorway flow management, fuel bans, lead to the biggest emissions improvements, and have the largest air quality and health benefits, rather than broader transport or planning measures. The case studies were:

- Controlled access by congestion charge – example: Sweden and London

- Control access by designated low emission zone – example: London

- Controlled traffic flow by speed cameras – example: Rotterdam

- Short-term incentive to switch travel modes – example: Strasbourg
- Area ban on marketing and sale of a category of solid fuel used in the domestic sector – example: Dublin.

The study has reviewed the emissions and air quality benefits of these schemes, including where possible their potential towards meeting local air quality limit values.  It has also considered the wider benefits of these schemes, both environmental, and from wider sustainability objectives. These are particularly important given the urban focus of these schemes.  The analysis has also monetised the air quality benefits of scheme.  Finally the study has assessed the costs of the measures, and compared these to the benefits.

The case studies show that all five measures have been successful in reducing emissions, and in some cases have made significant progress towards meeting the EU limit values.  The overall conclusion is that these schemes are considered cost-effective for improving air quality in relation to air quality limit values.  When the benefits of the schemes are evaluated, using the methodology from the CAFE CBA project, they all have positive benefit to cost ratios that are similar to or better than for the introduction of Europe-wide air quality policies.  This provides some initial support for these measures as an alternative to further European based legislation, both in relation to helping to address urban hot spots, and for achieving population weighted pollution reductions (and health benefits).  However, the case study analyses also show that these local measures are often insufficient to meet the EU limit values on their own: they therefore complement further European wide air quality policy, rather than replacing it.

***Discussion in relation to the Thematic Strategy on Air Pollution***

A number of conclusions have been drawn together from the study.  These are summarised below.

Firstly, specifically targeted local measures do appear effective in terms of local emissions reductions, air quality improvement and progress towards legally binding air quality limit values, particularly when these schemes tend to be targeted at air quality hot spots.  They also have good benefit to cost ratios, which are similar to or better than for the introduction of European level air quality policies.  This provides some initial support for these measures as a complement to further European based legislation.

Secondly, and extremely importantly, the effectiveness of all local measures is very site-specific. It is not possible to simply transfer schemes between locations without consideration of local conditions. Location-specific characteristics of the following key factors determine this effectiveness: background pollutant levels, pollutant formation and transport mechanisms, cultural and economic factors influencing the scale and frequency of emissions from various sectors, legal and informational limitations on the ability of responsible authorities to act.

Thirdly, the most effective schemes from the information gathered, in reducing emissions and reducing air quality hot spots appear to be those schemes directly focused on air quality improvements.  This includes measures such as low emission zones, motorway flow management, smoky fuel bans, etc in urban areas.  Many traditional local transport schemes appear less effective in achieving emissions or air quality improvements, though this is not surprising when these schemes are aimed at other problems (e.g. congestion). However, these latter schemes have other benefits (e.g. travel time benefits, reduced accidents, etc) that are often their primary objective. We recommend that further consideration is needed on achieving the right balance at local level between actions that concentrate on local measures aimed at improving local air quality, and/or those that give the greatest benefits consistent with improving the urban environment more generally (i.e. towards overall urban sustainability that improves congestion, accidents, noise, air quality, etc). The inter-relationship between these aspects is also highlighted as a research priority, and we identify the potential links between CAFE and the Urban Thematic Strategy in this area.

The study has also found there are limitations to the role of local measures. In some cases, the information collated showed modest improvements in air quality. There remains the problem of encouraging people to change behaviour voluntarily–for example to more efficient travel modes during peak episodes. Further work is required at the local level to determine how effective realistic short-term measures can be in reducing ozone peaks – it is anticipated that locations where these measures would have most effects would be concentrated towards the Southern member states. Plans for reducing ozone will need to be effective over much wider regions and to include better forecasting of peak episodes (hence operating for longer periods before peaks occur) to be more effective.

We also have found that the improvements in air quality from many transport-based measures will decline in future years, as the road traffic fleet becomes cleaner (even accounting for traffic growth). This means that the same measure will have less effect if introduced in 2007 than if introduced in 2000. The ranking of measures will also change over time, depending on the scheme type, and whether it affects certain vehicles in the fleet, or modal shift more generally.

Finally, the study has considered how these measures could play a role within the thematic strategy and future air quality. There is no evidence to suggest that the current EU legal framework for air quality is inadequate. However, the following issues are raised.

- There might be benefits in encouraging local measures by enforcing obligations for Member States to contribute more information to an experience database (such as the CAFEAIR database developed for this project) via their 'plans and programmes'. This would achieve strategy aims such as improving and sharing knowledge, simplifying (or unifying) reporting requirements, and improving transparency. The Commission might facilitate this process with enhanced specific guidance notes on best practise implementation of measures. However, it is difficult to see how the Commission could directly recommend specific short-term or local measures within existing legislation. Indeed, we do not believe this would be appropriate or effective, due to the site-specific nature of all urban areas, and the need to consider and implement policy responses that address local conditions.

- Obligatory and economic measures were found to be more effective than voluntary measures at controlling activity particularly in the road transport sector. Regulatory and economic instruments send clearer signals to stakeholders, although care has to be taken to ensure price signals are maintained at sufficient levels to achieve the policy aims. We find that additional European scale measures (such as lower emissions ceilings) are likely to be needed to contribute to improving the effectiveness of local measures for dealing with residual exceedences of the limit values.

- The site-specific local hot-spot issues that we find suggest that management of these problems could be effective if devolved to local authorities. However, such authorities would require access to significant levels of expertise, resources and regulatory powers to undertake this role more effectively.

- We reiterate that broad assumptions regarding the transferability of local or short term measures across Europe are dangerous but that continued reporting of progress under plans and programmes will tend to increase the understanding of where similar pollution profiles are observed and may improve knowledge on the transferability of measures.

- Apart from continued effort to improve the knowledge base of 'ex post' cost-effectiveness data, we believe it would be extremely useful to undertake a series of modelling studies in a number of major European cities, looking at the site-specific impacts of different short-term and local measures. . This would allow some consideration of the transferability of measures between locations. We also believe there may be some (limited) potential to use the European wide models to investigate sets of measures across Europe, to investigate how local measures can contribute to EU air quality policy.

# Rapport de synthèse

Le présent rapport communique les résultats du contrat de service sur *l'évaluation "ex-post" des mesures locales et à court terme dans le contexte CAFE (DG Environnement référence B4-3040/2003/366045/MAR/C1).*

L'étude se concentre sur les mesures permettant de traiter les pics de pollution à court terme, à savoir des concentrations très élevées pendant de courtes périodes (comme durant les épisodes de pollution), ainsi que sur les mesures qui visent les sources de pollution ponctuelle locales (permanentes) de la qualité de l'air ; l'étude évalue autant que possible ces mesures "ex post", c'est-à-dire après leur mise en place, afin d'examiner leur efficacité, leurs coûts et avantages, et leur impact sur les futurs plans d'actions.

Cette étude a établi une base de données de mesures de réduction des émissions locales ou à court terme après avoir réalisé une enquête sur les mesures mises en oeuvre ou planifiées par les municipalités ou les administrations régionales dans toute l'Europe. Ces informations ont été examinées et analysées dans le but de déterminer le potentiel présenté par les mesures locales ou à court terme. L'étude a ensuite sélectionné cinq programmes qui semblaient présenter un intérêt particulier, et a réalisé une analyse plus approfondie de leurs coûts et avantages. Pour terminer, après avoir regroupé ces informations, l'étude a permis d'émettre des recommandations stratégiques sur le rôle potentiel des mesures locales et à court terme au regard des thématiques.

***Base de données***

L'étude a compilé des informations sur les mesures locales et à court terme qui s'attaquent aux pics de pollution atmosphérique et aux sources permanentes de pollution ponctuelle. Faisant suite à une première enquête, des travaux d'enquête supplémentaires ont été réalisés afin d'obtenir des données sur les mesures.

La base de données a été développée au sein d'une architecture Access pour servir de ressource aux études suivantes qui soit consultable et accessible par Internet. Les données sont faciles à trouver, et différentes fonctions de recherche permettent aux utilisateurs de faire des recherches sur les thèmes suivants : 1) recherche par polluant, 2) recherche par lieu, et 3) recherche par mesure.

La base de données contient des informations sur 91 mesures provenant de 22 pays différents au niveau mondial (représentant essentiellement les milieux urbains), conçues pour traiter les pics de pollution ou les sources de pollution ponctuelle. Elle englobe une grande variété de solutions techniques et non techniques couvrant la plupart des secteurs d'activité humaine. L'analyse réalisée sur les données a fourni les résultats suivants :

- 76 % des informations reçues ont trait à des mesures locales permanentes, tandis que 24 % seulement se rapportent à des mesures à court terme. Jusqu'à un certain point, cet état reflète le potentiel relativement faible renfermé par les actions à court terme pour influencer de manière significative les pics de pollution sur de nombreux lieux (les pics de pollution résultant souvent d'épisodes polluants régionaux).

- 76 % des mesures se concentrent sur le contrôle des émissions issues du transport routier. 18 % des réponses se focalisent sur des sources stationnaires, ce qui montre jusqu'à quel point le trafic routier est généralement une source et un secteur importants à contrôler dans l'environnement urbain moderne. Les problèmes spécifiques liés aux sites déterminent si d'autres secteurs, tels que l'utilisation de combustible solide domestique, contribuent également à la pollution de manière significative.

- Le $NO_2$, l'$O_3$ et les $PM_{10}$ constituent 64 % de l'ensemble des problèmes de pollution relevés. La moitié d'entre eux sont présents toute l'année, tandis que la proportion de problèmes épisodiques hivernaux et estivaux représentent respectivement 26 % et 29 %. Les Européens interrogés soulignent le fait que les problèmes posés par ces polluants peuvent entraîner sur leur site le dépassement des valeurs limites stipulées dans la réglementation cadre sur la qualité de l'air et dans ses directives annexes. Dans de nombreux cas, ils font également remarquer que les mesures qu'ils ont mises en place localement de leur propre initiative ne peuvent pas respecter les valeurs limites de court terme et de long terme.

- Dans 12 % des cas, le problème de pollution ne touche que quelques rues, alors que dans 28 %, l'ensemble du périmètre administratif souffre du problème. D'autres collectivités se situent entre ces deux extrêmes. Lorsque l'étendue géographique de la pollution dépasse un petit groupe de rues, l'efficacité des mesures spécifiques à une source de pollution ponctuelle diminue, obligeant ainsi à mettre en œuvre des mesures d'une manière beaucoup plus rigoureuse et étendue.

- La plupart des personnes interrogées et autres sources d'informations n'ont pas pu fournir de bonnes données quantitatives sur l'efficacité et les coûts des mesures. Ce fait complique l'évaluation des mesures locales, permanentes ou à court terme, ainsi que leur comparaison avec celles instituées au niveau national ou international.

Le dernier point constitue l'une des conclusions les plus importantes de l'étude, dont découle l'une des premières recommandation de recherche. Il est extrêmement difficile de trouver des données fiables et cohérentes sur les coûts et avantages ex post (notamment dans le cadre des émissions et de la qualité de l'air) des mesures locales. De plus, même si des données existent, ces dernières ne sont pas suffisamment ventilées, et elles ne rendent pas compte des conditions premières, par exemple au moyen d'une analyse factuelle qui différencierait les effets dûs à une mesure, de ceux résultant d'autres plans d'actions ou changements. Des travaux supplémentaires sont nécessaires pour étudier l'intégralité des coûts et avantages, ainsi que le rôle joué par ces mesures pour arriver à satisfaire les valeurs limites de l'UE. Dans cette étude, nous soulignons que la création de la base de données constitue un point de départ important, mais nous préconisons de poursuivre les efforts pour mettre à jour et améliorer cette base, et d'accorder une plus grande place à la collecte cohérente des données ex post issues des différents programmes européens. Cette tâche s'en trouverait grandement facilitée si les Etats membres se conformaient à leur obligation de communiquer les résultats des "plans et programmes" au titre de la directive cadre et de ses directives associées sur la qualité de l'air. Il serait ainsi plus facile de repérer quelles mesures sont performantes, ainsi que leur potentiel de transférabilité.

***Etudes de cas***

L'étude a analysé de manière approfondie un certain nombre de projets importants qui ont réussi à traiter des questions de pollution à long terme et des sources de pollution ponctuelle. L'information compilée pour la base de données semble démontrer que les programmes locaux orientés sur l'amélioration des émissions, comme des zones de faibles émissions, la gestion du trafic autoroutier, l'interdiction de certains combustibles, sont les plus performants dans la réduction des émissions et offrent les meilleurs avantages en matière de qualité de l'air et de santé, contrairement aux mesures plus étendues de transport ou d'urbanisme. Les études de cas ont traité :

- L'accès contrôlé par péage urbain – exemple : la Suède et Londres
- L'accès contrôlé par des zones désignées à faibles émissions – exemple : Londres
- Circulation contrôlée par des radars – exemple : Rotterdam
- Incitations à court terme à changer de mode de déplacement – exemple : Strasbourg
- Interdiction dans certaines aires de promouvoir et vendre une catégorie de combustible solide destiné au secteur domestique – exemple : Dublin.

L'étude a examiné les avantages offerts pas ces programmes en matière d'émissions et de qualité de l'air, incluant dans la mesure du possible leur potentiel à satisfaire les valeurs limites locales relatives à la qualité de l'air. En outre, elle a pris en compte les bénéfices plus généraux de ces programmes, du point de vue de l'environnement et des objectifs plus vastes de gestion durable. Ces derniers revêtent une importance toute particulière, vu la focalisation de ces programmes sur les aires urbaines. Par ailleurs, l'analyse a chiffré les avantages apportés par les programmes en matière de qualité de l'air. Pour terminer, l'étude a évalué les coûts des mesures, pour les comparer ensuite aux avantages.

Les études de cas démontrent que les cinq mesures ont réussi à réduire les émissions, et dans certains cas, ont permis de se rapprocher de manière significative des valeurs limites de l'UE. Nous pouvons conclure globalement que ces programmes sont estimés être financièrement valables dans l'amélioration de la qualité de l'air par rapport aux valeurs limites y afférent. L'évaluation des programmes à l'aide de la méthodologie du projet CBA CAFE montre que leur rapport avantage-coût est toujours positif ; ces rapports sont similaires ou meilleurs que ceux des plans d'action visant la qualité de l'air à l'échelle européenne. Ces résultats justifient de soutenir initialement ces mesures, qui peuvent alors servir d'alternatives à une autre législation européenne, à la fois pour contribuer à traiter les sources urbaines de pollution ponctuelle et pour réduire la pollution pondérée par le nombre d'habitants (et pour apporter des avantages sanitaires). Toutefois, les analyses des études de cas montrent également que ces mesures locales ne suffisent souvent pas par elles-mêmes à satisfaire les valeurs limites de l'UE : en conséquence, elles complètent, plutôt qu'elles ne les remplacent, d'autres plans d'action d'envergure européenne sur la qualité de l'air.

***Débat relatif à la Stratégie thématique sur la pollution atmosphérique***

L'étude a établi un certain nombre de conclusions résumées ci-dessous.

En premier lieu, des mesures locales ciblées semblent véritablement efficaces en terme de réduction des émissions locales, d'amélioration de la qualité de l'air, et de progression vers les valeurs limites juridiquement contraignantes sur la qualité de l'air, notamment lorsque ces programmes tendent à viser les sources de pollution ponctuelle de qualité de l'air. Par ailleurs, elles présentent de bons rapports avantages-coûts qui sont similaires ou meilleurs que ceux des plans d'action visant la qualité de l'air à l'échelle européenne. Ces résultats justifient de soutenir initialement ces mesures, qui peuvent alors servir d'alternatives à une autre législation européenne.

La seconde réflexion mène à un point extrêmement important, à savoir que l'efficacité de toutes les mesures locales est très liée au site. Il est impossible de transférer simplement des programmes d'un site à l'autre en faisant abstraction des conditions locales. Les caractéristiques liées aux sites des facteurs cruciaux suivants déterminent cette efficacité : niveaux de la pollution de fond, formation des polluants et mécanismes de transport, facteurs culturels et économiques influençant l'envergure et la fréquence des émissions dans divers secteurs, limites juridiques et informationnelles définissant le champ d'action des organismes responsables.

En troisième lieu, selon les informations collectées, les programmes les plus efficaces relatifs à la réduction des émissions et aux sources de pollution ponctuelle de qualité de l'air semblent être ceux directement concernés par l'amélioration de la qualité de l'air. Ils comprennent des mesures comme les zones à faibles émissions, la gestion du trafic autoroutier, l'interdiction des combustibles à fort dégagement de fumée, etc. dans les aires urbaines. De nombreux programmes de transport locaux traditionnels semblent être moins efficaces au regard de l'amélioration des émissions ou de la qualité de l'air, ce qui n'est pas surprenant lorsque ces programmes ciblent d'autres problèmes (par exemple les engorgements de trafic). Ils présentent cependant d'autres avantages (comme des temps de transport plus courts, une baisse du nombre des accidents, etc.) qui constituent souvent leur principal objectif. Nous préconisons d'étudier plus avant les moyens d'arriver localement à un juste équilibre entre les actions dédiées aux mesures locales visant à améliorer la qualité de l'air locale et celles qui obtiennent les meilleurs résultats dans l'amélioration de l'environnement urbain d'une manière générale (en se focalisant par exemple sur un développement urbain durable qui réduit les engorgements de circulation, les accidents, les nuisances sonores, qui améliore la qualité de l'air, etc.). Les relations entre ces différents facteurs sont également mises en évidence comme sujet de recherche prioritaire, et nous identifions les liens potentiels entre le CAFE et la Stratégie thématique urbaine dans ce domaine.

L'étude a également révélé qu'il y avait des limites au rôle joué par les mesures locales. Dans certains cas, les informations collectées ont montré une amélioration modeste de la qualité de l'air. Et il reste le problème qui consiste à encourager les gens à changer volontairement de comportement - par exemple en adoptant des moyens de transport plus efficaces durant les pics de pollution. Au niveau local, il est nécessaire de poursuivre les efforts pour déterminer le degré d'efficacité de mesures à court terme réalistes sur la réduction des pics d'ozone ; nous anticipons que les localités où ces mesures seraient les plus efficaces se concentrent dans les Etats membres du sud. Pour une efficacité accrue, les plans de réduction de l'ozone devront couvrir des régions beaucoup plus vastes et intégrer de meilleures prévisions des pics (ils devront alors être en service pendant de plus longues périodes avant l'apparition des pics).

Nous avons également constaté que les améliorations de la qualité de l'air apportées par de nombreuses mesures orientées sur le transport vont régresser dans les années à venir, à mesure que la flotte de véhicules routiers va devenir plus propre (même en tenant compte de la hausse du trafic). Ce qui signifie que la même mesure sera moins efficace si elle est mise en place en 2007 plutôt qu'en 2000. La classification des mesures changera aussi avec le temps, en fonction du type de programme, et selon que le programme affecte certains véhicules de la flotte, ou de manière plus générale prévoie de changer de mode de transport.

Pour finir, l'étude a examiné comment ces mesures pouvaient jouer un rôle au sein de la stratégie thématique et future qualité de l'air. Rien ne prouve que le cadre juridique actuel de l'UE régissant la qualité de l'air est inapproprié. Il faut cependant souligner les questions suivantes :

- Il pourrait être bon d'encourager les mesures locales, en obligeant les Etats membre à respecter leur obligation de fournir davantage d'informations dans une base de données d'expériences (telle que la base de données CAFEAIR développée pour le présent projet), par le biais de leurs "plans et programmes". Des objectifs stratégiques, comme l'amélioration et le partage des connaissances, la simplification (ou l'unification) des critères de communication, et l'amélioration de la transparence, seraient ainsi atteints. La Commission pourrait faciliter ce processus en rédigeant des notes-conseils spécifiques améliorées sur les bonnes pratiques de mise en œuvre des mesures. Il est cependant difficile d'imaginer comment la Commission pourrait recommander directement des mesures locales ou à court terme précises dans le cadre de la législation existante. Nous sommes convaincus que cette démarche serait inappropriée ou inefficace, en raison des caractéristiques de toutes les aires urbaines qui sont liées au site, et du besoin d'étudier et de mettre en oeuvre des solutions qui tiennent compte des conditions locales.

- Les mesures obligatoires et économiques se sont avérées plus efficaces que les mesures volontaires pour contrôler l'activité, notamment dans le secteur du transport routier. Les instruments régulateurs et économiques transmettent aux actionnaires des messages plus clairs, bien qu'il faille veiller à ce que les indicateurs financiers soient maintenus à des niveaux suffisamment élevés pour atteindre les objectifs des programmes. Nous estimons que des mesures supplémentaires d'envergure européenne (telles que des plafonds d'émission plus bas) seront probablement nécessaires pour favoriser une meilleure efficacité des mesures locales, dans le but de ramener les valeurs excédentaires restantes en-deçà des valeurs limites.

- Les problèmes de sources locales de pollution ponctuelle liés au site que nous avons identifiés suggèrent que ces problèmes pourraient être traités avec efficacité s'ils étaient délégués aux collectivités locales. Toutefois, pour s'acquitter plus efficacement de cette tâche, ces dernières devraient avoir accès à de hauts niveaux d'expertise, de ressources et de pouvoirs régulateurs.

- Nous répétons qu'il est dangereux de supposer que les mesures locales ou à court terme sont transférables à toute l'Europe, mais nous pensons que le fait d'informer continuellement sur les avancées réalisées au titre des plans et programmes permettra de faire savoir plus facilement où sont observés des profils de pollution similaires et d'améliorer éventuellement les connaissances sur la transférabilité des mesures.

- Mise à part la poursuite des efforts pour améliorer la base de connaissance des données financièrement avantageuses "ex post", nous pensons qu'il serait extrêmement utile d'entreprendre une série de modélisation dans un certain nombre de grandes villes européennes, en se penchant sur les impacts liés au site des différentes mesures locales et à court terme. Cette démarche permettrait de réfléchir quelque peu sur la transférabilité des mesures entre les localités. Nous pensons également que l'utilisation de modèles d'envergure européenne pourrait offrir un certain avantage (limité) pour étudier des groupes de mesures applicables à toute l'Europe, et pour examiner comment les mesures locales pourraient appuyer la politique de l'UE sur la qualité de l'air.

# Bericht der Geschäftsleitung

In diesem Bericht werden die Ergebnisse des Dienstleistungsvertrags zur *"Ex-Post-Bewertung" von kurzfristigen und örtlichen Maßnahmen im Rahmen von CAFE (DG Umweltreferenz B4-3040/2003/366045/MAR/C1)* vorgestellt.

Inhaltlich konzentrierte sich die Studie auf Maßnahmen gegen kurzfristige Schadstoffspitzen, d. h. sehr hohe Konzentrationen an Schadstoffen, die für kurze Zeiträume auftreten (wie während Schadstoffepisoden), sowie außerdem auf Maßnahmen zur Bekämpfung örtlicher (permanenter) Problembereiche mit hoher Luftverschmutzung (sogenannten Hotspots). Im Rahmen der Studie werden die Maßnahmen weitestgehend 'Ex-Post' bewertet, d.h. nach ihrer Einführung. Dadurch können neben der Wirksamkeit der Maßnahme auch die damit verbundenen Kosten, ihr Nutzen sowie ihre Auswirkungen auf weitere Verfahrensweisen beurteilt werden.

Als Teil der Studie wurde eine Datenbank mit örtlichen oder kurzfristigen Maßnahmen zur Emissionssenkung erstellt. Zu diesem Zweck hat man bereits abgeschlossene oder geplante Maßnahmen begutachtet, die Städte oder regionale Behörden in ganz Europa eingeführt hatten. Die gewonnenen Informationen wurden gesichtet und analysiert, um ihre Eignung für kurzfristige oder örtliche Maßnahmen zu ermitteln. Danach hat man im Rahmen der Studie fünf Maßnahmen ausgewählt, die von besonderem Interesse waren und dazu eine detaillierte Kosten-/Nutzenanalyse angefertigt. Letztlich wurden diese Informationen in der Studie zusammengestellt, um grundsätzliche Empfehlungen zur potenziellen Rolle kurzfristiger und örtlicher Maßnahmen für die hier thematisierte Strategie zu geben.

***Die Datenbank***

Im Zusammenhang mit der Studie wurden Informationen über kurzfristige und örtliche Maßnahmen zur Bekämpfung hoher Luftverschmutzung und permanenten Hotspots zusammengetragen. Nach einem ersten Überblick erfolgte eine detailliertere Untersuchung, in deren Rahmen Daten zu verschiedenen Maßnahmen erfasst wurden.

Diese in Access erstellte Datenbank kann als Wissensquelle für zukünftige Studien verwendet werden, der Zugriff erfolgt über das Internet. Die Daten lassen sich leicht durchsuchen und den Benutzern steht eine Vielzahl an Funktionen zur Verfügung, mit denen nach folgenden Themen gesucht werden kann: 1) nach Schadstoffen, 2) nach geografischen Gebieten und 3) nach bestimmten Maßnahmen.

Außerdem enthält die Datenbank Informationen zu 91 unterschiedlichen Maßnahmen aus 22 verschiedenen Ländern (hauptsächlich Stadtgebiete), die zur Bekämpfung von Schadstoffspitzen oder Hotspots eingesetzt wurden. Dazu gehört ein breites Spektrum an technischen und nicht technischen Maßnahmen für fast alle Bereiche des täglichen Lebens. Die Daten wurden einer Analyse unterzogen. Nachfolgend werden die Hauptresultate aufgeführt:

- 76 % der eingegangenen Informationen beziehen sich auf permanente, örtliche Maßnahmen, wohingegen nur 24 % kurzfristige Maßnahmen beschreiben. In gewisser Hinsicht ist das ein Beweis dafür, dass kurzfristige Maßnahmen vielerorts zur Bekämpfung von Schadstoffspitzen weniger gut geeignet sind (da Schadstoffspitzen oft das Ergebnis regionaler Schadstoffepisoden sind).

- 76 % der Maßnahmen konzentrieren sich auf die Kontrolle von Emissionen aus dem Straßenverkehr. 18 % der erhaltenen Antworten beschreiben Programme gegen feststehende Schadstoffquellen. Das ist einmal mehr Beweis dafür, in welch hohem Maße der Straßenverkehr für Emissionen verantwortlich ist. Dies macht ihn zu dem Sektor, der in modernen Städten verstärkt kontrolliert werden muss. Standortspezifische Probleme bestimmen, inwieweit andere Sektoren, wie die Verbrennung fester Brennstoffe in Haushalten ebenfalls bedeutend zur Luftverschmutzung beitragen.

- $NO_2$, $O_3$ und $PM_{10}$ sind verantwortlich für 64 % der gemeldeten Schadstoffbelastung. Bei der Hälfte aller gemeldeten Fälle besteht das Problem ganzjährig, wobei der Anteil von Episoden im Winter und Sommer bei 26 % bzw. 29 % liegt. Europäische Teilnehmer der Umfrage erklärten, dass diese Schadstoffbelastungen nicht selten zur Überschreitung der an ihren Standorten geltenden Rahmenrichtlinien zur Luftqualität sowie der untergeordneten Richtlinien für Grenzwerte führen. In vielen Fällen reichen außerdem die vor Ort eingeführten Maßnahmen allein nicht aus, um die kurz- und langfristigen Grenzwerte einzuhalten.

- In 12 % der Fälle sind nur wenige Straßenzüge von der Verschmutzung betroffen, wohingegen bei 28 % der gesamte Zuständigkeitsbereich unter dem Problem zu leiden hat. Wieder andere Fälle beschreiben Situationen, die zwischen diesen beiden Extremen angesiedelt sind. Sind mehr als nur ein paar Straßenzüge vom Problem betroffen, zeigen Maßnahmen, die sich lediglich auf einzelne Hotspots beschränken, geringere Wirksamkeit, dann ist die Einführung strengerer, flächendeckender Maßnahmen erforderlich.

- Die Mehrzahl der Befragten und auch andere Datenquellen konnten keine quantitativ wertvollen Daten zur Wirksamkeit oder den Kosten solcher Maßnahmen liefern. Daraus ergeben sich Schwierigkeiten bei der Bewertung der örtlichen, kurzfristigen oder permanenten Maßnahmen im Vergleich zu jenen, die auf nationaler oder internationaler Ebene eingeführt werden.

Der letzte Punkt enthält eine der wichtigeren Schlussfolgerungen aus der Studie und führt zu einer der Hauptempfehlungen der Untersuchung. Es ist extrem schwierig, zuverlässige und konsistente Daten zu den Ex-Post-Kosten und dem Ex-Post-Nutzen örtlicher Maßnahmen zu finden (insbesondere in Bezug auf Emissionen und Luftqualität). Außerdem sind die Daten, wenn sie denn vorliegen, nicht ausreichend detailliert und geben nicht genügend Aufschluss über die grundlegenden Bedingungen. So könnte z. B. eine tatsachenwidrige Analyse die Auswirkungen der spezifischen Maßnahme von jenen anderer Methoden oder Veränderungen genau abgrenzen. Um die vollen Kosten und den Nutzen bzw. die Rolle zu erforschen, die die Maßnahmen bei der Einhaltung der EU-Grenzwerte spielen, sind weitere Arbeiten notwendig. Wir möchten die Erstellung der Datenbank in dieser Studie als einen wichtigen Ausgangspunkt hervorheben, empfehlen jedoch weitere Anstrengungen zur Pflege und weiteren Verbesserung dieser Datenbank. Außerdem sollte insgesamt mehr Wert auf eine konsistente Erfassung von Ex-Post-Daten zu Maßnahmen in ganz Europa gelegt werden. Einen wichtigen Beitrag dazu könnten die Mitgliedsstaaten leisten, wenn sie ihren Pflichten zur Meldung von „Maßnahmen und Programmen“ im Rahmen der Richtlinie zur Luftqualität und den untergeordneten Richtlinien nachkommen würden. Dann könnten wir uns viel eher einen Eindruck darüber verschaffen, welche Maßnahmen erfolgreich sind und sich möglicherweise auf andere Bereiche übertragen lassen.

***Fallstudien***

Im Rahmen der Studie hat man eine detailliertere Analyse einer Reihe großer Projekte durchgeführt, mit denen kurzfristige Episoden bzw. Hotspots erfolgreich bekämpft wurden. Aus den in der Datenbank gesammelten Informationen geht hervor, dass örtliche Vorhaben zur Senkung von Emissionen, wie eine Low-Emission-Zone (Bereich mit geringen Emissionen), das Management des Straßenverkehrsflusses oder Verbote von bestimmten Brennstoffen, die Emissionsbelastung am erfolgreichsten senken konnten und eine positivere Auswirkung auf Luftqualität und Gesundheit hatten, als weitreichende Straßenverkehrs- oder Planungsmaßnahmen. Zu diesen Fallstudien gehörten:

- Kontrollierte Zufahrt durch Staugebühr – Beispiel: Schweden und London
- Kontrollierte Zufahrt durch festgelegte Low-Emission-Zone – Beispiel: London
- Kontrollierter Verkehrsfluss durch Geschwindigkeitsüberwachungskameras – Beispiel: Rotterdam
- Kurzfristige Anreize zum Wechsel der Transportfahrzeuge – Beispiel: Straßburg
- Gebietsspezifisches Verbot für Marketing und Verkauf von bestimmten festen Brennstoffen, die im häuslichen Bereich zum Einsatz kommen – Beispiel: Dublin.

Im Rahmen der Studie wurden die Auswirkungen dieser Maßnahmen auf Emissionen und Luftqualität überprüft, einschließlich ihrer potenziellen Auswirkung auf die Einhaltung der örtlichen Grenzwerte für die Luftqualität. Außerdem betrachtete man die weiterreichenden Vorteile dieser Maßnahmen sowohl aus Umweltgesichtspunkten als auch aus Sicht der Nachhaltigkeit. Da sich diese Maßnahmen verstärkt auf Stadtgebiete konzentrieren, sind sie von besonderer Bedeutung. Im Rahmen der Analyse hat man die Auswirkung der Maßnahmen auf die Luftqualität auch in Geldwert ausgedrückt, und letztlich eine Gegenüberstellung von Kosten und Nutzen vorgenommen.

Aus den Fallstudien geht hervor, dass die Emissionen mit Hilfe aller fünf Maßnahmen erfolgreich gesenkt und in einigen Fällen wesentliche Fortschritte bei der Einhaltung der EU-Grenzwerte gemacht wurden. Insgesamt kommen wir zu dem Schluss, dass diese Maßnahmen kostengünstige Möglichkeiten zur Verbesserung der Luftqualität in Bezug auf die geltenden Grenzwerte darstellen. Werden die Vorteile dieser Maßnahmen unter Zuhilfenahme der Methodologie aus dem CAFE CBA-Projekt bewertet, so zeigen alle eine positive Auswirkung auf die Kostenkennzahlen. Diese Auswirkungen sind ähnlich oder besser als jene, die man durch die Einführung von europaweiten Grundsätzen zur Luftqualität erreichen konnte. Das ist ein erster Hinweis darauf, dass diese Maßnahmen eine echte Alternative zu weiteren EU-Gesetzen sind, sowohl zur Lösung städtischer Hotspots, als auch zur Senkung der Schadstoffbelastung zu Gunsten der Bevölkerung (und der Gesundheit). Allerdings zeigen die Analysen der Fallstudien auch, dass diese örtlichen Maßnahmen allein oft nicht ausreichen, um die EU-Grenzwerte zu erreichen: deshalb sollten sie nicht als Ersatz, sondern vielmehr als Ergänzung zu weiteren EU-Gesetzen zur Luftqualität verstanden werden.

***Diskussion in Bezug auf die thematisierte Strategie zur Luftverschmutzung***

Aus der Studie wurden die nachstehend aufgeführten Schlussfolgerungen gezogen.

Erstens: spezifische, zielgerichtete örtliche Maßnahmen scheinen im Hinblick auf die Senkung von Emissionen und die Verbesserung der Luftqualität wirksam zu sein und zeigen positive Auswirkungen auf die Einhaltung der gesetzlich verbindlichen Grenzwerte zur Luftqualität, insbesondere wenn sich diese Maßnahmen auf Hotspots mit hoher Luftverschmutzung richten. Außerdem leisten sie einen guten Beitrag zu den Kostenkennzahlen, diese sind ähnlich oder besser als jene, die durch die Einführung von europaweiten Grundsätzen zur Luftqualität erreicht werden können. Dies sind erste Hinweise darauf, dass solche Maßnahmen ergänzend zu weiteren EU-Gesetzen einsetzbar sind.

Zweitens muss besonders darauf hingewiesen werden, dass die Wirksamkeit aller örtlichen Maßnahmen äußerst standortspezifisch ist. Sie lassen sich ohne Berücksichtigung der örtlichen Bedingungen nicht auf andere Standorte übertragen. Die standortspezifischen Merkmale folgender Schlüsselfaktoren bestimmen ihre Wirksamkeit: grundlegende Schadstoffmengen, Bildung der Verunreinigung und Transportmechanismen, kulturelle und wirtschaftliche Faktoren, die Einfluss auf die Höhe und die Häufigkeit der Emissionen aus den verschiedenen Sektoren haben, Gesetzes- und Informationsbeschränkungen bezüglich der Fähigkeit der zuständigen Behörde, entsprechend zu reagieren.

Drittens geht aus den gesammelten Informationen hervor, dass die wirksamsten Maßnahmen zur Senkung der Emissionen und Hotspots mit hoher Luftverschmutzung jene sind, die sich direkt auf die Verbesserung der Luftqualität konzentrieren. Dazu gehören Maßnahmen wie Low-Emission-Zones, Management des Straßenverkehrsflusses, Verbote für Brennstoffe mit hoher Rauchentwicklung usw. in Stadtgebieten. Viele herkömmliche örtliche Straßenverkehrsmaßnahmen zeigen scheinbar weniger Wirkung im Hinblick auf die Senkung der Emissionen oder die Verbesserung der Luftqualität, was allerdings nicht überrascht, wenn man bedenkt, dass diese Maßnahmen eigentlich ganz andere Probleme bekämpfen sollen (z. B. Staus). Nichtsdestotrotz ergeben sich aus den letztgenannten Maßnahmen andere Vorteile (z. B. Vorteile bei der Fahrzeit, geringere Anzahl an Unfällen usw.), die nicht selten auch ihr Hauptziel waren. Wir empfehlen weitere Überlegungen, um auf örtlicher Ebene die richtige Ausgewogenheit zwischen Maßnahmen zu finden, die sich auf die Verbesserung der Luftqualität konzentrieren bzw. jene, die den größten Nutzen bei der Verbesserung der städtischen Umwelt im Allgemeinen bringen (d. h. die die gesamte Nachhaltigkeit in städtischen Gebieten, Staus, Unfälle, Lärm, Luftqualität usw. verbessern). Die Wechselbeziehung zwischen diesen Aspekten hat auch Priorität in der Forschung, und wir konnten in diesem Bereich potenzielle Verbindungen zwischen CAFE und der thematisierten städtischen Strategie finden.

Mit Hilfe der Studie wurde außerdem herausgefunden, dass diese örtlichen Maßnahmen durchaus ihre Grenzen haben. In einigen Fällen zeigten die gesammelten Informationen nur geringe Verbesserungen der Luftqualität. Die Menschen sollten ermutigt werden, ihr Verhalten freiwillig zu ändern – z. B. effektiveres Fahrverhalten bei Spitzenbelastungen. Auf örtlicher Ebene sind weitere Anstrengungen erforderlich. Hier muss bestimmt werden, wie effektiv realistische kurzfristige Maßnahmen bei der Senkung der Ozonspitzenwerte sein können. In diesem Zusammenhang ist absehbar, dass solche Maßnahmen eher in den südlichen Mitgliedsstaaten die größte Wirkung zeigen werden. Maßnahmen zur Senkung der Ozonbelastung müssen in ausgedehnteren Regionen zum Einsatz kommen und bessere Prognosen zu Spitzenbelastungen enthalten, um wirksamer zu sein (d.h. bereits längere Zeit eingeführt sein, wenn solche Spitzenbelastungen entstehen).

Des weiteren haben wir festgestellt, dass die Verbesserungen der Luftqualität durch Maßnahmen, die sich auf den Bereich Straßenverkehr beziehen, in den nächsten Jahren zurückgehen werden, da die Fahrzeuge weniger Schadstoffe abgeben (selbst unter Berücksichtigung eines Anstiegs des Straßenverkehrsaufkommens). Das bedeutet, dass dieselben Maßnahmen weniger wirksam sind, wenn sie 2007 eingeführt werden, als wenn sie bereits 2000 zum Einsatz kommen. Außerdem wird sich je nach Typ der Maßnahme bzw. je nach dem, ob sie Einfluss auf bestimmte Fahrzeuge oder einen Umstieg auf andere Transportmittel im allgemeinen hat, die Klassifizierung der Maßnahmen verändern.

Letztlich wurde im Rahmen der Studie untersucht, welche Rolle diese Maßnahmen innerhalb der thematisierten Strategie und zukünftigen Luftqualität spielen. Wir haben keine Beweise dafür gefunden, dass der aktuelle gesetzliche Rahmen der EU für die Luftqualität ungeeignet ist. Allerdings wurden folgende Fragen aufgeworfen.

- Es wäre unter Umständen von Vorteil, die Mitgliedsstaaten durch bestimmte Prozesse zu verpflichten, über ihre „Maßnahmen und Programme" weitere Informationen in eine etablierte Datenbank zu liefern (wie die CAFEAIR-Datenbank, die für dieses Projekt entwickelt wurde). Damit könnte man strategische Ziele wie die Verbesserung und Weitergabe von Informationen, die Vereinfachung (oder Vereinigung) von Meldeanforderungen und eine Verbesserung der Transparenz erreichen. Die Kommission sollte dies durch spezifischere Anweisungen für beste Praktiken bei der Einführung von solchen Prozessen unterstützen. Allerdings ist es schwierig vorstellbar, wie die Kommission im Rahmen der bestehenden Gesetzgebung spezifische kurzfristige oder örtliche Maßnahmen empfehlen könnte. Auf Grund des standortspezifischen Charakters aller Stadtgebiete halten wir dies sogar weder für angemessen noch wirksam, da immer nur solche Maßnahmen eingeführt werden sollten, die auf die örtlichen Bedingungen zugeschnitten sind.

- Wir haben festgestellt, dass verpflichtende und wirtschaftliche Maßnahmen wirksamer sind als freiwillige Programme, wenn es darum geht, bestimmte Handlungen insbesondere im Straßenverkehrssektor zu kontrollieren. Regulierungs- und Wirtschaftsinstrumente senden klare Signale an die Interessenvertreter. Allerdings sollten sich die Preise in einem angemessenen Rahmen bewegen, um die Ziele solcher Grundsätze zu erreichen. Außerdem haben wir herausgefunden, dass möglicherweise zusätzliche europäische Maßnahmen (wie geringere Emissionswerte) erforderlich sind, damit örtliche Maßnahmen gegen die immer noch bestehende Überschreitung der Grenzwerte wirksamer werden.

- Die von uns gefundenen standortspezifischen, örtlichen Hotspots zeigen, dass sich diese Probleme wirksamer lösen lassen, wenn die Zuständigkeit dafür auf örtliche Behörden übertragen wird. Allerdings benötigen diese Behörden dann Zugang zu umfangreichem Fachwissen, Ressourcen sowie Regulierungsbefugnisse, um ihre Funktion effektiver zu erfüllen.

- Wir wiederholen noch einmal, dass es gefährlich wäre, anzunehmen, dass sich diese örtlichen oder kurzfristigen Maßnahmen europaweit übertragen lassen. Allerdings erfahren wir nur durch eine fortlaufende Meldung der Fortschritte solcher Maßnahmen und Programme, wo ähnliche Schadstoffe beobachtet werden und können somit vielleicht unsere Kenntnisse zur Übertragbarkeit solcher Maßnahmen verbessern.

- Abgesehen davon, dass wir ständig bemüht sind, unsere Kenntnisse über „Ex-Post-Daten" zur Wirtschaftlichkeit zu erweitern, glauben wir, dass es außerordentlich nützlich wäre, in mehreren großen europäischen Städten eine Reihe von Modellstudien durchzuführen, die sich mit den standortspezifischen Auswirkungen von verschiedenen kurzfristigen und örtlichen Maßnahmen beschäftigen. Dies würde auch weitere Überlegungen zur Übertragbarkeit dieser Maßnahmen zwischen unterschiedlichen Standorten zulassen. Außerdem sind wir der Meinung, dass es (in beschränktem Maße) möglich ist, in ganz Europa Modelle zur Erforschung von Maßnahmen einzusetzen, um den Beitrag örtlicher Maßnahmen zur EU-Politik zur Luftqualität zu untersuchen.

# Contents

## Appendices



# Acknowledgements

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# SECTION 1 – INTRODUCTION

This report presents the findings of the service contract on *"Ex-post" evaluation of short-term and local measures in the CAFE context (DG Environment reference B4-3040/2003/366045/MAR/C1).* The study is focused on measures to address short-term pollution peaks i.e. very high peak concentrations for short periods of time (such as during pollution episodes), and also measures to address local (permanent) air quality hot-spots. The study evaluates the effects of measures 'ex post', i.e. after their introduction, rather than assessing the anticipated effect of the measures 'ex ante' (before implementation, as estimated in appraisals). Ex post, evaluation allows an analysis of the effectiveness of policies or measures, their costs and benefits, and what this might mean for future policy decisions.

## 1.1 BACKGROUND INFORMATION

The 6$^{th}$ Environment Action Programme is due to be adopted by the Council and European Parliament in mid-2005. Within this framework seven thematic strategies will be established, of which, air pollution will be one. To inform the strategy the Clean Air For Europe (CAFE) programme was created.

Over the past 15 years, European Directives (implemented through individual member state legislation) have significantly driven down air emissions from major sources, including industrial and transport activities. These have had benefits in reducing the emissions and concentrations of common pollutants such as nitrogen dioxide, sulphur dioxide, particulate matter, volatile organic compounds and the secondary pollutant ozone, and in turn reducing impacts on human health and the natural environment.

However, despite this legislation, air quality limit values are still exceeded widely in specific locations (so-called "hot-spots") and at specific times ("pollution peaks"). Reasons for these exceedences can include specific adverse topography (street canyons or local geography) or weather patterns (summer high pressure systems or winter inversions) but commonly are due to the intensity of certain activities (for example the use of road transport, industrial processes or use of solid fuels). The widely available monitoring records demonstrate that urban areas are particularly prone to such problems.

The exceedences are usually limited in terms of the area affected or in their duration. The aim of this project is to gather data and assess whether local actions, either in the short-term or permanently, are a more cost-effective method than European-wide measures for addressing remaining exceedences of the air quality limit values.

To achieve this, the study has established a database on experiences in urban-scale local air quality management and evaluated this information. Following from this, the study has analysed this data for the opportunity, feasibility and effectiveness of short-term and/or local measures, and from this to relate the potential for such measures in the context of the "thematic strategy".

## 1.2 REPORT STRUCTURE

The remainder of this report is divided into the following sections

- Section 2 presents the development of an experience database and an analysis of the results
- Section 3 presents detailed assessments of a number of case study experiences of implementing short term and local measures.
- Section 4 discusses the results in the context of the thematic strategy on air quality and provides a set of policy recommendations.
- Section 5 presents the study references.
- A number of appendices provide additional relevant information.

# SECTION 2 – DATABASE OF EXPERIENCE INVENTORY

## 2.1 TASK OBJECTIVES

The primary objective of this task was to establish a database of local or short-term emission reduction measures including a summary of the main features of each measure. The data come from completed or planned measures implemented by municipalities or regional authorities. To achieve this the following sub-tasks were developed in consultation with the Commission and carried out:

- Definition of a typology of the measures to be considered.
- Creation of a questionnaire that addresses all of the relevant information criteria.
- Correspondence with targeted contacts to identify and to survey a first list of relevant measures and primary contacts.
- Development of a searchable and accessible database holding the results of the responses.

The remainder of this report presents the methods used to carry out these sub-tasks and presents a simple analysis of the results.

## 2.2 MEASURES TYPOLOGY

A typology of possible short-term or permanently local measures was defined. Table 1 presents the initial typology. The typology as shown is divided according to headings describing the main objectives of a given measure. Sub-headings define the action in more detail. Thus:

- **An emission source could be moved to reduce exposure**.
    - Through spatial planning specifically for air quality management or
    - Through complementary spatial planning actions that *may* produce air quality benefits.
- **Emission source activities could be managed**.
    - By an overall limitation or reduction in the emitting activities, or
    - Or an optimisation of individual or sector activity to minimise emission/unit-activity.
- **Source technology could be managed to reduce emissions**.
    - By: 1) more efficient combustion, 2) using cleaner fuels or 3) additional abatement techniques.

    - Complementary actions could also play a part in temporarily influencing whether older technologies are used or not.

It is possible to define at least two more discrete sets of measures. Firstly, in theory **one could remove the receptors that are exposed to pollution**. In reality there are large practical and political difficulties in moving people from an existing exposed situation but it is possible that planning policies can avoid the conjunction of emission sources and exposed individuals in future cases. Secondly, **there are decision support or preventative measures** (i.e. to provide the knowledge to trigger short-term measures actually influencing emissions). These could take the form of information management systems containing monitoring, modelling, meteorological forecasting and dynamic traffic management and information dissemination capabilities.

Within each of these headings the human activities at which the measures are aimed can be split into several sectors that, in large part, account for the local and short-term air quality problems observed. The sectors can be further split since it is possible that measures would be aimed at a sub-set. The sectors are:

- **Road Transport**. A self-evident definition that can be split into:
    - Public Transportation
    - Freight delivery and
    - Private transportation. (It is of course possible to further sub-divide this category according to fuel, etc.)
- **Industry**. A definition including large and medium scale
    - Combustion for industrial heating and manufacturing processes including processes such as power generation and waste incineration.
    - Processes giving rise to emissions
- **Small scale combustion processes**. This sector includes:
    - Small boilers used in residential, institutional, commercial and agricultural settings for space and water heating and possibly cooking.
    - Domestic heating in individual dwellings for all space and water heating and cooking activities
- **Others**. Perhaps of lesser importance overall, but typically containing less well regulated activities, this sector includes:
    - Off-road transport & mobile machinery (including aviation and shipping)
    - Domestic and Small scale combustion not for any heating purpose (i.e. bonfires).

- Quarrying activities

In compliance with the requirements of the contract the typology notes all forms of measures having the effect of reducing pollution temporarily and/or locally where those measures are NOT taken at national or the European level. The typology also covers all types of instruments through which measures could be implemented including information, economic instruments or "command and control" strategies. Furthermore the typology does not exclude the possibility that certain measures can be taken that do not have the direct objective of improving air quality but have a significant impact nonetheless. Although the contract is for an "ex-post" evaluation of these measures, those that have been planned but which appear promising in terms of pollution reduction have not been excluded.

**Table 1: Typology of short-term and local measures**

| Heading | Sub-heading | Sector | Sub-sector | Measure | Possibility of an element of adaptive choice? (I.e. an economic instrument) | Potentially helpful in dealing with peak concentrations? | Main local pollution issues addressed? | Main peak pollution issues addressed? |
|---|---|---|---|---|---|---|---|---|
| Manage location of receptors | Spatial planning | | | | | | $NO_x$,PM,C6H6,Pb, Others | |
| Decision-support tools | | | | Monitoring/Modelling /Weather forecasting | | Y | | $NO_x$,PM,CO,$O_3$ |
| Manage location of source | Spatial planning | Road Transport | Freight | freight-free routes/zones | Y | Y | $NO_x$,PM | $NO_x$,PM,CO,$O_3$ |
| | | | Private Transport | bypass | | | $NO_x$,PM | |
| | | | | car-free zones | Y | Y | $NO_x$,PM | $NO_x$,PM,CO,$O_3$ |
| | | Industry | industrial combustion | industrial zones | | | $NO_x$,PM | |
| | | | industrial processes | industrial zones | | | C6H6,Pb,Others | |
| | | Small scale combustion | Small-scale heating (residential/institutional/commercial/agricultural) | combustion-free zone | | Y | $NO_x$,PM | $SO_2$,$NO_x$,PM,CO,$O_3$ |
| | | | Single dwelling domestic (heating) | combustion-free zone | | Y | PM,PAH | $SO_2$,PM |
| | Complementary actions | Road Transport | | congestion management | Y | | $NO_x$,PM | |
| Manage the existing source activity | Limit use | Road Transport | Freight | quotas | Y | | $NO_x$,PM | |
| | | | Private Transport | limited parking | Y | | $NO_x$,PM | |
| | | Industry | industrial combustion | operating conditions | | Y | $NO_x$,PM | $SO_2$,$NO_x$,PM,CO,$O_3$ |
| | | | industrial processes | operating conditions | | Y | C6H6,Pb,Others | $SO_2$,PM |
| | | Small scale combustion | Small-scale heating (residential/institutional/commercial/agricultural) | operating conditions | | Y | $NO_x$,PM | $SO_2$,$NO_x$,PM,CO,$O_3$ |
| | | | Single dwelling domestic (heating) | operating conditions | | Y | PM,PAH | $SO_2$,PM |
| | | Other | Off-road transport & mobile machinery | operating conditions | | Y | $NO_x$,PM,C6H6,Pb | $NO_x$,PM,CO,$O_3$ |
| | | | Domestic combustion (non-heating) | operating conditions | | Y | PM,PAH | PM |
| | Optimise activity | Road Transport | Public Transport | integrated public transport strategy | Y | | $NO_x$,PM | |
| | | | Freight | optimised delivery | | | $NO_x$,PM | |

| Heading | Sub-heading | Sector | Sub-sector | Measure | Possibility of an element of adaptive choice? (I.e. an economic instrument) | Potentially helpful in dealing with peak concentrations? | Main local pollution issues addressed? | Main peak pollution issues addressed? |
|---|---|---|---|---|---|---|---|---|
| | | | Private Transport | speed control | | | $NO_x$,PM | |
| | | | | flow control | Y | | $NO_x$,PM | |
| | | Industry | | operating conditions | | | $NO_x$,PM,C6H6,Pb, Others | |
| Manage source technology | Fuel/ combustion efficiency/ additional abatement | Road Transport | | low emission zone | | | $NO_x$,PM | |
| | | | | age limit | | Y | $NO_x$,PM | $NO_x$,PM,CO,$O_3$ |
| | | | | cleaner fuels infrastructure | Y | | $NO_x$,PM | |
| | | | | scrappage scheme | Y | | $NO_x$,PM | |
| | | Industry | industrial combustion | fuel switching | | Y | $NO_x$,PM | $NO_x$,PM,CO,$O_3$ |
| | | | | CHP | | | $NO_x$,PM | |
| | | | | operating conditions | | | $NO_x$,PM | |
| | | | industrial processes | operating conditions | | | C6H6,Pb,Others | |
| | | Small scale combustion | Small-scale heating (residential/institutional/commercial/agricultural) | update equipment | Y | | $NO_x$,PM | |
| | | | | cleaner fuels | Y | Y | $NO_x$,PM | $NO_x$,PM,CO,$O_3$ |
| | | | Single dwelling domestic (heating) | update equipment | Y | | PM,PAH | |
| | | | | cleaner fuels | Y | Y | PM,PAH | $SO_2$,PM |
| | | Other | Off-road transport & mobile machinery | update equipment | Y | | $NO_x$,PM,C6H6,Pb | |
| | | | | cleaner fuels | Y | Y | $NO_x$,PM,C6H6,Pb | $SO_2$,PM |
| | Complementary actions | Road Transport | Private Transport | information | | Y | $NO_x$,PM | $NO_x$,PM,CO,$O_3$ |
| | | Industry | industrial combustion | energy efficiency best practice programme | | | $NO_x$,PM | |
| | | Small scale combustion | Small-scale heating (residential/institutional/commercial/agricultural) | energy efficiency best practice programme | | | $NO_x$,PM | |
| | | | Single dwelling domestic (heating) | information | | Y | PM,PAH | $SO_2$,PM |
| | | Other | Off-road transport & mobile machinery | information | | Y | $NO_x$,PM,C6H6,Pb | $NO_x$,PM,CO,$O_3$ |

## 2.3 DEVELOPMENT OF A SURVEY QUESTIONNAIRE

In consultation with the Commission a questionnaire covering all of the required information criteria was developed (see Appendix 1 to this report for a copy). It was produced in English, French and German so that contacts would be able to respond in their preferred language of the three available.

**In compliance with the requirements of the contract the questionnaire is structured to ask respondents to provide information for the following:**

- A relevant contact for each measure. ***(Section 1:Question 1)***
- The location of corresponding sources of information (such as reports and web-sites) if they exist. ***(Section 1:Question 5, Section 2:Question 12 and Section 3:Question 10)***
- Pollutants of concern regulated by current European Directives (i.e. $PM_{10}$, ozone, $NO_x$, SOx, CO, lead and benzene) as well as any others if relevant in a given location (e.g. $PM_{2.5}$, PAHs and heavy metals). ***(Section 4:Questions 1-4 and 6)***
- Distinguishing between
- Permanent measures taken in specific locations and ***(Section 1:Question 8)***
- Temporary measures taken in specific zones when a peak occurs or is predicted. ***(Section 1:Question 7)***
- A description of the measure taken and its main objective. ***(Section 2:Questions 2, 5, 6 and 10, Section 3:Questions 2, 4, 5 and 8)***
- The zone in which it is implemented. ***(Section 2:Question 8 and Section 3:Question 3)***
- The period during which it is implemented. ***(Section 2:Question 3)***
- Any specific legal basis or decision process for implementing the measure. ***(Section 2:Questions 4, 13 and 14, Section 3:Questions 11 and 12)***
- The main effects of the measure. ***(Section 2:Questions 5, 6, 7, 9, 11 and 12, Section 3:Questions 4, 5, 6, 7, 9 and 10)***

There is also the opportunity in Section 5 to provide information or suggestions on additional action at the European level aimed at facilitating local and short term air quality management.

By fully completing this questionnaire it is possible to state where in the typology the authorities' measures fit and make a first evaluation of the overall effectiveness of the measure in dealing with the pollution problem.

## 2.4 TARGETED CONTACTS

A number of attempts to contact targeted individuals were made with the objective of identifying measures that had either been implemented or are planned. In this sub-task the project associates ICLEI and Eurocities were involved as well as ongoing discussion with the Commission. The following list presents those to whom a cover note was sent requesting *"…whether (the air quality expert is) aware of good examples of short term and/or local measures…"*

- Suggested by the Commission
  - Known contacts of the project officers within the Commission.
  - Coordinators of recent key European projects in the field of local air quality management.
  - Information based on recent work within DG TREN surveying member states on traffic management measures aimed at environmental improvements.
- Generated by ICLEI and Eurocities
  - ICLEI members worldwide with known pollution problems.
  - All members of the Eurocities Environment Committee including those that are members of the INTEGAIRE project.
- Generated by AEA Technology Environment
  - Selected members of the CAFE steering committee representing each post-accession member state and external observers.
  - Principal Environmental Managers of more than 20 UK local authorities (including the major urban centres) known to be planning measures for reducing air pollution impacts.
  - Individuals within the USEPA who are involved in actions either at State or urban-scales.

In addition a number of other written sources were studied to identify potential respondents for the survey. They were:

- Suggested by the Commission
  - (2004/279/EC) Commission Decision of 19 March 2004 concerning guidance for implementation of Directive 2002/3/EC of the European Parliament and of the Council relating to ozone in ambient air.
  - CAFE Working Group on Particulate Matter April 6th, 2004, Second Position Paper on Particulate Matter – final draft.

    - Proceedings of the 4th International Conference on Urban Air Quality Measurement, Modelling and Management, Charles University, Prague, Czech Republic 25-27 March 2003.
    - *"Integration of environment in transport policy"*, conference highlights, 10-11 October 2002, Brussels, Belgium.
    - The Certu report "*Plans de circulation d'urgence et pics de pollution de l'air*" and other French documents dealing with short term actions during pollution peaks.
- Generated by AEA Technology Environment
    - Eurocities report "*Good practice in European urban air quality management*"
    - Web-based searches for information on the experiences and effectiveness local air quality management and the integration of local environmental and transport policies.
    - Coordination with the CAFE project team on "*Cost and environmental effectiveness of reducing air pollution for small-scale combustion installations*"
    - A call for participation aimed at delegates of the 13th World Clean Air and Environmental Protection Congress and Exhibition, London, 22-27 August 2004.
    - Information sources within an existing AEA Technology air quality management database (AirAction).

These activities aimed to comply with the terms of the contract and the wishes of the Commission in seeking to establish a first list of relevant experiences of local or short-term emission reduction measures taken in all post-accession Member States and other comparable countries (including United States, Canada, Central America, East Asia including Hong Kong and Japan, India and non-EU countries such as Switzerland and Norway).

The sub-task identified a number of experiences fulfilling the project criteria. Numerous attempts over several months have been made to make contact with individuals who could provide further data on the experiences and preferably to complete the questionnaire. As of 25th August, more than 100 regional authorities or municipalities had received the questionnaire and 38 had responded. In a number of cases no contact was possible but information was publicly available on the relevant measures that has allowed additional experiences to be considered within the project.

## 2.5 DATABASE DEVELOPMENT

AEA Technology brought an existing database to this project, compiling key "ex ante" data regarding local measures taken from a review of the research literature during 2002. This includes results from the Cantique project, the AutoOil II Programme, the Jupiter 2 project and the evaluation of transport measures to meet UK national air quality strategy objectives. This database was used as the starting point for the database developed under this project that has been named CAFEAir. The use of the original database is different from that required for this project (see section 3) and hence it has been adapted to comply with these requirements. Essentially the database contains a field for each of the questionnaire response fields. Data from several individual measures implemented within the same authority can be recorded.

By agreement with the Commission, the database will be available in MS Access 2000 format from a key air quality management website that AEA Technology Environment manages (www.airquality.co.uk) If data representing new experiences or updates of the existing ones becomes available CAFEAir can be updated to account for these.

A full manual for using the database is presented in appendix 2 and a shortened version is included here. The database is searchable using any one of three approaches to the data.

- **A pollutant based search**. The user can specify a pollutant of interest as well as EITHER the period of concern (i.e. winter peak/summer peak/or permanent) OR a source sector of concern. Source sectors can be differentiated according to their significance in terms of their contribution to air quality and also by their type or subtype (e.g. road sources – cars). Such searches would answer questions such as *"where have winter peak* $NO_2$ *concentrations exceeded guideline values"* or *"where is road traffic sourced* $PM_{10}$ *causing exceedences?"*

- **A geography based search**. The user can choose EITHER a country from those included in the database entries OR an authority type (i.e. urban, semi-urban, rural) OR a named authority from the data.

- **A measures based search**. The user can choose the objective of a measure EITHER from its period of influence (i.e. long or short term) OR from a list of emission sectors influenced by the measure (i.e. the same sector typology as that available in the pollutant based search). This search would answer questions such as *"where have attempts been made to deal with pollution peaks"* or *"where have attempts to permanently reduce local diesel car fleet emissions been attempted?"*

When selecting search criteria the options presented are derived from the complete set of valid options and codes defined in the database, so it is possible that there may not be any matches within the records. In such cases a message box is displayed to inform that no matching records were found.

Results that do match the search string are presented as a series of formatted reports (one for each relevant municipal or regional authority) containing a sub-set of key data for each match. Users have a choice of calling up a formatted summary report containing the same set of data as that shown on-screen or a formatted detailed report containing all data associated with the authority and measure records found by the search. Both types of report can be printed if required.

## 2.6 ANALYSIS OF RESULTS

This section presents an analysis of the information gathered in the survey..

**Type of pollution issues found in the survey**

Respondents were asked to state the temporal nature of their pollution problems. Just over half (51%) responded that they have a permanent hotspot issue. Around one quarter (26%) experience winter peak episodes while a similar percentage (29%) experience summer peaks. The pollutants causing these problems and the frequency with which respondents cited them are listed in Table 2 below.

**Table 2: Summarised frequency (%) with which respondents cite pollutants and type of issue.**

| Pollutant | Winter peak problem | Summer peak problem | Long term problem | Aggregate |
|---|---|---|---|---|
| $O_3$ | 2 | 36 | 10 | 37 |
| $SO_2$ | 3 | 0 | 5 | 7 |
| $NO_2$ | 14 | 5 | 34 | 42 |
| C6H6 | 0 | 0 | 5 | 5 |
| $PM_{10}$ | 24 | 19 | 41 | 56 |
| $PM_{2.5}$ | 8 | 5 | 12 | 17 |
| PAH | 0 | 0 | 2 | 2 |
| CO | 5 | 2 | 3 | 10 |
| Pb | 2 | 0 | 2 | 3 |
| As | 0 | 0 | 0 | 0 |
| Cd | 0 | 0 | 0 | 0 |
| Ni | 0 | 0 | 0 | 0 |
| Black smoke | 0 | 0 | 5 | 5 |
| Aldehydes | 0 | 2 | 0 | 2 |

It is clear from these data that $NO_2$ and $PM_{10}$ are currently the dominant pollutants of concern in the context of hotspots. $PM_{2.5}$ is probably equally of concern but lack of a European air quality objective for this pollutant and a relatively small number of monitoring sites in comparison with $PM_{10}$ are probable reasons why this pollutant is not also cited with high frequency. This may change in future.

Winter peaks of $PM_{10}$ (again $PM_{2.5}$ should be considered important in this context) and $NO_2$ are the most frequently cited. Such episodes are associated with particular meteorological conditions (often high pressure systems and temperature inversions causing stagnation) but also with increased emissions of combustion products due to increased heating needs during the winter months.

Summer peaks of $PM_{10}$ (and once more $PM_{2.5}$) are also cited but the dominant pollutant in this respect is ozone, which twice as many respondents cite than any other summer pollutant.

Atmospheric conditions and activity levels that cause ozone peaks are experienced in all Member States nearly every summer and as during 2003 such episodes can be very severe.

The geographical extent to which these pollution issues manifest themselves is illustrated in Figure 1 below.

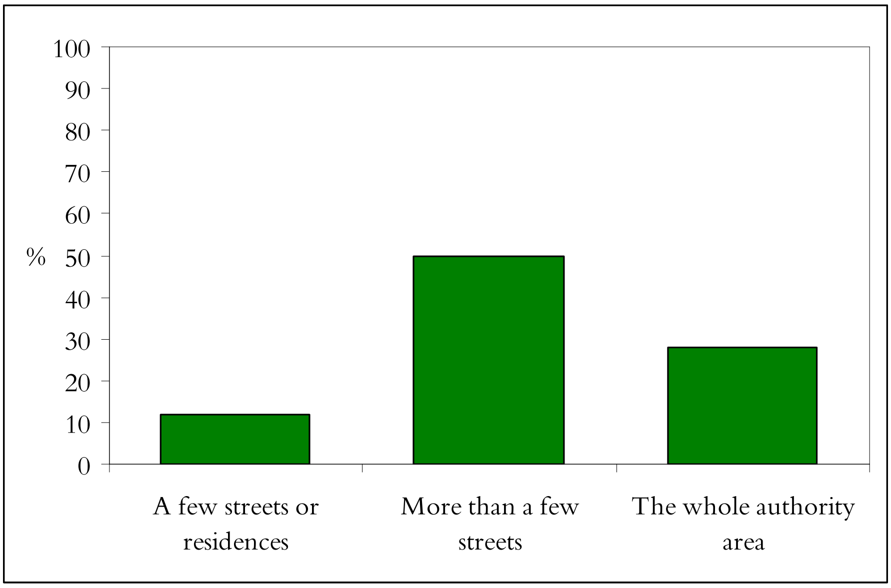


**Figure 1 Geographical scale of pollution issues identified in the survey**

The figure demonstrates that of those respondents who replied to this question that most have to deal with pollution issues somewhat larger than just a few streets or houses. More than a quarter (28%) has pollution problems that extend over the whole authority area. The greater the area affected then potentially the greater the area over which measures must be taken. Simple closure of one or two roads or of a particular stationary source would apparently only be effective in the minority of cases. Measures implemented over large areas have the potential of being less well understood (by those affected by the measure but not the pollution), more expensive and harder to implement successfully. Generally the larger the region experiencing the pollution problem then the more likely that additional national or international policies will be necessary to achieve better air quality.

## Profile of respondents and situations

- There are 58 different respondents or other projects identified in the database. This comprises 35 questionnaire responses and 24 additional experiences identified from the literature.
- 91 measures are currently detailed as far as possible in the database
- Data from 22 different countries are included in the database. The responses include 13 from the UK, 4 from Italy, 3 from Denmark, Ireland, Sweden and the Netherlands, 2 from Finland, France and Germany and 1 from Belgium and

Portugal. Outside of the EU there are notably 7 experiences in the USA and 2 from Mexico and also several far-east Asian and South American experiences.

- 45 respondents (76%) were from urban areas, 6 (10%) from semi-urban areas, 1 for a rural area and for 4 respondents there were no data.
- The size and number of people resident in these areas ranged from a few tens of people affected up to several millions being affected in the case of Mexico City.

These results demonstrate the extent to which air quality problems are experienced worldwide particularly in urban locations.

**Respondents access to local inventories or action plans**

- All respondents cited that they are taking action to improve air quality
- 28 respondents (47%) cited an emissions inventory of which 9 provided a web address
- 35 respondents (59%) cited an action plan with 13 of these providing a web address

Not only were emissions inventories unavailable in many cases but also the quality of the emission inventories available for study varied widely. In some cases the inventory is a national or regional one, which does not distinguish those emissions that cause specific pollution problems. There were no consistent sector classifications used throughout all cases. Good inventory data are required to draw up reasoned policies or action plans to combat local or peak air pollution. The survey demonstrates that in approximately half of the cases for which information was available the authorities with responsibility for managing air quality may not have access to these key data.

**Integration with other urban strategic plans**

Figure 2 below presents in percentage terms the respondents who have either integrated or planned to integrate their air quality management plans or strategies with other urban strategies.

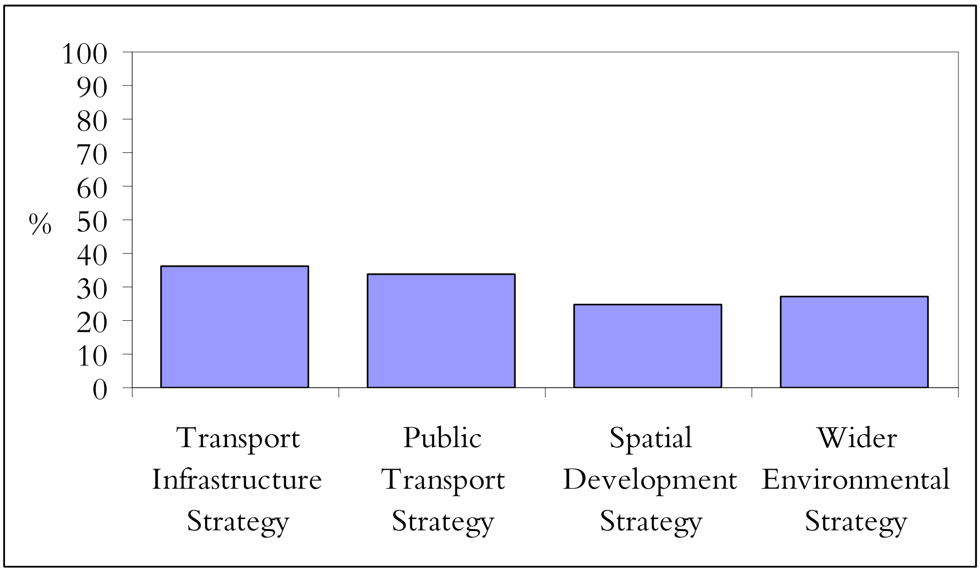


**Figure 2 Percentage of respondents who have integrated air quality planning with other urban strategies**

In 5 cases other strategies were cited with which the measures were being integrated. In the case of The Greater London Authority in addition to the strategies cited above, economic development, noise, energy, waste, biodiversity and culture are all subject to strategies with the aim of improving sustainable development, health and equality in that city. Where issues cross boundaries between each strategy, efforts are made to ensure that a consistent approach is achieved in each.

The conclusion drawn is that for most respondents there were either no data or no attempt to integrate the measures with these other strategies. The lack of integration with strategies such as transport and spatial planning may have important consequences in future. Without a clear view of how these activities impact on air quality then many urban areas may continue to develop without relieving existing or future pollution issues.

## Types of measures implemented

Figure 3 shows in percentage terms whether the response to the pollution problem has been to take permanent local measures or short term plans.

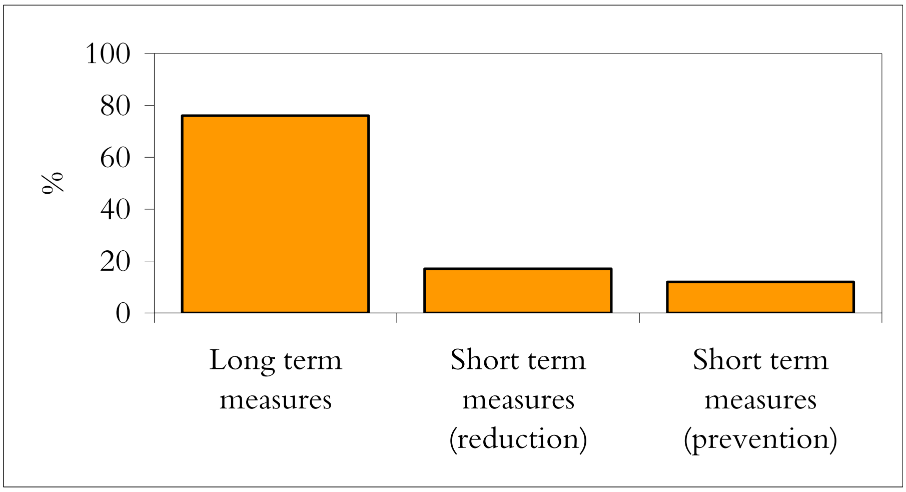


**Figure 3 Percentage of respondents attempting to address pollution through either permanent local measures or short term measures.**

Results clearly show that authorities have mostly implemented permanent local measures. In some cases there are no peak pollution issues that would require taking short term actions but in others it is felt that short term actions have a very limited potential to be effective. These different types of measures are discussed further in the following sections.

### Responses to short term pollution peaks

In the case of short term measures only 1 is reported as complete. This was the case of Atlanta, USA where the hosting of the summer Olympic games in 1996 allowed the closure of the city centre to public traffic. In 7 cases actions are ongoing, in 2 cases the measures are ready to implement and in 3 cases they are still planning. These other cases are discussed further below. Figure 4 below illustrates the main aims of the measure in these cases.

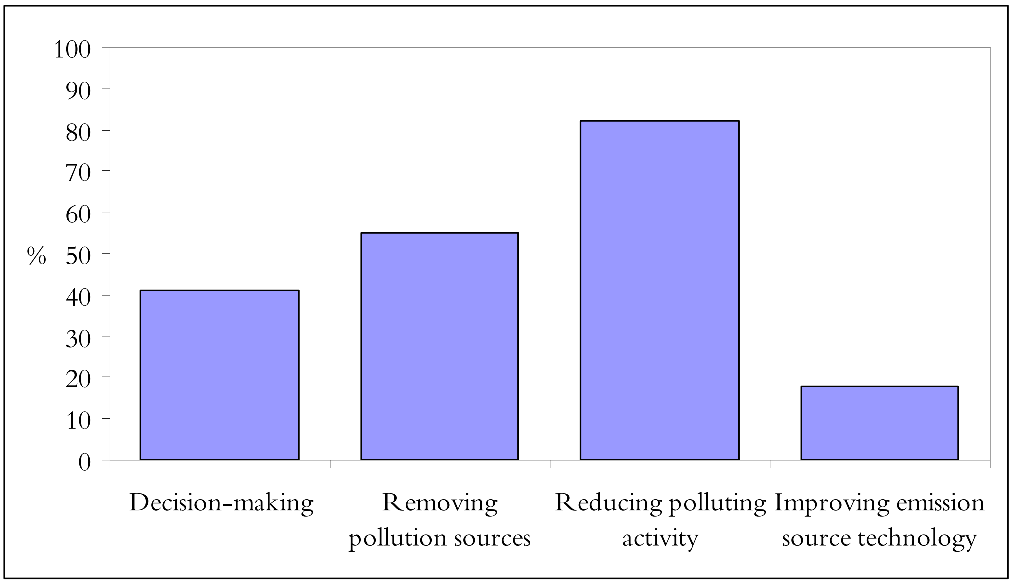

**Figure 4 Frequency with which main aims of short term actions are attempted**

The large majority of measures address polluting activities and limit them in some way and a sizeable subset of these do this through defining an area where these activities are banned from one or more sources. There are also around 40% of cases where decision-making has a part in the measure. These are cases where monitoring or other forecasting methods are used to predict the occurrence or persistence of a peak episode in order to make a decision to restrict polluting activities. In several cases where information was available the decision process involved experts running the monitoring or forecasting tools. For example in Strasbourg ASPA predicts ozone concentrations for the following day and jointly takes the decision with the city authority to implement either voluntary or compulsory measures on road transport.

Since short term actions require time for information to be disseminated to a wide variety of stakeholders (e.g. public transport operators, police and the press so that the public can be informed) in order that the measure is complied with it may be surprising that the proportion of responses with a decision-making element as described is not greater. This may be due to gaps in how respondents completed the survey rather than true omission of such systems from their short-term plans.

Table 3 below lists the available frequency data on the actual activities that are influenced by the short term measures.

**Table 3 Which activities do the short term measures influence?**

| Activity | Number of cases |
|---|---|
| Cars | 19 (86%) |
| Light Duty Vehicles | 1 (5%) |
| Non public transport heavy duty vehicles | 7 (32%) |
| Combustion in the commercial, institutional or domestic sectors | 3 (14%) |
| Combustion in industry | 5 (23%) |
| Industrial processes | 3 (14%) |
| Other stationary combustion | 1 (5%) |
| Other stationary source | 1 (5%) |

Efforts to reduce or restrict road transport are clearly seen to be the most popular response. Several Italian experiences are noted in the responses. Turin restricts vehicles without catalytic converters within a city zone between 8:00-18:30 from October 22 to March 31. Milan has a very similar scheme to Turin while Naples bans the same vehicles during mornings 3 times a week. Turin notes that the measure reduces the number of vehicles circulating but it must be noted that non-catalytic vehicles are now rather old and the measure while encouraging people to replace their older vehicle would currently have rather a limited impact.

Another limitation in the effectiveness of these measures is the voluntary nature of the responses. Unless the pollution peaks are above alarm thresholds then the response is to disseminate information about the following day's peak concentration but then to rely on individual choices to take alternative transportation and hence reduce overall activity. The responses of New Jersey, USA and the French cities of Paris and Strasbourg correspond to this case.

In the Italian cases there are also measures in their plans that require large power plants and other industry to cut-back on their output during the episodes and also instructions to citizens limit their residential heating requirements hence further reducing emissions.

Scandinavian respondents (Stockholm and Helsinki) suffer from peak $PM_{10}$ episodes due to the resuspension of street dust. More frequent street cleaning, public information campaigns and novel dust binding agents are being tried to manage the problem.

Data on how the measures impact on emissions or air quality were only available from around half of respondents and even then quantitative data were rarely obtained from them.

The effects ranged from a slight increase in ozone concentrations (owing to the $NO_x$ titration effect where $NO_x$ emissions had been reduced) through to negligible. However, there were no data in these cases determining the role of meteorology in these impacts.

In only 7 cases (32% of those implementing short term measures) were there data on how the success of measures is monitored. In most of these cases respondents hoped to use ambient air quality monitoring data even though impacts may be very difficult to identify by this means and meteorological conditions have a very great influence. However in the case of Strasbourg the intention is to monitor the number of organisations or commuters who engage with the measure and make some change to their normal activity. It should be easier to monitor the success of such measures via such activity change metrics.

Only in the Strasbourg case had an economic instrument been tried. This measure concerns ozone peaks and includes the possibility of reducing public transport tariffs during such episodes. This measure is subject to a detailed assessment including such available costs data in a later report in this project. No other cost effectiveness reports were available at all from respondents for short term measures.

In all of the other cases the measure is either a straightforward banning order on key activities at key times or a voluntary code of practice to be followed during pollution peaks. 14% of those implementing short term measures cited local legislation (essentially banning orders) to enforce their measures.

On a final note regarding short term measures it appears that in only 23% of cases that respondents engaged with other stakeholders while developing the measure This would include dialogue with transport operators as well as representatives from business and residential communities. Firm conclusions should be tempered by the fact that survey responses may have been returned incomplete but this may indicate partly why voluntary measures have failed to achieve much in the way of air quality impacts (as judged on the evidence of this survey). Greater involvement with the development process may have led to a greater awareness of the pollution problems and the role of each stakeholder in achieving improvements.

### Responses to local hot-spot pollution

70 cases of local permanent measures for dealing with hotspot pollution were found during the survey. The frequency with which key aims of these measures were cited are presented in Figure 5 below.

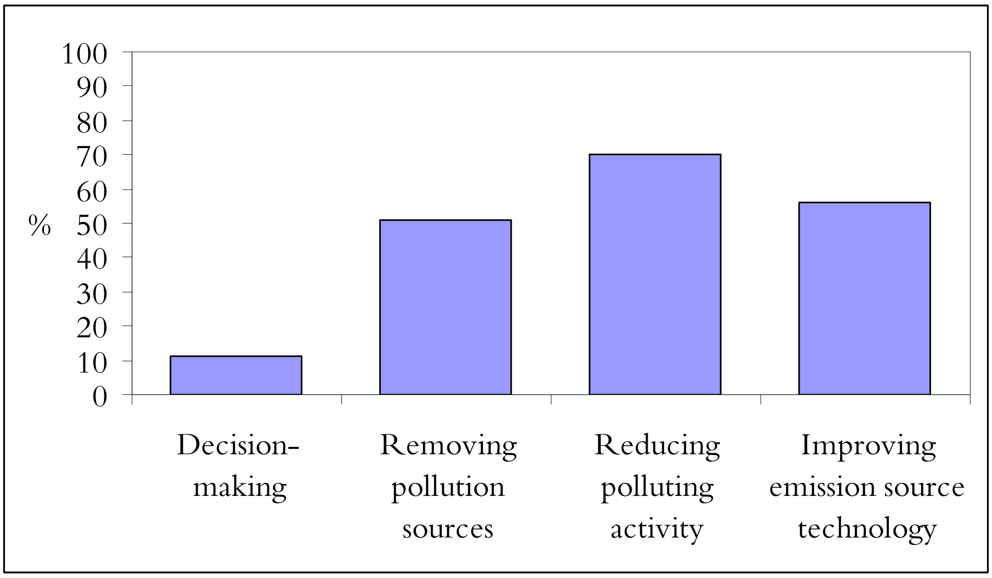


**Figure 5 Frequency with which key aims of local measures were cited in the survey.**

Those citing decision-making as a key attribute of their measure are those still at the planning phase. Most authorities are focussing their local measures on either reducing polluting activities or removing them altogether from polluted zones – two aspects of hotspot pollution that have a greater opportunity to be controlled locally. In addition despite national and European scale policies to improve the technology of emissions sources, the evidence of the survey clearly demonstrates that local circumstances are forcing authorities to consider additional measures to accelerate the uptake of these larger-scale policies.

Table 4 below lists the frequency with which certain activities are influenced by the local measures.

**Table 4: Which activities do the measures influence?**

| Activity | Number of cases |
|---|---|
| Air fleet | 1 (1%) |
| Motorised 2 wheeled vehicles | 6 (9%) |
| Cars | 47 (67%) |
| Light Duty Vehicles | 4 (6%) |
| Non public transport heavy duty vehicles | 28 (40%) |
| Public transport heavy duty vehicles | 20 (29%) |
| Shipping fleet | 1 (1%) |
| Train fleet | 1 (1%) |
| Combustion in the commercial, institutional or domestic sectors | 9 (13%) |

| Activity | Number of cases |
|---|---|
| Combustion in industry | 9 (13%) |
| Industrial processes | 7 (10%) |
| Other stationary combustion | 1 (1%) |
| Other stationary source | 1 (1%) |

Road transport is clearly once again the main focus of the measures particularly cars and heavy duty vehicles. However, there are still a number of cases where either industrial or small-scale combustion sources are the focus of attempts to reduce pollution hotspots. Examples of the different types of measures found in the survey are discussed below.

**Road transport based measures**

Flow management measures.

Other new infrastructure measures aim to relieve congestion through managing speed in defined zones or installing dynamic traffic and information management systems to influence traffic behaviour. The control zone on the motorway in Overschie in the Netherlands is an excellent example of this measure including quantitative data on its impacts.

At the local level building new roads to relieve pressure on existing ones was found to be a valid measure to reduce impacts in some cases but the survey also found measures utilising existing roads. These included re-routing the transit of various classes of road vehicle to avoid conflicts, e.g. routing freight or long distance commuting around urban centres. The strategy for Strasbourg city centre includes measures of this type. Oswestry in the UK also believes that a bypass road would alleviate their $NO_2$ hotspot but notes that the local authorities do not have the power or resources alone to direct such a road to be built.

Further measures using the existing road network involve creating lanes prioritised for various forms of traffic including public transport or high occupancy vehicles. The cities of Sheffield and Newcastle in the UK are considering this type of response.

Access restrictions

A frequently attempted measure is to restrict access in a defined zone either permanently or at set times. The restriction can range from a complete ban (i.e. pedestrianisation scheme) through a ban by vehicle class to a more subtle control by the age of vehicle (e.g. a Low Emissions Zone). The survey found that the bans are not always total but allow drivers to make an economic choice (i.e. to pay a charge to enter the restricted zone). The congestion charge zones in London, UK and Trondheim, Norway are examples of an economic instrument response rather than an outright ban. London is also considering a low emissions zone and this is examined in more detail in section 3.

Several cases were found where alternate circulation is practised. These schemes restrict a fraction of the vehicle fleet entering a zone on alternate days so that no one is permanently prohibited from entering the restriction zone but the overall level of traffic activity is restricted. Schemes of this sort operate in the mega cities of Sao Paulo and Mexico City.

Voluntary restrictions found in the survey include schemes where park and ride facilities are provided to encourage fewer cars entering an urban centre. Cork City in Ireland has attempted this measure although its impact is described as ‘marginal’.

Public Transport Schemes

The survey found many cases where it is attempted to encourage the greater take up of public transport. Measures include the integration of different forms of transport and ticketing to ease multi-mode journeys and improving the quality and capacity of the transit systems. In some cases the price of public transport is subsidised so that it is an attractive economic option. Strasbourg in France has a particularly well-developed strategy of this type.

The survey found cases where authorities are encouraging the development of organisational travel plans including targets for the numbers of people taking up public transport options. Sheffield in the UK is pursuing such actions as a small part of an action plan.

Cleaner vehicles

Many authorities aim to accelerate the take up of currently available cleaner vehicles. London in the UK is addressing this issue in several ways. For public service fleets environmentally sensitive procurement and the implementation of alternative fuelling infrastructure are being used to cultivate a viable market for others to change their vehicle fuel or engine technology. The private fleet can take advantage of national funding available to help pay for differently fuelled or powered vehicles. There is also a program of roadside emissions testing which while not very cost effective is considered useful for raising awareness of the importance of the quality of existing vehicles.

Low emissions zones are also examples of policies to accelerate the uptake of cleaner vehicles. Stockholm has operated such a zone for several years while London has studied the feasibility and effectiveness of such a zone (the political decision to implement this scheme has yet to be finalised and its impacts and benefits are assessed in detail in section 3 of this report).

**Domestic sector**

Where the domestic/commercial/institutional sector is significant (usually emissions associated with space heating for these premises) the survey found several examples of measures attempting to reduce these emissions. Obligations to change fuel to a less polluting one have been implemented in Dublin, Ireland (an area ban on the sale of bituminous coal) with great success. In other locations schemes for maintaining the combustion efficiency through maintenance or local funding to upgrade building insulation or to replace solid fuel heating systems with cleaner ones have been found. Rome and Milan in Italy demonstrate schemes of these types.

**Industry**

Large industry in Member States is generally regulated under the IPPC Directive. However the survey found examples of local attempts to further reduce emissions from certain industrial installations. They include technical type measures either converting to a cleaner fuel, upgrading the process technology or other wise abating emissions. In Strasbourg, France there is a commitment to investigate economically and technically feasible abatement of industrial $SO_2$, $NO_x$ and $PM_{10}$ emissions – there is no further information at present. In other locations there are attempts to force industry to voluntarily consider what efficiency gains, fuel or process changes could be implemented to contribute to emissions abatement.

**Others**

In a few cases the survey found measures addressing other sources of pollution.

Emissions from ships. Sweden introduced port fees differentiated by the emissions performance of individual ships. Those that had abatement systems and in particular used lower sulphur oil paid less. This was quickly a successful measure but one that has been superseded since by European scale policy to reduce the sulphur content of liquid fuels.

Some respondents have a significant problem due to the proximity of a major airport (for example Hillingdon in the UK is the area where Heathrow airport is located and which causes widespread exceedence of the EU annual mean $NO_2$ objective). Their authority does not extend sufficiently to control activities in the airport hence their actions are to lobby central government to bring about emissions reductions either through international agreements for regulating aircraft emissions or control over the development of airports.

It is seen that several of these measures (around 30% of the total) combine traditional command and control elements with economic instruments (e.g. parking charges, road tolls or other access charges, fuel/technology conversion grants and fuel cost social allowances). The combination of these instruments seems to be particularly true for measures aimed at private road vehicles. Straightforward access bans on such vehicles to remove their contribution to hotspot pollution (command and control strategy) are sometimes seen as politically unpopular or damaging to local economies whereas economic instruments allow individuals to retain choice as to how they respond. However, a key in such strategies is that the pricing of the instrument is correctly set in order to achieve the required air quality benefit. No evidence was available in this study to suggest that authorities have had to adjust the pricing of their economic instruments as yet. Also it must be recognised that in some locations the scale of the hot-spot problem is such that finally command and control instruments may still be required.

A feature of many responses to the survey was an indication that many different measures are being attempted simultaneously in a coordinated package or action plan. This indicates recognition that frequently many different source types contribute to local pollution levels, the scale of the pollution problem sometimes requires a large degree of local action and that there is a local political commitment to implement measures across society to reduce environmental impacts. However it may also be a symptom of insufficient local information on what are the key emitters and the most cost-effective way of achieving air quality objectives.

This latter point is reflected in the response rate for data on the impacts of the measures cited above.51% of respondents provided some information on the effect of the measure on emissions and 47% provided some information on the effect on air quality. However, these responses most often stated that the effects had not been assessed yet or were ex ante predictions of as yet unimplemented measures.

Only in a few cases were there data to suggest a significantly positive outcome. The most positive examples where such data were available have been assessed in more detail in Section 3 of this report.

Data quality and availability is also an issue in terms of cost-effectiveness reporting and how the success of measures is monitored. Only 31% of respondents provided any comment.. In most of these cases the hope is to use ambient air quality monitoring data. Since this indicator is influenced by non-local emissions, meteorological conditions and noting the fact that several measures are being simultaneously implemented it is difficult to monitor the effectiveness of individual local measures in this way – although this indicator is clearly key to demonstrating progress towards compliance with the air quality objectives. However, in other cases the intention is to monitor other indicators such as traffic counts or speeds (Overschie in the Netherlands and London, UK) or the number of people switching to public transport (Strasbourg, France). These indicators are directly linked to the measure being implemented and their effects on emissions and air quality can be assessed via models.

In only 11% of cases did respondents provide data on how local measures are implemented in a legal sense. Where this information was available (e.g. London, UK) a picture emerged of using local powers to create traffic control orders within urban areas. However, authorities may need to depend on national scale regulators (i.e. of industry or of major road routes) to implement measures needed to alleviate local hotspot problems. An example of this is seen in the Overschie District of Rotterdam the Netherlands. The national Transport Minister had to approve a plan to smooth traffic flow on a motorway adjacent to a large housing estate. Strong local lobbying was required before the measure was implemented to the benefit of the residents. This example is assessed in more detail in Section 3 of this report.

In a small proportion of cases (13%) other stakeholders in addition to the final regulators were consulted during the planning of the measure. Where this did occur consultation included dialogue with transport operators and manufacturers as well as representatives from the business and residential communities. In the UK, local authorities are legally obliged to consult widely within the residents' communities and among other stakeholders when defining air quality action plans. It is felt that this exercise could lead to a clearer definition of measures and a better rate of implementation or compliance hence increasing the chance that measures will succeed. Consultation can be clearly important in identifying those measures that while probably effective in improving air quality have little chance of successful implementation under anything else but an unpopular command and control strategy.

Beyond the analysis in this section it is important to point that very few of the responses are complete enough to be very useful in evaluating whether localised or short-term measures are more cost-effective than larger scale measures. In many cases we have found little or no evidence of either ex-ante or ex post cost benefit analyses or of adequate monitoring demonstrating the actual effect of the measures. Those that did offer adequate data and which appeared to provide positive experiences are assessed in detail in Section 3 of this report.

# SECTION 3 – DETAILED ASSESSMENTS

This section presents the analysis of the detailed case study assessments and the methodology used for the analysis.

## 3.1 TASK OBJECTIVES

The key objective of this task was to undertake a limited number of representative in-depth case studies. The information included in the studies comprises:

- Detailed descriptions of the initial objectives of the measure;
- Analyses of the environmental benefits, notably on emissions, air quality, and health and other relevant indicators;
- Analyses of the costs of measures and a comparison with the benefits;
- Analyses of other scheme criteria, for example, public and political acceptance, ancillary benefits of greenhouse gas emission reduction or noise mitigation.

For each case study there is also a discussion of the advantages and limitations of the measure. This includes a discussion of the possibilities of transferring the measure to other locations.

## 3.2 SELECTION OF CASE STUDIES

The case studies have been selected from an analysis of the data in the experience database, supplemented with additional literature review.

The experience database contains information on 92 different measures that have been used to address pollution peaks or hot spots. The measures address road transport emissions in 76% of cases, and it is clear that this sector dominates urban pollution concerns. In 50% of cases the pollution problem is experienced year round and covers a significant area, i.e. larger than just a few streets, but rarely over the whole area of the authority. In 73% of cases, a permanent scheme has been introduced to reduce transport based polluting activities.

The pollutants that concern each authority do vary: 27% cite difficulty in achieving the EU limit values for $PM_{10}$, 20% cite $NO_2$ and 17% cite ozone.

From this evidence four case studies were selected that focus on road transport emissions through controls implemented in particular zones. One of the measures is short-term (too address peak pollution episodes), while in the other three are permanent. The case studies are:

- Controlled access by congestion charge – example: London
- Controlled access by designated low emission zone – example: London

- Controlled traffic flow by speed cameras – example: Rotterdam
- Short-term incentive to switch travel modes – example: Strasbourg

The second most significant sector cited in the database as causing local or short-term pollution problems is the small-scale combustion sector (18% of responses). In particular poorly dispersed emissions from this sector are implicated in $PM_{10}$ and $SO_2$ pollution through the use of solid fuels (Pye 2004). A representative case study addressing these emissions has also been completed.

- Area ban on marketing and sale of a category of solid fuel used in the domestic sector – example: Dublin.

A number of other studies of interest are also included but in less detail due to much less data being available.

## 3.3 METHODOLOGY FOR ASSESSING THE COSTS AND BENEFITS OF LOCAL MEASURES

### 3.3.1 Introduction

This section sets out the approach used for quantifying benefits from the air pollution improvements of local measures.

The main benefits that could be quantified in such an analysis are:

- Impacts on health (mortality and morbidity, both from acute and longer-term 'chronic' exposure);
- Impacts on building materials and cultural heritage;
- Impacts on agricultural and horticultural production;
- Impacts on ecosystems;
- Other secondary effects associated with the schemes, including greenhouse gas emissions, noise, congestion, accidents, and wider socio-economic effects. Note these could be both positive and negative.

Ideally, we would quantify and value each of the benefits of all individual schemes[1]. However, this would require extensive local air quality modelling and assessment. Instead, the approach used is a simplified approach, using estimates of the health benefits and economic benefits, using unit pollution factors, in terms of the health impact and economic cost per tonne emitted.

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[1] The underlying methodology used in the benefits analysis for quantification and monetisation of impacts recommended is the 'impact-pathway' approach, as developed by the US/EC fuel cycle project and the ExternE project.

A set of these unit pollution factors (based on this type of analysis) has been published by the European Commission in it's BeTa database and values (Holland and Watkiss, 2003).

However, since BeTa, the EC has commissioned a major review and update of the benefits analysis, as part of CAFE, under the *Service Contract for carrying out cost-benefit analysis of air quality related issues, in particular in the clean air for Europe (CAFE) programme*[2] (the CAFE CBA project).

The CBA project presented an updated approach to benefits quantification and valuation in July (Holland et al , 2004). The final methodology was peer reviewed, and the final methodology published at the end of the January 2005 (Holland et al, 2005). The new CAFE CBA methodology has been used to provide an updated interim set of unit pollution costs. These are reported as a range of values, the range reflecting the uncertainty in the quantification and valuation of chronic mortality impacts. A final set of values is being prepared, which uses the underlying EMEP runs to derive country to grid transfer matrices and unit pollution costs. These will be published in February 2005. Further details of the CAFE CBA methodology are available from the web-site (http://www.cafe-cba.org/).

A number of caveats are associated with the CAFE CBA approach and the values in this report. Most importantly, the numbers exclude several categories, notably: impacts on ecosystems (acidification, eutrophication, etc) and impacts on cultural or historic buildings from air pollution. Therefore the benefits given in the report are only a sub-total of the full value.

Also important is that the environmental costs vary according to a number of factors, including overall levels of pollution, geographic location of emission sources, height of emission source, local and regional population density, meteorology etc. The numbers used here take these issues into account to a certain degree only. One of the most important aspects to account for is the location of emissions (see box below). To account for this, the interim values have an urban increment, to account for the higher health impacts of urban emissions.

[2] Led by AEA Technology Environment, and including a European wide, multi-disciplinary consortium.

The location of emissions has a very large impact on the magnitude of impacts. This is particularly important for primary $PM_{10}$ emissions from transport, because of the local population density exposed to pollution. Emissions in large, densely populated urban areas have impacts that are many times higher, per unit tonne of emissions, than rural areas. A recent UK analysis has analysed the population-weighted exposure from $PM_{10}$ emissions in different urban locations in the UK. The relative economic damage cost, per tonne of emissions, are shown below, set against emissions in central London on the left hand side (the area with highest population density), through to rural emissions on the far right.

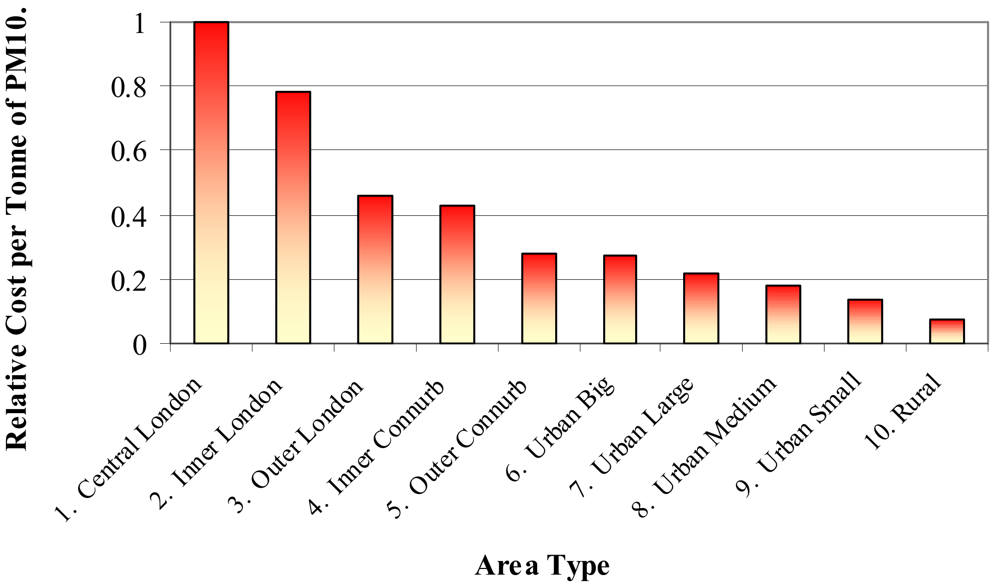



**Figure 6 Relative Unit pollution Costs from a Tonne of primary $PM_{10}$ emitted in different urban areas in the UK (left Central London – right rural), where cost per tonne in central London = 1. Source: Watkiss et al, 2005.**

Note this effect is not seen for other pollutants (e.g. $SO_2$, $NO_X$ and VOCs), at least in the cost-benefit analysis studies, because there are no direct health impacts attributed to these pollutants (see the CAFE CBA analysis). However, these pollutants do contribute to health impacts through the formation of secondary pollutants (e.g. secondary particulates from $SO_2$ and $NO_X$, ozone from $NO_X$ and VOC emissions). As these pollutants typically form over time (and therefore distance), they therefore have a less significant effect on the population in the immediate area of the emission source.

It will be useful to compare the benefits of the local measures below to the main analysis of policies in the CAFE thematic strategy. This would help inform how effective local measures might be when compared to European wide policies.

However, some care should be taken in comparing the results in the following sections to the CAFE CBA work. There are two main reasons for this. Firstly, the analysis here has only covered air quality benefits, and many local measures have wider benefits. Secondly, there are issues of environmental justice that should be considered for local air pollution hot-spots. In deciding whether a European scale or a local scale measure is more appropriate, it is necessary to consider both these aspects. To illustrate:

- *Wider urban effects*. Some measures will have a larger degree of overall benefits (and benefit to cost ratio) when considered across all urban sustainability criteria, e.g. taking into account congestion reduction, decreased accident rates, etc, rather than when considering air quality benefits alone. This stresses the importance of achieving the right balance at local level between actions that concentrate on local measures primarily aimed at improving local air quality, and/or those that give the greatest benefits consistent with improving the urban environment more generally (i.e. towards overall urban sustainability that improves congestion, accidents, noise, air quality, etc).

- *Environmental justice vs. environmental efficiency*. There are two ways to consider the future effectiveness of air quality improvements.

    - The first is to focus on the progress towards legally binding air quality limit values. This seeks to ensure environmental protection and environmental justice by protecting human health, i.e. by ensuring concentrations do not exceed levels known to impact on health. This is particularly important in terms of social deprivation, because lower income groups tend to be exposed to higher air pollution concentrations (see King and Stedman, 2000; Pye, 2001). It is stressed that local measures might be more effective in this regard: i.e. in progress towards air quality limit values.

    - The second is to focus on maximising health benefits, i.e. to focus on economic efficiency and delivering most health benefit for least cost. This leads to a consideration of cost-benefit analysis (the absolute levels of health improvement) and a move towards gap closure for future policy.

    - The above two policy objectives are not necessarily consistent, i.e. measures that best achieve the air quality limit values do not necessarily deliver maximum health benefits[3]. To illustrate, an individual scheme may have a large health benefit (when compared to another), but actually achieve less progress towards the air quality limit values, or vice versa.

Where possible, we have also identified wider urban benefits, and the potential reduction in air quality exceedences of the limit values, for the case studies below.

[3] This occurs because $NO_2$ is probably a threshold pollutant, at least for short-term exposure, whilst PM dominates the health impacts of air pollution, and there is no threshold of effect for this pollutant.

## 3.4 DETAILED ASSESSMENT LONDON CONGESTION CHARGING

### 3.4.1 Description of the initial objectives of the measure

Congestion charging schemes aim to reduce vehicle use by charging users to pay for entering or travelling in a particular zone, or for using a particular stretch of road.

There are many examples of road user charging schemes in operation across Europe on highways, where drivers pay by cash or token for using the bridge or tunnel as they pass through a toll plaza. However, these do not address urban air quality hot spots, and so are not considered further here.

This section considers the use of charging systems in major urban areas. In such areas, toll plazas are not used, because they delay traffic flow. Instead, a number of targeted schemes have been implemented. The first example of such a scheme was introduced in Singapore in 1975, which was initially based on a paper licence system (subsequently replaced by and electronic system in 1988). However, the most far-reaching scheme is the road user-charging scheme in operation in London – the London Congestion Charging Scheme LCCS).

The London Congestion Charge came into effect in February 2003. The Charging zone covers an area bounded by the London inner ring road, and drivers of non-exempt vehicles must pay a charge of £5 per day (approximately 7.5 Euros) to enter and travel within this zone. The scheme is enforced by a network of Automatic Number Plate Recognition (ANPR) cameras that monitor all vehicles entering and circulating within the zone. The number plates of vehicles are read and stored on a database. At the end of each 24-hour period, the vehicle registration data held in this database is crosschecked against vehicle registration data collected from those drivers known to have paid to enter the charging zone. Drivers found to be evading payment are issues with a Penalty Charge Notice.

The congestion charging zone is 21 square kilometres in size; representing 1.3% of the total 1579 sq km of Greater London. Note, while the area is large for existing congestion charging schemes, it is still small in relation to London, see figure below.

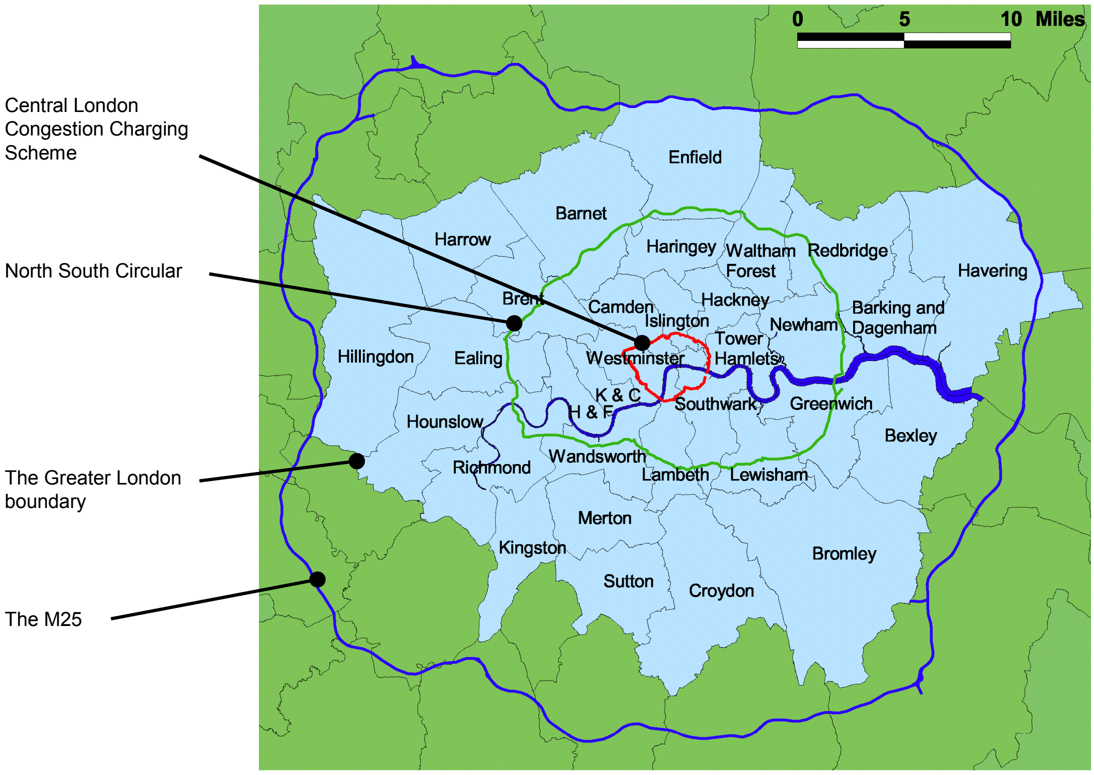



**Figure 7 London Congestion Charging Scheme in Relation to London**

### 3.4.2 Background information on London traffic numbers and emissions

A very large number of vehicles operate in (Greater) London during the course of any single year. While there is good data on London traffic flows, there is unfortunately no robust information on the numbers of vehicles operating in London. The estimated number of vehicles travelling in Greater London each year is shown in below. The number of vehicles is high, as it includes vehicles that only come into the city once a year, as well as vehicles that enter frequently. The estimates indicate that at least 14%, and probably more likely, around 36% of the British lorry fleet come into London each year. A higher proportion of coaches, possibly as many as half of all British vehicles, also operate in London during the course of a year. Finally, an estimated 14 – 18% of all British vans travel in London at some point during any year.

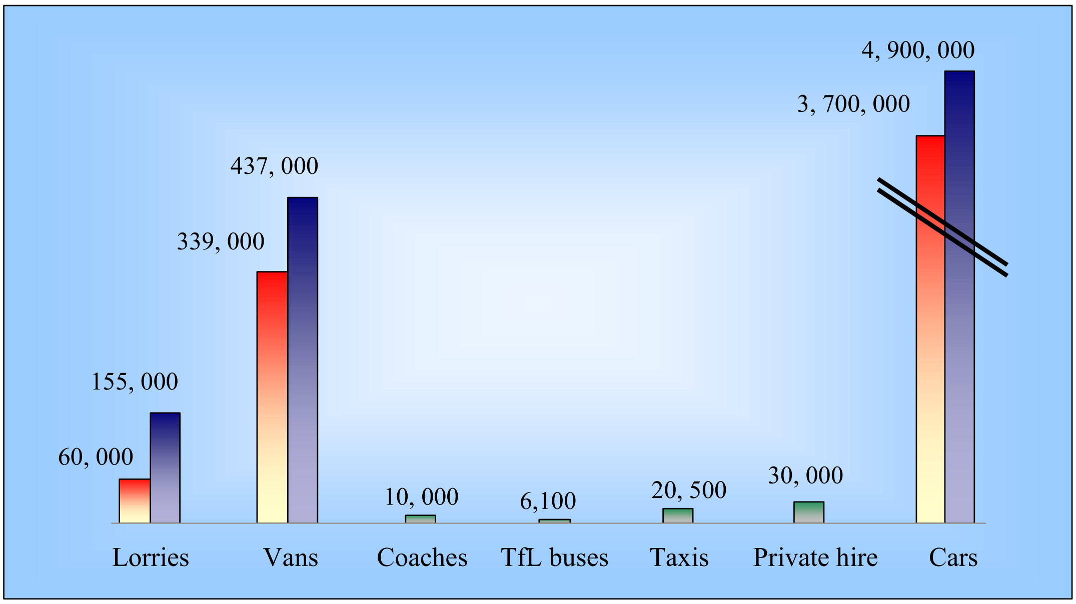



**Figure 8 Total Number of Vehicles Operating in Greater London each year (2002).**

Source: Watkiss et al, 2003. The values for lorries, vans and cars show a low and high range. Values for other vehicles are presented as a central estimate only. The scale is linear for all vehicles except cars, the numbers of which far exceed other categories (denoted by parallel lines). The number of vehicles in future years will be higher due to fleet growth.

Most taxis, buses and coaches are active in central London. The numbers of other vehicles entering the central area of London is much lower, as a % of vehicles entering London. An estimate was made of the numbers of the national fleet operating in London, and the congestion charging area, prior to the introduction of the congestion charge

**Table 5 Nationally Registered Fleet and Vehicles operating in London (Numbers), Prior to Introduction of Congestion Charge.**

| | National | Central London* | Inner London | Greater London |
|---|---|---|---|---|
| **Articulated lorries (low)**<br>% of Nat. Fleet | 114,451 | 2,150<br>**2%** | 5,518<br>**5%** | 16,032<br>**14%** |
| **Articulated lorries (high)**<br>% of Nat. Fleet | 114,451 | 5,051<br>**4%** | 17,867<br>**16%** | 39,316<br>**34%** |
| **Rigid lorries (low)**<br>% of Nat. Fleet | 310,977 | 19,050<br>**6%** | 30,047<br>**10%** | 44,026<br>**14%** |
| **Rigid lorries (high)**<br>% of Nat. Fleet | 310,977 | 44,756<br>**14%** | 98,285<br>**32%** | 115,227<br>**37%** |
| **Coach** * | 20,000 | 7,502 | 10,538 | 9,959 |
| % of Nat. Fleet | | **38%** | **53%** | **50%** |
| **Vans (low)**<br>% of Nat. Fleet | 2,469,445 | 164,423<br>**7%** | 197,426<br>**8** | 338,796<br>**14%** |
| **Vans (high)**<br>% of Nat. Fleet | 2,469,445 | 139,751<br>**6%** | 355,027<br>**14%** | 437,447<br>**18%** |
| **Cars (low)**<br>% of Nat. Fleet | 23,196,112 | | | 3,674,815<br>**16%** |
| **Cars (high)**<br>% of Nat. Fleet | 23,196,112 | | | 4,897,863<br>**21%** |

*Area of the congestion charge

Road transport is the single most important source of emissions in London, as seen in the Figure below.

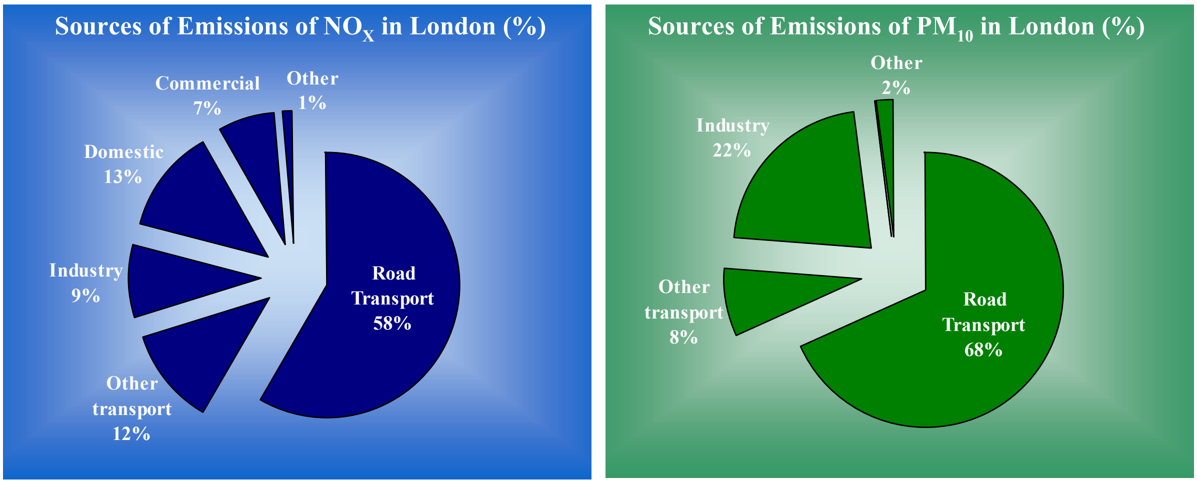



**Figure 9 The Current Contribution of Road Transport to Air Pollution in London.**

Based on 1999 data. Source: Watkiss et al, 2003.

It is also useful to look at the total contribution of different vehicles to road transport emissions in London. The estimated the contribution from different vehicles to future road transport emissions in London for the years 2005 to 2010 is shown below.

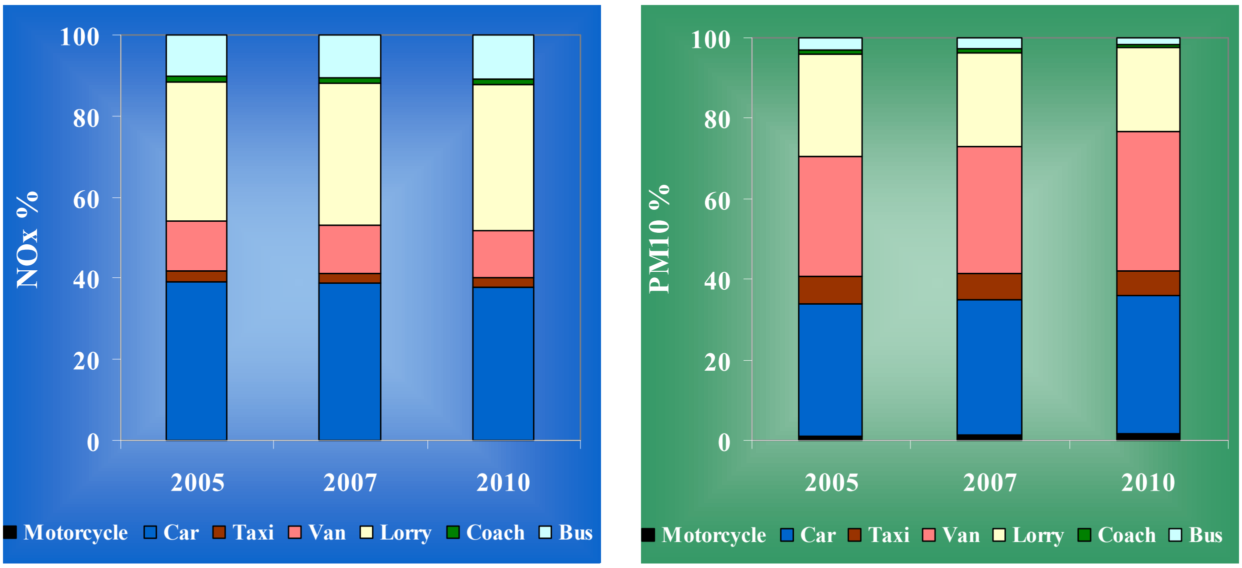
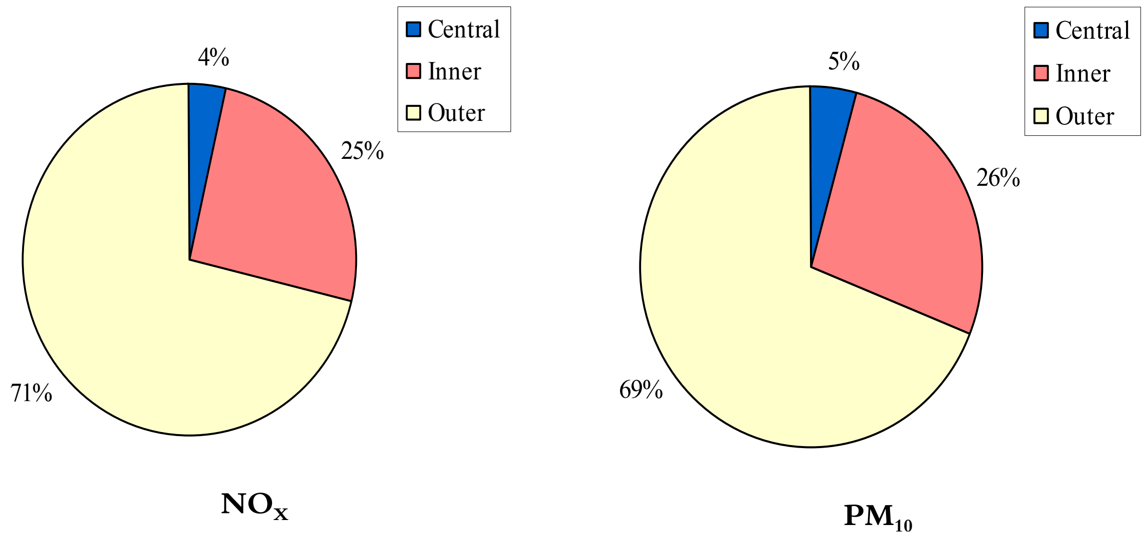



**Figure 10 Emissions from Vehicles in London (as % of Total Road Transport Emissions).**

Source: Watkiss et al, 2003.

Overall, transport emissions from central London are small in relation to the Greater London area (see below). There is also a different pattern of vehicles for different areas of London than shown in the figure above. Buses and licensed taxis are much more significant sources of emissions in central London, whilst car and lorry emissions are lower (as a %).

**Transport Emissions in London in 2005 by Area.**




Note the central area represents the area of the congestion charge.

### 3.4.3 Analysis of costs and benefits

***Ex-Ante Environmental Impacts (Emissions and Air Quality)***

As part of the work carried out in the London Congestion Charging Research programme (MVA, 1995), an assessment was of the potential effect of a charge on $CO_2$ and CO emissions in Central London (the are that the charge covers). The study estimated a47% and 21% reduction respectively, associated with a 22% reduction in vehicle kilometres in the zone: no estimates were made for the effects on $NO_x$ and $PM_{10}$. Estimates were also provided for the Inner London area (which includes an area extending beyond the zone itself – up to the north south circular – see map above). The study indicated that for a 3% reduction in vehicle kilometres, there would be a 7% reduction in $NO_x$.

Subsequent studies, including the ROCOL report (Halcrow, 2000) and the Greater London Congestion Charging Order report to the Mayor (GLA, 2002), did not examine the emissions and air quality benefits of a charging zone at all. As stated in the Congestion Charging Report to the Mayor,

"the environmental benefits of the scheme in terms of improved air quality, pedestrian amenity, or reduced traffic noise are expected to be small and have not been examined further…".

The ROCOL study also acknowledged that the air quality benefits from fewer private cars might be offset by increases in numbers of heavier vehicles.

### *Ex-Post Environmental Impacts (Emissions and Air Quality)*

A number of ex post studies are now available on the congestion charging scheme. We have based most of the analysis on the Impacts Monitoring Second Annual Report (TfL 2004). This is the second in a series of annual reports describing the impacts of congestion charging in and around central London. It supersedes and extends the previous material published by Transport for London (TfL), in June and October 2003, and in February 2004.

The ex post analysis in the report has estimated that by reducing the volumes of traffic in the zone, congestion charging has led to a reduction of 12% in both $NO_X$ and $PM_{10}$ from road traffic in the central area of London. There have been some changes in the emissions on the inner Ring Road, but these are estimated at less than 2%.

These benefits arise because there are reduced volumes of traffic, and the traffic is moving faster (this is important because emissions are higher, per km, at very low vehicle speeds).

The ex post analysis estimates that between 2002 (pre-charging) and 2003 (post charging), primary emissions of $NO_X$ from road transport in the central zone of London fell from 810 to 680 tonnes/year (16% reduction). 75% of this is estimated to be due to congestion charging. It also estimates that primary $PM_{10}$ emissions from road transport in the central zone have fallen from 47 to 40 tonnes/year (16%) and that again, 75% of this is due to congestion charging (the rest due to changes in the vehicle fleet).

The Impacts Report has also assessed the potential benefits to air quality concentrations, as estimated by models and monitored. This comparison is difficult, because of the large number of variables that determine pollution concentrations, and because 2003 was an exceptional year for $PM_{10}$.

### *Health Indicators (Exposure, Mortality And Morbidity)*

No quantified estimates exist of the ex ante health benefits of the scheme. Similarly, there are no plans to measure direct health benefits arising from the scheme ex post, and none are reported in the Impacts Monitoring Second Annual Report.

### *Other Relevant Indicators*

The primary aim of the scheme is not air quality benefits. The congestion charging scheme has four transport priorities:

- To reduce congestion;
- To improve bus services (through revenues generated);
- To improve journey time reliability for car users;
- To make the distribution of goods and services more efficient.

The most relevant indicator for the scheme is traffic congestion. The benefits from the above four priorities are much more important in relation to the overall benefits from the scheme (and wider urban sustainability objectives).

Since the implementation of the CCS, T*f*L has published reports presenting the effects that the scheme has had on actual traffic flows and congestion levels both within the charging zone and on the inner ring road. The following tables present some of the findings from these reports. The original report showed baseline traffic data for 2002 (before the scheme was implemented) and ex-post data for 2003.

**Table 6 Average traffic flows within the charging zone before and after implementation of the CCS**

| **Vehicles entering charging zone (7.00 am to 6.30 pm)** | **Average speed** | **Cars** | **Taxis** | **Vans** | **Pedal cycles** | **Motor cycles** | **Bus and coach** | **HGVs and other** | **TOTAL (excluding cycles)** |
|---|---|---|---|---|---|---|---|---|---|
| May 2002 - actual traffic flows (before CCS implemented) **(A)** | 13 km/h | 390,000 | 110,000 | 110,000 | 25,000 | 50,000 | 27,000 | 35,000 | **722,000** |
| Forecast traffic flows for 2003 if CCS had not been implemented **(B)** | N/A | 391,873 | 110,528 | 110,528 | 25,120 | 50,240 | 27,130 | 35,168 | **725,467** |
| Feb/March 2003 - actual traffic flows (after CCS implemented) **(C)** | 17 km/h | 240,000 | 120,000 | 100,000 | 27,000 | 55,000 | 29,000 | 32,000 | **576,000** |
| Change in traffic flow due to CCS **(C - B)** | 4 km/h | -151,873 | 9,472 | -10,528 | 1,880 | 4,760 | 1,870 | -3,168 | **-149,467** |
| Percentage change | 31% | -39% | 9% | -10% | 8% | 10% | 7% | -9% | **-21%** |

Source: Central London Congestion Charging Scheme – 3 months on (except Estimate of traffic growth for 2003 if CCS had not been implemented – calculated using TEMPRO traffic growth factors for the London Boroughs in which the CCS operates)

The data shows that on average there has been a reduction in traffic flows of 21% within the charging zone since the congestion charging scheme came into operation at the beginning of 2003. This percentage reduction is as a proportion of the estimated traffic flows for 2003 if the scheme had not come into operation.

Analysis of the traffic flow data for the inner ring road shows that there has been a 4% increase in traffic flows between 6.00 am and 8.00 pm since the CCS was introduced, shown in Table 7.

**Table 7 Average traffic flows on the Inner Ring Road before and after implementation of the CCS**

| Date | Weekday average traffic flows (all vehicles) 6.00 am -7.00 am | 7.00 am - 10.00 am | 10.00 am- 1.00 pm | 1.00 pm - 4.00 pm | 4.00 pm - 6.30 pm | 6.30pm - 8.00pm | TOTAL (6.00 am - 8.00 pm) |
|---|---|---|---|---|---|---|---|
| **2002 average (measured data) (A)** | 7,500 | 34,000 | 34,000 | 35,100 | 32,500 | 18,500 | **161,600** |
| **2003 forecast if CCS had not been implemented (B)** | 7,536 | 34,163 | 34,163 | 35,269 | 32,656 | 18,589 | **162,376** |
| **Average flows for Feb-May 2003 (measured data) (C)** | 8,386 | 37,454 | 35,407 | 36,471 | 32,457 | 18,957 | **169,132** |
| **Change in traffic flow due to CCS (C-B)** | 850 | 3,290 | 1,244 | 1,203 | -199 | 368 | **6,756** |
| **% change in traffic flow due to CCS** | 11% | 10% | 4% | 3% | -1% | 2% | **4%** |

Source: Central London Congestion Charging Scheme – 3 months on (except Estimate of traffic growth for 2003 if CCS had not been implemented – calculated using TEMPRO traffic growth factors for the London Boroughs in which the CCS operates)

The information on the scheme has recently been updated in the Impacts Monitoring Second Annual Report. This shows that congestion within the charging zone has reduced by 30% and the volume of traffic circulating in the zone during charging hours has reduced by 15% (excluding two-wheeled vehicles), and the traffic entering the zone has reduced by 18% (during charging hours). The report states that these reductions are at the top end of the ex ante predictions, for example, the reduction in volume of traffic predicted ranged from 20 to 30%. The ex post analysis also finds that the proportion of time that drivers spend stationary or moving slowly in queues has reduced by up to one third. There is no evidence of systematic increases in traffic outside the zone.

The report also assesses the journey timesavings from the scheme. Panel surveys have shown that journey timesavings average 14%, with an increase in reliability of journey times increasing (27% for outward journeys, 34% for return journeys). On a typical trip of 80 minutes, on average, this could mean travel timesavings of about 10 minutes.

Finally, public transport is successfully accommodating displaced car users. Of the 65000 to 70000 car trips that are no longer made to the zone during charging hours, 50-60% have transferred to public transport, 20-30% divert around the zone, and 15-25% have made other adaptations, such as changing the timing of trips.

A number of other indicators are relevant. These are discussed in later sections.

***Analysis of ex-ante and ex post costs of the Congestion Charging Scheme***

A number of studies were carried out to assess the potential costs of introducing and operating a charging scheme in London.  In 1995, the MVA Consultancy was commissioned by the Government Office for London's Planning and Transport Directorate to carry out the London Congestion Charging Research Programme

In 2000, a further study entitled "Road Charging Options for London: a Technical Assessment" (commonly known as the ROCOL study) was carried out by a team of consultants led by Halcrow Fox.  As part of the assessment, estimates of the set-up and annual operational costs were provided.

As part of TfL's study into the Congestion Charging Scheme in 2002, the scheme's start-up and operating costs were estimated over a ten-year time period – the assumption being that the scheme would remain in operation from February 2003 until February 2013.

The cost estimates from all of these studies are presented below.  It can be seen from the table that the start-up costs estimated in 1995 as part of the London Congestion Charge Research Programme are much greater than in the subsequent studies.   This is because this study assumed that requiring all vehicles that travel into London to be fitted with electronic in-vehicle transponder units would enforce the scheme.  Subsequent studies showed that whilst this would be the most effective way of enforcing the scheme, the time it would have taken to develop and procure suitable units would have meant that the scheme could not have become operational during the first term of office of the Mayor.  Consequently, a simpler enforcement mechanism using camera technology was chosen.  The ROCOL report and the TfL study for the Mayor both provide costs based on using ANPR camera technology to enforce the scheme.

**Table 8 Ex-ante costs associated with implementing a Congestion Charging Scheme in London**

| Study | Costs | Costs at time of scheme assessment | Costs in 2003 prices |
|---|---|---|---|
| | ***Ex-ante costs*** | | |
| London Congestion charging Research Programme (1995) | Start-up costs | £95 million to £145 million | £116 million to £178 million |
| | Annual operating costs | £55 million to £60 million | £67 million to £73 million |
| | Annual revenues from scheme (revenues given negative sign) | | |
| ROCOL report (1999/2000) | Start-up costs | £30 to £50 million | £33 million to £55 million |
| | Annual operating costs | £30 to £50 million | £33 million to £55 million |
| | Annual revenues from scheme (revenues given negative sign) | -£260 million to -£320 million | -286 million to -£353 million |
| Congestion Charging Order: Report to the Mayor (2001/2) | Start-up costs | £15 million | |
| | Operating and management costs (over ten years) | £816 million | |
| | Traffic management costs (over ten years) | £40 million | |
| | Additional public transport costs (over ten years) | £176 million | |
| | Scheme compliance costs to road users (over ten years) | £200 million | |
| N/A | ***Ex-post costs*** | | |
| | Capital costs | Unknown as yet | Unknown as yet |
| | Operating and Maintenance costs | Unknown as yet | Unknown as yet |

A detailed report in the actual ex post costs of the scheme has not been produced. However, some ex post cost data are available in the Impacts Monitoring Second Annual Report. This was presented as the following analysis of the costs and benefits of the scheme (Table 9). Note the values do not include the annualised cost of capital (the ANPR camera system), which are known to have been significant. These would need to be added to the annual costs below to properly assess the cost-benefit analysis of the scheme. Including these would reduce the net annual benefits of the scheme.

**Table 9 Preliminary Estimates of Quantifiable Costs and Benefits of the Central London Congestion Charging Scheme**

| Category | £ Million per year | Million Euro per year |
|---|---|---|
| **Annual Costs** | | |
| Administration and other costs | 5 | 7.5 |
| Scheme operation | 90 | 135 |
| Additional bus costs | 20 | 30 |
| Charge-payer compliance costs | 15 | 22.5 |
| **Total** | **130** | **195** |
| | | |
| **Annual Benefits** | | |
| Time savings to car and taxi users, business use | 75 | 113 |
| Time savings to car and taxi users, private use | 40 | 60 |
| Time savings to commercial vehicles | 20 | 30 |
| Time savings to bus passengers | 20 | 30 |
| Reliability benefits to car, taxi, commercial | 10 | 15 |
| Reliability benefits to bus passengers | 10 | 15 |
| Vehicle fuel and operating savings | 10 | 15 |
| Accident savings | 15 | 22.5 |
| Dis-benefit to car occupants transferring to public transport | -20 | -30 |
| **Total** | **180** | **270** |
| | | |
| **Net Annual Benefit** | **50** | **75** |

Source: Impacts Monitoring Second Annual Report

The table also does not include the payment of charges, as the report states '*in cost-benefit terms these are a transfer payment*'.

Finally, the values above do not value air pollution benefits. It is possible to estimate these using the approach outlined in the methodology section, reflecting the CAFE CBA unit pollution costs. Using these values, the estimated annual benefits of the CCS scheme (in 2003, compared to 2002) are estimated at 0.75 to 1.5 million Euros. It can be seen that these benefits are low in relation to the main objectives of the scheme (in the table above). However, these do not cover all benefits (i.e. they exclude benefits to ecosystems and cultural heritage) and the emissions analysis does not cover all pollutants (only PM and $NO_X$): additional benefits would arise from reductions in other air pollutants (e.g. VOCs) and $CO_2$ emissions.

### 3.4.4 Other Evaluation Criteria

***Public and Political Acceptance***

There were widespread concerns about the scheme prior to introduction. To address this, extensive stakeholder consultation work was carried out before and after the scheme was implemented. The Impacts Monitoring Second Annual Report has a detailed analysis of the response to the scheme.

There has been a generally positive response to the scheme observed, reinforced by the success of the measure in alleviating congestion in the charge zone.

Surveys of the attitude of Londoners to the scheme before and after show a shift of opinion towards favouring the scheme and its effects. Ex ante, around 38 to 40 of people surveyed supported the scheme and 40% to 43% opposed the scheme. After introduction, 48 to 59% of people surveyed supported the scheme and 24% to 31% opposed the scheme (the range of values represents different surveys undertaken at different times). 80% of those who expressed an opinion in surveys considered the scheme had been effective in achieving its primary objectives.

It also found that London residents perceive fewer negative effects from the scheme than they expected ex ante. Indeed, over 40% of residents within the charging zone consider their area as a place to live has improved.

A business survey found that the response of the majority of businesses in the zone or close to the boundary have been neutral, with businesses generally supportive of the scheme (ex post). The response varies according to sector: finance and business sectors are positive because of the reduction in journey times; retail and leisure businesses perceived that congestion charging had affected their business performance. The majority of respondents surveyed reported little or no change to business performance after introduction – while there was some decrease in performance for some respondents, it is difficult to separate this from wider economic trends (i.e. a small decline that happened in other areas across the UK).

Overall, the performance of the London economy was similar to that of the UK as a whole. The analysis found that the direct impact of congestion charging on the central London economy was small (and that there had been much greater other influences).

***GHG reduction***

No detailed ex ante predictions were made for the scheme. However, the Impacts Monitoring Second Annual Report has assessed the potential ex post benefits of the scheme. The scheme is estimated to have led to savings of 19% in traffic related $CO_2$ emissions, and 20% in fuel consumed by road transport within the charging zone.

*Noise reduction*

Predictions of changes in noise levels were made ex ante for the scheme. These suggested that changes in the charging zone and around would be insignificant. There were some concerns that congestion charging might actually increase noise levels, as the reduction in traffic would lead to greater speeds, leading to higher car noise, albeit from a smaller number of vehicles.

The Impacts Monitoring Second Annual Report has assessed the potential ex post benefits of the scheme, based on noise measurements. This has found no evidence from sample noise measurements that there have been significant changes in the ambient noise levels within the charging zone, and where increases have occurred, these are considered to be below the levels that would be perceptible.

*Accidents*

One of the other main indicators is the reduction in accidents. Ex ante, it was predicted that the scheme would result in 150 - 250 fewer accidents each year.

The Impacts Monitoring Second Annual Report has confirmed that benefits have occurred. A full annual data set is not yet available, but the data shows a fall in accidents that is proportionally greater than elsewhere in London.

There has also been no evidence of an increase in accidents involving two-wheeled vehicles. This was one concern prior to the introduction of the scheme.

*Others*

The ex ante analysis identified the main socio-economic effects of congestion charging fall on private car users, who are likely to be excluded from the London LEZ. The report also concluded that commercial vehicles would derive large economic benefits, from journey time and reliability benefits.

The Impacts Monitoring Second Annual Report has a detailed analysis of the business impacts of the scheme. The analysis found that the direct impact of congestion charging on the central London economy was small (and that there had been much greater other influences).

### 3.4.5 Advantages and limitations of the measure

The London congestion charging scheme needs to be viewed in relation to it's primary objectives: reducing congestion levels, improving journey times, and improving public transport (through revenues). The scheme has been considered a success against these objectives.

Because the scheme has reduced traffic flows in the Charge zone by 21%, it has led to emissions benefits. This has also helped progress towards the EU limit values (though on it's own, the CCS scheme is not sufficient to achieve the limit values across the zone).

As long as lower traffic flows are maintained, the scheme will also lead to lower emissions in future years. However, it is likely that the emissions benefits of the scheme will be lower in absolute levels (in tonnes of emissions abated) in future years, when compared against the baseline conditions that would have existed without the scheme in place. This is because emissions from the fleet will fall anyway with the introduction of later Euro standards. To illustrate, the while a 16% reduction in estimated emissions has occurred with the scheme in place, around 25% of this improvement is due to the changes in the vehicle fleet (and would have happened in the absence of the scheme).

The scheme has a number of advantages. Firstly, it has travel time benefits for users. Secondly, it is self-financing, and the revenues from the scheme have been used to increase investment in public transport. It has also led to benefits to accidents and emissions.

In terms of limitations, the scheme does have high capital costs. Moreover, the costs of the scheme (and the revenues generated) are a transfer from the public, and there are inequality issues in relation to the nature of the regressive charge (i.e. it primarily impacts on low income vehicle owners).

Overall, the scheme has been effective and successful, though it has led to lower revenues than anticipated ex ante. This has been positive in reducing traffic levels and improving air pollution, but has reduced the revenues available for investment in public transport.

The general perceptions towards the scheme are more positive than anticipated before introduction.

### 3.4.6 Analysis of possibility of extension to other cities

There has been widespread interest in adopting this scheme in other cities.

The London scheme is based on a central urban cordon. The advantage is there is a ring road around the charging area, to allow traffic to avoid the zone. Any replication of the scheme would need to examine the suitability of the urban road network, to avoid potentially large problems with diverted traffic (i.e. there is little point in introducing a scheme that reduces congestion in one area if it greatly increases congestion in another area outside the charging boundary). The scheme is most suited to larger cities. The scheme also has high capital costs, and fairly high operating costs, so it may only be applicable for larger areas where the revenues will support such a scheme. Areas that already have extensive pedestrianisation or have other schemes in place may not be suitable.

In order for the scheme to work, a good public transport infrastructure is needed to allow users to access the area of the scheme, though the revenues from the scheme can be used to improve existing public transport services. Finally, any scheme will be seen as more publicly acceptable if there is an existing congestion problem, otherwise the scheme may just be seen as an additional tax.

Smaller schemes can be introduced, even down to the level of individual roads with air quality problems. However, the advantages of small schemes need to be evaluated carefully to ensure that this does not merely move congestion hot spots from one area to another.

Technological barriers have been addressed. Alternatives do exist to ANPR systems, notably electronic tagging systems, or electronic toll stations. These systems may become more attractive as Europe moves towards a system of lorry charging, i.e. it would be relatively easy to alter charges according to the location under such systems and avoid the need for expensive camera based detection systems. Simpler alternatives do exist (permit based schemes, enforcement based on parking checks) but these tend to be more difficult to enforce.

There are potential political barriers. These include the negative perceptions before the scheme, from car users who enter the area, from businesses located in the area, and the political issue of increased taxes. To be successful, schemes need to make sure revenues are not used solely as income generator: the London scheme has addressed this problem by recycling the revenues into public transport.

### 3.4.7 Contact for more information (air quality related)

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Further details on the scheme can be found at:

http://www.london.gov.uk/mayor/congest/index.jsp

# 3.5 LOW EMISSION ZONES

## 3.5.1 Detailed description of the initial objectives of the measure

Modern vehicles have much lower emissions due to European vehicle emissions legislation ('Euro standards'). The legislation was initially introduced in 1993 (Euro 1) and were tightened in 1996-1997 (Euro 2) and in 2001 (Euro 3). Legislation is also in place for further controls in 2006 (Euro 4) and in later years. The faster adoption of cleaner road vehicles therefore offers opportunity for reducing emissions. One of the more promising options to introduce greater numbers of cleaner vehicles, and reduce the numbers of older, more polluting vehicles on the road network, is through the introduction of a **low emission zone** (**LEZ**). An LEZ is a defined area that can only be entered by specified vehicles meeting certain emissions criteria or standards, e.g. certain Euro standards. An LEZ prohibits older vehicles from operating in an area, and so accelerates the turnover of the vehicle fleet (or requires operators of older vehicles to fit abatement equipment to their vehicles). Although traffic volumes do not necessarily change, vehicles travelling in an area have lower emissions, and this leads directly to air quality improvements. LEZs for freight vehicles have already been successfully implemented and run for many years in Sweden, where they have led to improvements in air quality levels, see box below.

**Box 1. Swedish Experience with Low Emission Zones**

Low Emission Zones have been in place in Sweden since 1996, when Stockholm, Gothenburg and Malmo introduced 'Environmental Zones' in their city centres, with the purpose of improving air quality and reducing noise. The zones target all diesel lorries and buses over 3.5 tonnes. On introduction, the scheme required all these vehicles to meet the Euro 1 standard. Vehicles between 9 and 15 years old were also allowed to operate in the zone if they had been retrofitted with a certified emissions control device or new engine. There was also a special permit for vehicles that only travelled rarely in the zone. The zone is enforced using a permit system for older vehicles (windscreen stickers) with visual inspections. Vehicles driving illegally in the zone are subject to a fee, enforced by police authorities. The zone does not have any signage. The compliance rate is around 90% (based on visual inspections). The zone is simple and has low costs to administer.

From January 2002, the environmental zones (Stockholm, Gothenburg, Malmo and Lund) introduced an 8 year age limit from date of first registration on all heavy-duty vehicles (>3.5 tonnes). Older vehicles, with first year of registration after 1993 (i.e. minimum Euro 1) may enter the zone with the approved after treatment device. A two-tier system was introduced. Level B, which requires the retrofit technology to reduce emissions of particulates and hydrocarbons by 80%, and level C, which requires an additional 35% reduction in $NO_X$. For both levels, no increase in noise levels is allowed with the retrofit technology. Level B corresponds with a particulate filter and catalytic converter and level C with current $NO_X$ reduction equipment. Vehicles meeting level B requirements are allowed to operate for another 4 years in the zone (i.e. until 12 years old). Vehicles meeting level B+C requirements are allowed to operate for an additional 2 years on top of this (i.e. until 14 years old). Special conditions are set out for vehicles with a special body. For these vehicles (even if pre-Euro), vehicles over 8 years old are allowed to enter the zone with relevant emissions after-treatment equipment. In addition, vehicles meeting the level B emissions requirements are permitted to operate for longer (vehicles between 8 and 15 years are allowed to in the zone if they meet level B emission requirements and an additional 2 years on top of this if they meet B+C requirements). Vehicles are also allowed to enter if they re-engine. For example, if a new engine is put into a vehicle after January 2002, the vehicle may enter the zone for a maximum of 6 years from the year of manufacture of the engine (provided the engine meets the most severe European environmental class at that time). It may also enter the zone for longer if the level B and B+C emission requirements are met through additional approved abatement equipment.

LEZs are also being widely considered by other UK and European cities, with advanced plans in London. Indeed there is now a commitment to press ahead with the London scheme. Details of the scheme are outlined in the box below.

**Box 2. The Proposed London Low Emission Zone**

A feasibility study was undertaken (reporting in 2003) on the potential for a London Low Emission Zone (Watkiss et al, 2003). This considered the costs and benefits of the LEZ, what it could achieve and how it could be implemented, with the aim of informing whether low emission zones would work towards meeting London's air quality targets and whether they should be taken forward to implementation. The study considered a very large number of different options for a low emission zone in London. The conclusions from the study, should a low emission zone for London be taken forward, were:

**Area**. The study recommended that the most appropriate option for a London LEZ would be a scheme including all of the Greater London area.

**Vehicles**. The study recommended that the low emission zone started with a scheme that targeted lorries, London buses and coaches. These vehicles have disproportionately high emissions per vehicle and targeting them produces greatest emissions reductions for least cost. However, the study recommended that the zone be potentially extended in later years to include vans (subject to further investigation of the socio-economic effects of such a scheme on small companies/owner drivers) and taxis (though taxis should be addressed earlier through the licensing process). The study did not recommend that cars should be included in the scheme, but did recommend that some action is needed, alongside any LEZ, to target the removal of very old cars in London (those built before 1993).

**Legislation and Enforcement**. The study recommended that a manually enforced scheme, targeting heavy vehicles only, would enable the quickest introduction of an LEZ (where offenders are pursued through the courts). However, automatic enforcement using cameras would ensure higher compliance and so greater air quality benefits. The study concluded that an automatic approach would be needed if the LEZ were to include vans to ensure adequate detection rates.

**Implementation Date.** The work necessary to set up the legal basis for a London LEZ would make it extremely difficult to implement a fully operational scheme before the middle of 2006, and more realistically before late 2006.

**Emission Criteria.** The emission criteria set for a London low emission zone will dictate the air quality benefits and the costs to operators. The study recommended that for lorries, buses and coaches the criteria were based on Euro standard (age) and other emission standards (the Reduced Pollution Certificate (RPC)). The study recommended that vehicles should meet an initial criterion of Euro 2 plus RPC (or equivalent) in 2006/7. It also recommended that this criterion be tightened to Euro 3 plus RPC (or equivalent) in 2010. However, there were two additional conclusions put forward alongside this latter recommendation. Firstly that a $NO_x$ based RPC scheme would help the effectiveness of the scheme and could allow greater $NO_2$ improvements. Secondly that it might be beneficial to introduce the Euro 3 plus RPC criterion earlier than 2010 using a rolling approach (applying the RPC to Euro 3 vehicles based on age). The study recommended a different approach for vans, should these vehicles be included, using a rolling ten-year-old age limit. A similar age-based standard was also recommended for licensed taxis and private hire vehicles.

The emission criteria above would impact on an estimated between 22000-59000 heavy goods vehicles or approximately 37% of HGVs travelling in Greater London. No buses would be affected as they must already comply with the emission criteria by 2005. However, an estimated 5800 coaches would be affected which represents 56% of these vehicles travelling in Greater London. The approximately 4 million cars, taxis, light goods vehicles and private hire vehicles that travel in Greater London each year would be unaffected. Heavy Goods Vehicles will be responsible for 34% of the London road transport total for $NO_x$ and 25% for $PM_{10}$ in 2005. While it possible to indicate the contribution of the road vehicles potentially affected by the LEZ towards London emission totals there are no data available to indicate the contribution towards ambient air quality levels currently experienced.

There are also other area access control measures such as 'home-zones': these are focused on residential areas where safety and community enhancements are the primary drivers, rather than road transport emissions and indeed such schemes may actually increase emissions by decreasing vehicle speeds. These residential schemes are not considered further in this study.

'Ex post' data does exist on the Swedish LEZs (though we have found little 'ex ante' analysis for the schemes that would be transferable to the current study). There is also a very detailed 'ex ante' analysis of the proposed London scheme. Both are summarised in the following sections. Note much of the background information on emissions and vehicle numbers in London was presented in the previous section.

Road transport accounts for approximately 58% of $NO_x$ emissions and 68% of $PM_{10}$ emissions in London. Furthermore, HGVs of all kinds in 2005 will be responsible for 34% of the London road transport total for $NO_x$ and 25% for $PM_{10}$. While it possible to indicate the contribution of the road vehicles potentially affected by the LEZ towards London emission totals there are no data available to indicate the contribution towards ambient air quality levels currently experienced.

### 3.5.2 Environmental Impacts (Emissions and Air Quality)

***The Swedish LEZs (Ex Post)***

In Stockholm, the environmental zone covers around 30% of the total population of the city (i.e. an area with around 220,000 people). An assessment of the air quality benefits of the scheme in 2000 (Johansson and Burman) found that emissions of $NO_X$ from heavy vehicles within the zone were reduced by 10% and emissions of particulates by 40%. These benefits are relative to the emission reductions that would have occurred from heavy vehicles (only) without the zone. The corresponding reductions in air pollution concentrations were estimated at 1.3% reduction for $NO_X$ (with a range of 0.5% - 2%) and 3% for particulates (with a range of 0.5% to 9%), compared to the predicted concentrations without the zone. The values are much lower than with emissions because of the importance of other road vehicles and other sources to total air quality concentrations. The analysis also concluded that the effect of the environmental zone was large when compared with other actions that it was possible for the local city administration to implement.

***London LEZ (Ex Ante)***

The London analysis undertook very detailed analysis on emissions and air quality.

It concluded that a London low emission zone would have modest benefits in improving overall emission levels and absolute air quality concentrations in London, but it would make a larger contribution to reducing exceedences of the air quality targets. The recommended LEZ would have greatest impact in targeting $PM_{10}$ emissions and air quality exceedences. It is estimated that the recommended scheme would achieve a 23% reduction in total London $PM_{10}$ emissions in 2010. It would also achieve a 43% reduction in the area of London exceeding the relevant $PM_{10}$ air quality target in 2010, and a 19% reduction in the area of

London exceeding the relevant $NO_2$ air quality target in 2010. The emissions and air quality improvements are summarised below.

**Table 10 Air Quality Benefits of the Recommended London LEZ**.

| | Reduction in Emissions (relative to baseline) | | | Reduction in Area Exceeding Targets (relative to baseline) | | |
|---|---|---|---|---|---|---|
| **Pollutant** | **2007** | **2010 A)** | **2010 B)** | **2007** | **2010 A)** | **2010 B)** |
| **$NO_x$ ($NO_2$)** | 1.5% | 2.7% | 3.8% | 4.7% | 12% | 18.9% |
| **$PM_{10}$** | 9.0% | 19% | 23% | 0%* | 32.6%** | 42.9%** |

* London should meet the relevant air quality for $PM_{10}$ in this year without any additional action for an average year's weather. ** Exceedence of the annual mean$PM_{10}$ objective.

The 2007 scheme only includes lorries, buses and coaches. In 2010: A) includes lorries, buses and coaches and B) includes lorries, buses and coaches, vans and taxis. Source: Watkiss et al, 2002.

The comparison of the Swedish and London studies provides some interesting conclusions. The Swedish schemes have achieved very large emissions improvements, because they were introduced early, when the fleet had higher emissions (i.e. by targeting pre-Euro vehicles). Essentially, because the London scheme is being introduced in later years, the benefits are mitigated by the ongoing improvements in the vehicle fleet as a result of the Euro standards: by 2007, emissions from road vehicles will be significantly lower than they are today, and much lower than the early years of the Swedish scheme (introduced in 1996).

Interestingly, the London study also found that a London low emission zone would have a greater impact in improving air quality concentrations than it would in reducing emissions, at least in relation to the specific air quality targets set by the UK Government and the European Union. This happens because many locations in London are likely to be close to the air quality target levels for future years. Even small changes in emissions can significantly affect the area of exceedence, so that an area that previously exceeded the air quality target could drop below the threshold level with the introduction of a low emission zone in place.

### 3.5.3 An analysis of costs and benefits of the measure

Some analysis was made of the population weighted exposure from the London LEZ, and the likely improvements in health, as a reduction in mortality and morbidity.

The analysis showed that a London LEZ would have a relatively small improvement in reducing the number of $PM_{10}$ related acute deaths from air pollution (more accurately known as the deaths brought forward). It would also lead to a relatively small reduction in the numbers of severe hospital admissions from $PM_{10}$. For both of these health endpoints, the improvements would be measured in only several cases avoided each year. However, the LEZ would also reduce down the number of total health effects (including less severe air pollution related health impacts) very significantly from $PM_{10}$, i.e. by tens of thousands of cases each year. It would also lead to an increase in years of life gained, with perhaps a thousand extra years of life per year gained from the scheme[4]. The relatively modest

[4] We do not report the detailed analysis here, because the methodology used is different to that recommended in the CAFE CBA health impact assessment.

improvement in health is due to the relatively small changes in background ambient concentrations from the scheme. Note the scheme only assessed the direct effects of $PM_{10}$, and only considered pollution benefits in London: there would be additional benefits from $NO_X$ and from all pollutants outside London from regional air pollution transfer. We do not report the detailed analysis here, because the methodology used is different to that recommended in the CAFE CBA health impact assessment.

### *The Swedish Schemes (Ex Post)*

Some analysis of the costs of the Swedish low emission zones (environmental zones) has been compiled. The zone works by excluding heavy goods vehicles that are older than eight years old, or have approved emissions control technology fitted if older. However, Swedish cities are much smaller than London and a much lower number of total vehicles is affected – for example the Swedish Stockholm scheme affects 7,000 heavy vehicles, whereas the London scheme (potentially) affects as many as 30,000 to 70,000 heavy vehicles. While small businesses were identified as being affected by a potential Swedish zone, no special measures were introduced to assist these businesses. The cost of compliance of the Stockholm scheme was estimated at around 37 M crowns, with other schemes in Gothenburg and Malmo estimated at 14 M crowns and 11M crowns respectively for 1997. The actual costs in Stockholm were actually found to be around half the estimated value, while the costs in the other two cities were about the same as those predicted. No attempt was made to estimate the social and economic costs of the schemes. The Swedish scheme did consider a five-year, rather than an eight-year cut-off for eligible vehicles (the recommended proposals for the London LEZ effectively introduce a 5 year age limit). However, this tightened age limit was ruled out in Sweden because most vehicles had an eight-year warranty and a feasibility study indicated that the 5-year age limit would result in very high costs to business.

### *The London Scheme (Ex Ante)*

The costs of setting up and running a London low emission zone vary with the exact scheme and the types of vehicles included. A manually enforced (permit) scheme for lorries would have the lowest cost to set-up, at an estimated £2.8 million to set-up, with running costs of around £4 million each year (4.2 million Euro set-up, 6 million Euro running costs). There are a number of ways an automatically enforced scheme (based on vehicle recognition through cameras) could be introduced. The costs of introducing a network of fixed cameras across London are prohibitively high. Therefore, should an automatic enforcement approach be adopted, the LEZ feasibility study recommended the use of the existing Central London Congestion Charging Scheme (CCS) infrastructure, combined with the use of mobile ANPR cameras, and possibly a small number of additional fixed cameras outside this area. This type of scheme is estimated to cost £6 million to £10 million to set-up (9 to 15 million Euro), with running costs of around £5 million to £7 million each year (7.5 to 10.5 million Euro), but might generate revenues of £1 million to £4 million per year (1.5 to 6 million Euro). Note the revenue raised should not be included in a cost-benefit analysis as it is a transfer. It is stressed that none of the London LEZ schemes considered in the study would be likely to be self-financing. The costs of different schemes are shown below.

**Table 11 Estimated Costs (£ Million) of the Recommended London LEZ Schemes.**

| | Heavy vehicles only | | | | Heavy vehicle and light vans |
|---|---|---|---|---|---|
| | Manual enforcement | Automatic enforcement via mobile ANPR cameras | Automatic enforcement via fixed ANPR cameras | Automatic enforcement via mobile and fixed ANPR cameras | Automatic enforcement via mobile and fixed ANPR cameras |
| **Start-up costs** | £2.8 million | £6.4 million | £7.6 million | £9.3 million | £10.4 million |
| **Annual operating costs** | £3.9 million | £5.0 million | £5.8 million | £6.4 million | £7.0 million |
| **Annual revenue** | -£0.4 million | -£1.2 million | -£1.8 million | -£3.9 million | -£4.3 million |

Note: automatic enforcement and any revenues are conditional on a decriminalised regime being introduced. The revenues shown are those likely to arise initially on scheme introduction, but would be expected to fall in later years as compliance improved. Source: Watkiss et al, 2002.

It is stressed that there is a trade off between the levels of non-compliance, the revenues generated, and the air quality benefits of a scheme. The estimated revenue streams arise because a small proportion of vehicle owners would continue to use their vehicles on an irregular basis in the zone and pay penalty charges, rather than invest in a new vehicle or abatement equipment. These vehicles would not be generating anticipated air quality benefits, which is the primary reason for introducing the scheme. It is also expected that operators would change their behaviour as the scheme progressed, i.e. compliance rates would increase in later years (which would be good for air quality), and so revenues would decline. When all capital costs and operating costs are considered, even with potential revenues in early years, it is clear that a London LEZ would not be self-financing, i.e. it would require funding.

It is also important to recognise that a low emission zone would have significant cost implications for vehicle operators. The study has clearly shown that the costs to operators are likely to exceed the costs of setting up and running a London LEZ (presented in an earlier section). Indeed, the total costs of many LEZ options to vehicle operators could be extremely high. These costs are relevant in any cost-benefit analysis.

Estimating these costs is very difficult, not least because it depends on the behavioural response of vehicle operators. The study undertook stakeholder consultation and industry surveys to get some indications of possible behaviour. The conclusions were:

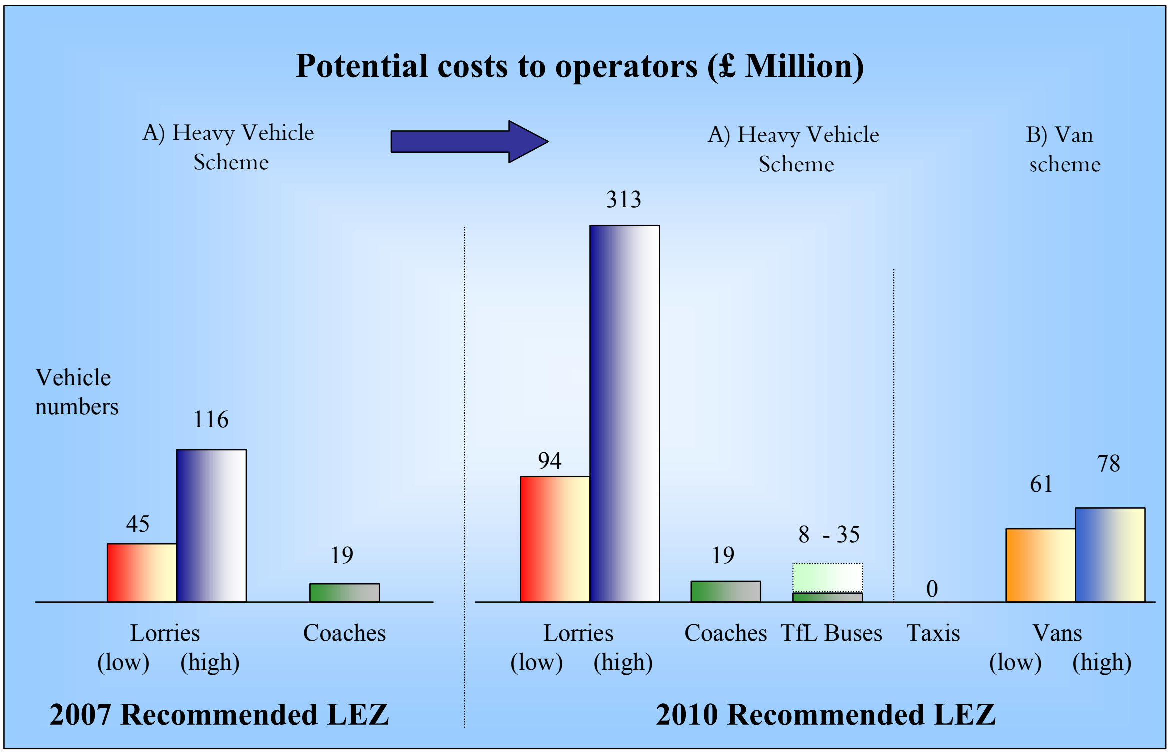
- For many national/larger operators, with larger fleets, a low emission zone might not have a large impact, as many of these companies only keep their vehicles for 5-6 years.
- Even for operators with a mix of older and newer vehicles, there would be a zero cost option, which would be to alter their fleet logistics so that their older vehicles were moved to other parts of the country(25% of those questioned expected their companies to adopt such a strategy). The impacts of a LEZ would therefore be greatest on London registered vehicles, particularly specialist vehicles that have longer lifetimes.

For relatively new heavy vehicles, it is possible to fit relatively low cost equipment that can improve vehicle $PM_{10}$ emissions, such as a diesel particulate filter. Operators can also refit a new engine into an existing vehicle to improve the emissions performance to a similar level to modern vehicles.

Operator may also decide to replace a vehicle – buying either a second hand or new vehicle. All fleet operators have a natural cycle of vehicle replacement and in any given year, around 10% of the vehicle fleet are replaced with new vehicles. For relatively new vehicles, this is generally a more expensive option than retrofitting. For older vehicles, bringing forward the purchase of newer vehicles can actually lead to an economic benefit to the operator because of the improved fuel efficiency and lower maintenance of a modern vehicle.

The potential costs to operators from the recommended low emission zone are shown in Figure below, based on the consultation response. It is stressed that the costs for *individual* vehicles are not high – but the total costs are large because of the very large number of vehicles that operate in London each year. The costs of introducing the recommended LEZ in 2007 could have a cost to industry of £64 million to £135 million (96 to 203 million Euro), depending on the number of vehicles that operate in London.

**Figure 11 The Potential Costs of the Recommended LEZ to Vehicle Operators.**




The figure shows present value costs, taking account of the capital costs and changes in maintenance, fuel efficiency, etc over the lifetime of the vehicles. The low and high values for lorries and vans reflect a range of the number of vehicles operating in London. Figures assume full compliance with the LEZ (though the figures for freight vehicles are adjusted down by 25% to take account of fleet redeployment, in line with the industry consultation). The same assumption has been used for the coach fleet. The analysis assumes that all Euro 2 vehicles are retrofitted with abatement equipment to meet the emissions criteria, but does not include potential grants (CleanUp) or VED rebate for this action. The range in the values presented for TfL London buses in 2010 reflects the uncertainty over the potential responses available to the LEZ. Source: Watkiss et al, 2003.

However, more recent work on costs, taking into account revised technical costing for abatement measures, indicators a lower range from £37 million to £95 million for the first phase of the scheme to operators.

The potential costs to operators would be less if current Government grants continue or are extended. They would also be lower than shown above if the current Government vehicle duty rebates were maintained in future years. At present, lorry operators who achieve the RPC are entitled to a discount on annual Vehicle Excise Duty (VED) of £5 to £500 per year (depending on the type of vehicle).

The study also found that the costs of the scheme would rise very dramatically if the emissions criteria were stricter for two reasons. Firstly there are many more vehicles affected, and secondly, operators would need to take greater action (more expensive retrofit equipment or new vehicles) to meet the stricter emission criteria. The recommended LEZ (above) would allow operators of most relatively new heavy vehicles to continue operating in the zone provided they took some action to improve emissions (i.e. it would preserve the asset value of the vehicle). A stricter zone would significantly reduce the value of these vehicles, or require expensive abatement options, and it is clear that a strict scheme would have a very large detrimental impact on vehicle operators.

***Benefit to Cost Ratio Sweden (Ex Post)***

A CBA was undertaken for the Swedish environmental zones and the analysis estimated that 80% of the costs of the zone had been offset by direct gains for the environment. Unfortunately the data is not available to re-assess the cost benefit ratio with the new unit pollution values used in other areas of the report.

***Benefit to Cost Ratio London (Ex Ante)***

The London study also undertook a cost-benefit analysis. This found that the benefits were broadly comparable to the full costs of the scheme (i.e. the costs of implementation and the costs to industry). The London LEZ feasibility study conclusions were:

> *The benefits of health improvements have been estimated to be £26 million (39 million Euro) from the recommended LEZ in 2006/7 in the first year of introduction alone, and just under £100 million (150 million Euro) in total, based on the net improvement to the vehicle fleet. The benefits for the two recommended schemes in 2010 are £32 million (heavy only) and £40 million (including vans and taxis) in the first year of introduction, and £122 million and £143 million respectively in total.*
>
> *A London low emission zone would improve the health of Londoners by reducing air pollution related impacts. The economic benefits of these environmental improvements would more than offset any costs of introducing and operating the scheme, for example the estimated health benefits in London from the recommended scheme for 2007 are estimated at £100 million (£150 million Euro). Moreover, these benefits are a sub-total, as they only include the air quality improvements in London - there would also be benefits outside London from cleaner vehicles affected by the London LEZ travelling elsewhere. Overall, the study concludes that the benefits*

*of the schemes are likely to be broadly similar to the overall costs (including the costs to vehicle operators). The recommended heavy vehicle LEZ has greatest benefits, relative to costs.*

We have reanalysed the study findings with the approach presented in the methodology section, reflecting the CAFE CBA unit pollution costs. The analysis is based on the emissions reduction in London. The analysis shows that the benefits of the 2007, in the first year, are estimated at 9.5 million to 18.7 million Euro.

Of course, there are benefits from the scheme in later years, but these decline over time (unless the LEZ scheme is tightened in later years). Based on the estimated marginal benefits of the scheme over and above the baseline, the total benefits of the LEZ scheme (first phase) are estimated at 30.5 million to 55.4 million Euro. Note these benefits may underestimate the benefits of the scheme, as they do not adequately take into account the full population weighted increment from PM emissions in London.

This compares to estimated costs of the scheme of:

- Costs of introduction of 9 to 15 million Euro (assuming an automatic scheme), with running costs of 7.5 to 11 million Euro (but possible revenue generation of 1.5 to 6 million Euro).
- Total costs to operators of 56 to 143 million Euro.

Consistent with the LEZ conclusions, we find that the benefits of the scheme outweigh the costs of introducing and operating the scheme (a high benefit: cost ratio), but that the total costs of the scheme, including costs to operators, are probably broadly similar (and the upper range of cost estimates is potentially higher than the benefits).

The scheme is potentially tightened in 2010. The benefits analysis for the scheme to heavy vehicles only (Euro III plus RPC) is shown below. An additional scheme was considered which also included vans. The benefits of the revised heavy vehicle scheme rises to 15.4 to 25.3 million Euro in the first year. Based on the estimated marginal benefits of the scheme over and above the baseline, in the four years from 2010 – 2013, and using the same values as above, the total benefits of the LEZ scheme (second phase) are estimated at 59.5 to 98 million Euro.

This compares to estimated costs of the scheme of:

- Running costs of 7.5 to 11 million Euro (but possible revenue generation of 1.5 to 6 million Euro).
- Total costs to operators of 182 to 551 million Euro.

The possible extension of the scheme to cover vans would increase the benefits (by an additional Euro 4 to 8 million), but increase the costs more significantly (by some Euro 90 to 120 million) and so the benefit to cost ratio would fall. This reflects the higher relative abatement costs needed to tackle smaller vehicles.

### 3.5.4 Other evaluation criteria

A large number of other criteria are important for a Low Emission Zone.

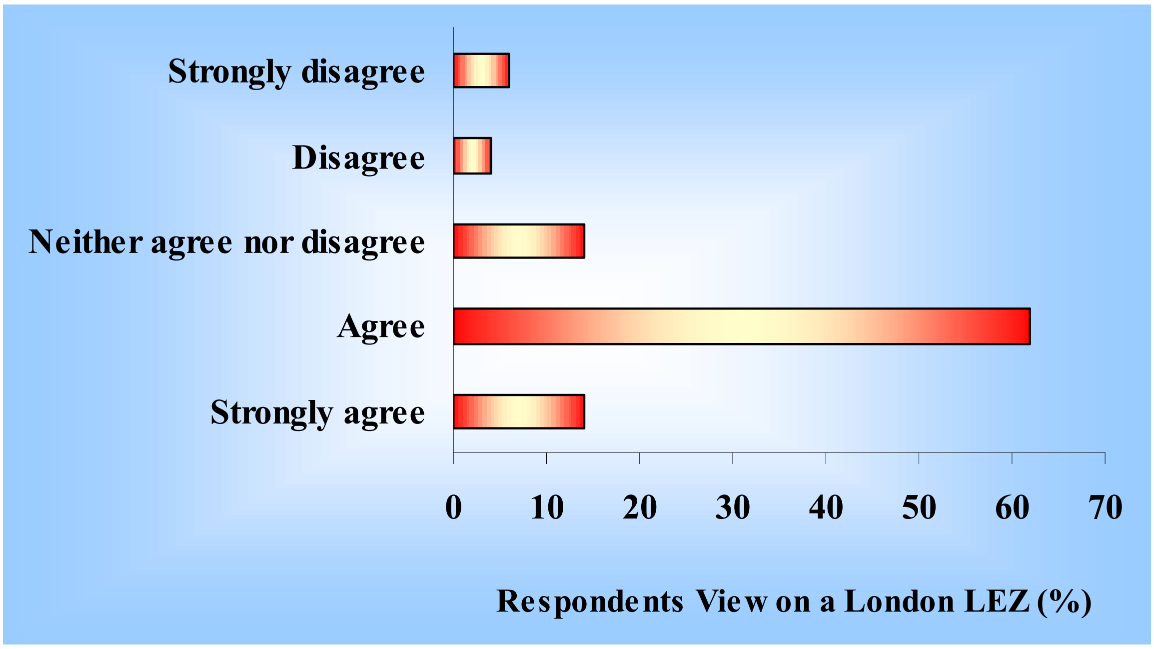
***Public and Political Acceptance***

The feedback that exists in Sweden indicates a fairly positive response to the scheme. The London study explicitly undertook stakeholder surveys to elicit views on the scheme.

The study investigated the likely response to a London LEZ by freight operators. It undertook face-to-face and telephone interviews, and a questionnaire survey with hauliers/fleet operators. This found more concerns amongst smaller operators, who often have longer replacement cycles, and owners of vehicles with specialist bodies (e.g. cement lorries), which also have longer replacement cycles as these vehicles are more expensive and tend to do less mileage. Most people questioned responded that they would comply with an LEZ. The most likely responses in what this response would be were to fit exhaust modification or buy new vehicles, though a very clear message came back that operators would use newer (compliant) vehicles in London and displace older vehicles outside London. There was a wide range of responses to the potential costs of an LEZ, with a general reaction that smaller companies were more concerned about costs, as they typically had older vehicles and less capital to modify or change their vehicles.

Overall, the survey indicated that operators would be broadly supportive of a London low emission zone, as shown in Figure 12 below, which reports the results of the survey questionnaire. Operators stressed the need for adequate notification (as early as possible) of any forthcoming LEZ, so that they could take this into account in planning their vehicle replacement strategies.

**Figure 12 The Attitude of Freight Vehicle Operators Towards a London LEZ.**



A survey of 50 companies asked ' Which of the following best describe your views on the low emission zone concept for London?' Answers were a mix of personal and company views. Source: Watkiss et al, 2002.

The additional positive and negative effects from LEZs are summarised below.

### *GHG reduction*

The introduction of an LEZ can lead to changes in greenhouse gas emissions from road vehicles, due to improvements or reductions in fuel consumption (fuel efficiency) from modern vehicles or from the introduction of abatement equipment. However, these changes are not necessarily positive (i.e. an LEZ would not necessarily lead to greenhouse gas emissions reductions, and it could actually lead to increase in emissions).

This occurs because there remains some debate on the fuel consumption changes when replacing an older vehicle with an equivalent vehicle of a newer Euro category, either when replacing the engine or when replacing the whole vehicle. There also appear to be fuel efficiency penalties with certain abatement equipment.

For **heavier** vehicles, data shows that average fuel consumption of HGVs has decreased by over 1% per year over the last 10 years for articulated HGVs and medium sized rigid HGVs (between 17 and 25 tonnes). For smaller rigid HGVs there has been no change. The fuel efficiency improvement for heavier vehicles reflects changes in the engine technology and control systems, the use of lighter materials, better transmission systems and other improvements. However, fuel efficiency penalties also arise from the increased use of pollution control devices in later Euro standards. In practice, many manufacturers and operators report fuel efficiency penalties when moving to newer heavy good vehicles. Fuel efficiency penalties have also arisen for modern buses due to increases in the weight due to safety engineering and the switch to low floor buses (although these have been partially compensated by engine improvements). The fuel consumption of Euro 4 vehicles is unknown, though they could potentially be up to 8% more fuel efficient if manufacturers fit selective catalytic reduction (SCR) technology.

For **light vehicles**, data shows little change in fuel consumption over the last decade. Whilst the increased use of pollution control devices in later Euro standards tends to increase fuel consumption, this has been matched by accompanying improvements in engine technology. Moves to larger vehicles (such as 4x4s and multi-purpose vehicles for cars) and increased use of auxiliary equipment such as air conditioning, might increase overall fuel use. However, European carmakers are now bound by the ACEA (Association des Constructeurs Européens d' Automobiles) voluntary agreement on maximum greenhouse gas emissions from cars and so, in future, cars are likely to have fuel efficiency benefits. These benefits would also be reflected for car-derived vans, but not larger vans, which are excluded from the ACEA agreement.

The London study concluded that there would be no greenhouse gas emission benefits for most LEZ options, and indeed in many cases there may be a small dis-benefit for options in 2005 and 2007. However, the introduction of Euro 4 vehicles would change this. Heavy Euro 4 vehicles are likely to have better fuel efficiency (as SCR is likely to be fitted to reduce $NO_X$ emissions). Smaller light goods vehicles and cars will have better fuel efficiency (because of the ACEA agreement). LEZ options in 2010 would therefore be likely to reduce greenhouse gas emissions.

### *Noise reduction*

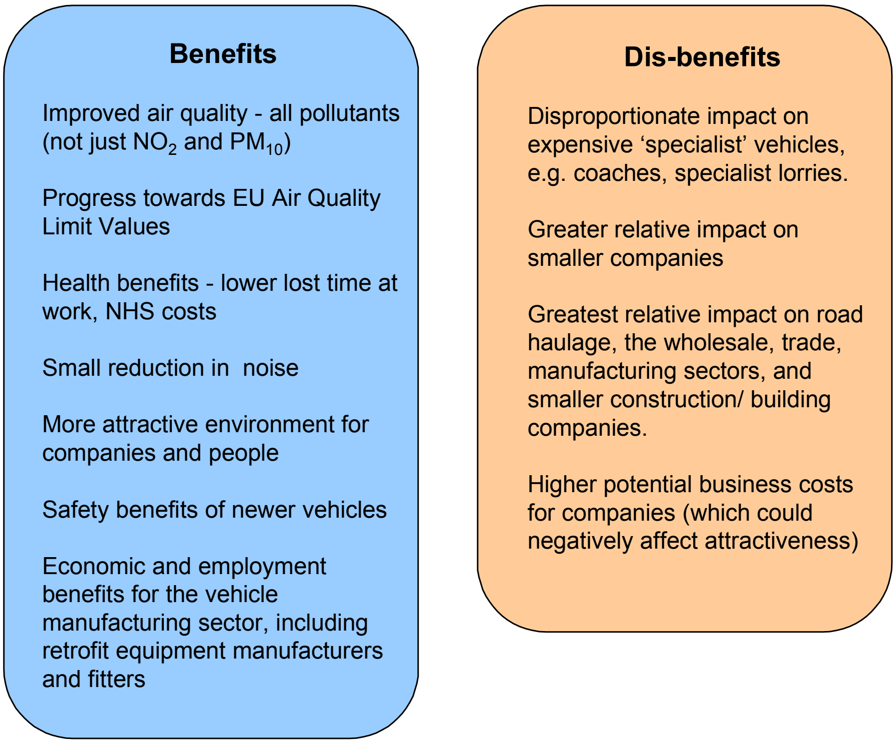
Transport noise affects amenity and numerous surveys have shown it to be a major nuisance. Changes in vehicle noise legislation have not followed those of exhaust emissions, but Euro 2/3 vehicles are quieter than older vehicles. Noise limits are in place, and it is clear that pre-Euro (and some Euro 1 vehicles) will only comply with noise limits enforced in 1988/9 whereas Euro 2 and 3 vehicles will comply with noise limits set in 1996. An LEZ should therefore have noise benefits. However, as traffic noise is the combination of engine, exhaust system and transmission noise, and noise generated from the interaction of the tyres with the road surface. Only the first of these is affected by an LEZ. The London study modelled the noise benefits of an LEZ which required all commercial vehicles (i.e. excluding cars) to be Euro 2/3 compliant (i.e. so that they would comply with 1996 legislation). It found that traffic noise levels would not be significantly altered after implementing such a scheme i.e. the reductions are less than 0.5 dB(A). The main reason that there is very little effect on noise levels is that the proportion of the noisier heavy vehicles in the traffic stream only accounts for about 0.3% of the total flow. Replacing these noisier vehicles has little effect despite a difference of 4 dB(A) in pass-by levels. However, this is a function of $L_{Aeq}$ energy averaging and people could actually notice and appreciate a reduction in the maximum noise level of some of the pass-by 'events'.

The study therefore concluded that whilst modern vehicles (i.e. those permitted to operate in an LEZ) are quieter, in practical terms, the net change in noise levels would be low for all options. However, people could actually notice and appreciate a reduction in the maximum noise level of some of the pass-by 'events'.

### *Others*

The London study also assessed the potential socio-economic effects from a London LEZ, summarised below. It stressed that the impact of any LEZ is likely to have a disproportionate impact on certain fleet operators, notably those with specialist vehicles, rather than the larger conventional fleet operators. These specialist vehicles are much more expensive to purchase and therefore tend to have longer replacement cycles, i.e. they are operated for longer before being replaced. Ideally, existing and future grants should be prioritised towards such vehicles. An alternative, which is present in the Swedish scheme, is to allow specialist vehicles to operate for longer periods in the zone, provided they have some abatement equipment fitted (i.e. provided they have $PM_{10}$ abatement equipment).

**Figure 13 Potential Socio-economic Effects from a London Low Emission Zone.**




There were some particular concerns over the issue of diverted traffic from the scheme. This would include changes in travel time and potential congestion effects, arising from increases in transport distances (as well as increases in fuel consumption and emissions outside of the LEZ area). It might also have effects through changes in accident rates and with certain routes, community severance effects due to the physical/social perception of changes in HGV traffic. For the London wide scheme, these effects are likely to be low.

### 3.5.5 Advantages and limitations of the measure

The main limitation with a low emission zone is that it only accelerates the introduction of new vehicles, therefore it only moves forward emissions and air quality improvements that would have occurred (in time) anyway. The London study showed that most LEZ schemes would have a modest reduction in emissions and improvement in air quality. The reason is that the air quality benefits of any LEZ have to be seen in the context of a significant decrease in emissions, year on year, as a result of the ongoing, normal replacement of older vehicles by newer vehicles in the fleet. By 2005, emissions from road vehicles will be significantly lower than they are today. Nonetheless, when compared to other options in London, the potential for an LEZ was seen as one of the most cost-effective methods of achieving (relatively) large-scale improvements.

### 3.5.6 Analysis of possibility of extension to other cities

The Swedish system has shown that LEZs can be applied in different cities successfully.

As with the congestion charging scheme, there are specific issues with the boundary of the scheme. The London scheme proposes existing orbital roads around London. This should help to address the issues of diverted traffic. Schemes in other cities would have to assess the potential for these traffic issues.

The existing Swedish schemes, and the proposed London scheme, concentrate on targeting heavy-duty vehicles. This was shown to be the most cost-effective approach (and had the highest benefit to cost ratio). London has a high proportion of heavy vehicles – it is a major hub for public transport – it has high influx of tourists and it has a large number of heavy goods vehicles movements. Other cities might have lower HDV levels, and this might reduce the effectiveness of the scheme.

This is also important in relation to the scheme used to register and enforce the LEZ. The existing London scheme is proposing to use the existing CCS infrastructure and extend. Other cities would face high capital costs in pursing a camera based enforcement system. Alternative systems, such as permits, have been successful in Scandinavia, but they might achieve lower levels of compliance.

There is also an issue of timing. The continual replacement of the vehicle fleet and the introduction of successive Euro standards mean that emissions benefits from an LEZ are likely to decline in future years. In order to maximise the benefits, schemes are needed to be introduced quickly, and also tightened in later years (though this then introduces additional compliance costs for operators). This is important in considering the transferability of the scheme to other cities.

The scheme has most benefit in targeting urban areas, particularly larger cities. There is less justification for introducing motorway based schemes, and the costs of setting up and enforcing the schemes are prohibitive for smaller urban areas. There has been some calls for national based schemes, though these are difficult to justify, because of the low benefit to cost ratio (i.e. the benefit to cost ratio would be low for rural areas and most highway driving). However, once several cities in a country have schemes, or for an important city such as London that influences such a large proportion of the vehicle fleet, schemes effectively become national and so benefits accrue at a national level.

The road transport fleet is important across Europe, in all major cities. The LEZ schemes tend to target diesel vehicles and so they will have a primary benefit in reducing $PM_{10}$ in major urban areas, where pollution exposure is highest. The extension of the scheme to include vans is potentially important, as some of the CAFE baseline analysis shows a growing proportion of $PM_{10}$ emissions from these vehicles, as a percentage of overall emission.

Note, the London scheme made a detailed analysis of the extension of the LEZ scheme to cars. This was found to have very low cost-effectiveness, and a very low benefit to cost ratio. As a result, the inclusion of cars in the scheme was not recommended. However, the analysis did highlight that action on pre-Euro cars might be cost-effective. A number of different options exist to target these vehicles, including scrappage subsidies, and the report concluded that these other schemes might offer more cost-effective ways to target this section of the fleet.

Both the permit system, and the ANPR camera technology, used for the scheme have been proven and demonstrated. There are some political barriers, in that the scheme has a potential impact on some businesses or sectors. The London study found high acceptance for the scheme amongst large fleet operators. The main potential barriers are over smaller fleets (usually smaller companies) and other industries that operate specialist vehicles. This includes coach operators, waste vehicles, cement lorries, etc, as these vehicles have high capital costs and have longer lifetimes.

There are potential legal barriers, for example, in London, the use of camera technology would require new legislation (though the permit system would not). This can increase the time taken to introduce the scheme, as well as increasing the costs of introduction.

### 3.5.7 Contact for more information (air quality related)

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## 3.6 STRASBOURG "PLAN OZONE" FOR SHORT TERM PEAKS

### 3.6.1 Detailed description of the measure objective(s)

*The Issue*

The Communauté Urbaine de Strasbourg (CUS) in the Alsace region of France covers approximately 300km$^2$ and is home to 450,000 people. It is situated in a valley where high-pressure weather conditions can cause the stagnation of air and hence the build-up of air pollution. The city has a mixed economy and in a 1997 survey recorded about 1.07million journeys per day within the city metropolitan area. Table 12 lists data on the long-term pollutant levels in Strasbourg and on the sectors contributing to these.

**Table 12 Pollution characteristics in Strasbourg**

| | $NO_2$ | NMVOC | $SO_2$ | $PM_{10}$ |
|---|---|---|---|---|
| Recorded mean concentration[1] | 42 | - | 20 | - |
| Total annual emissions[2] (tonnes) | 14,396 | 8,368 | 11,508 | 1,013 |
| Emissions contribution from: | | | | |
| Road Transport | 67% | 61% | 4% | 18% |
| Industry | 20% | 24% | 71% | 62% |
| Residential and tertiary sectors | 13% | 15% | 25% | 20% |

1) 1990-97, concentration units, µg/m$^3$. Source: Medina et al 2002, Elstein 2004
2) Within the CUS area. Source PDU 2000

Note that the $NO_2$ concentration is above the long-term EU limit value for this pollutant and research predicts that a large part of the central urban area experiences concentrations above this level.

The geographical and meteorological properties of the region in conjunction with the emissions indicated above also result in peak ozone pollution episodes. During the summer of 2003 these were particularly severe (ASPA 2004). This reference notes that agricultural sources in the Alsace region produce NMVOC emissions equivalent to those produced by the sum of the industry, road transport and the tertiary sectors, hence contributing to regional ozone problems. Between June 7 and September 20 the EU ozone information threshold (1 hour mean concentration 180µg/m$^3$) was exceeded on 26 days in Strasbourg. This included an episode of 17 consecutive days between August 1-17 and during which the EU alarm threshold (1 hour mean concentration 240µg/m$^3$) was exceeded on two separate occasions. Hence Strasbourg is implementing actions with the aim of reducing long-term and peak pollution.

*The Local Response*

In response to the issues described above Strasbourg has made many improvements to mobility in the city including new traffic routing and heavy investment in public transport.

This assessment focuses on the actions to mitigate ozone pollution peaks and those involving public and private transport in particular.

French legislation[5] requires that authorities develop regional air quality plans (*Plans regionaux pour la qualité de l'air*, PRQA) to attain the air quality objectives and to prevent and reduce atmospheric pollution. At the same time authorities must develop an urban transport plan (*Plan de déplacement urbain*, PDU) in which the needs of mobility and ease of access must be balanced with the protection of health and the environment. A key aspect of the framework is that the PDU must be compatible with the PRQA, that is, mobility should be planned to achieve the air quality objectives.

The strategy has integrated several strands[6] and over several years major developments have included:

- Four tramlines with stations within 400m of 65% of the conurbation population and carrying nearly 200,000 passengers per day.
- Park and ride sites with integrated connections with the tram and bus routes. A tariff of €2.70 includes a return journey to the city centre as well as parking for the day.
- Integrated ticketing with the national rail network.
- 400km of cycle paths and a 30km/h speed limit on many streets in the central zone. Also, cycles are available for hire and can be taken on public transport during non-peak hours.
- A 3-hectare pedestrian zone in the city centre.
- Changes to routing to relieve the city of through traffic.

A 1988 survey found that 74% of motorised commuting journeys used the car while only 11% used public transport. As a result of the changes described above, the public transport share increased by 43% between 1997 and 2000 (i.e. up to 16% of journeys). In particular the Park and Ride scheme caused a modal shift towards public transport in those people who had previously driven into the city centre.

Specific measures are implemented during pollution peak episodes. The conditions defining what kind of peak ozone episode (information level or a more serious alert level) and the consequences in terms of the measures thereby implemented are listed in Table 13 below.

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[5] Décret n°98-362 du 6 mai 1998 relatif aux plans régionaux pour la qualité de l'air. *Journal Officiel de la République française 13 mai 1998* modified by Décret n° 2003-1085 of 12 November 2003.

[6] http://www.transport-strasbourg.org/en/HTML/politiqu_deplacement/accueil.htm

**Table 13 Measures implemented in Strasbourg and the Region d'Alsace during defined peak ozone episodes**

| Conditions that must be simultaneously met |
|---|
| 1) One of the following pollutant thresholds is surpassed (as recorded by a background monitoring site in the Alsace region.) |
| 2) An observation, at another background monitoring site in the Alsace region in a similar geographic situation, that an increase in the concentration of the same pollutant may lead to the information threshold being surpassed. |
| 3) At least one of the two monitoring sites cited above is situated in the Bas-Rhin department (where Strasbourg is located.) |

| Threshold | Concentration[a] | Consequence |
|---|---|---|
| Information | $180\mu g/m^3$ | Le plan "Ozone" 1999 –measures.<br>• Public messages (via variable message signs, radio and other media) making the public aware of the ozone peak and asking them to voluntarily take public transport and to reduce speed.<br>• More frequent trams and standard buses replaced by larger articulated buses<br>• Free loan of bicycles to passengers who have travel passes.<br>• Reduced daily tariff 10F (€1.52 at final exchange rate) for use of:<br>o urban public transport networks<br>o park and ride and urban public transport networks<br>o intercity and urban networks (tariff of 8F (€1.22 at final exchange rate) for use of intercity networks only). |
| Alert | 1° $240\mu g/m^3$ [b]<br>2° $300\mu g/m^3$ [b]<br>3° $360\mu g/m^3$ | Additional measures (when the 3° level is surpassed) implemented from 6-22h.<br>• Speed limited to 70kph on motorways and main routes into the Strasbourg agglomeration.<br>• "Alternate circulation" for all categories of vehicle in Strasbourg city centre ('*pastille verte*[c]' cars, vehicles with more than 3 occupants, 2-wheeled vehicles, foreign registered vehicles and those on the official derogation list[d] are exempt). That is, each affected vehicle can only drive on alternate days.<br>Free travel on the both the city and regional public transport networks |

a) Hourly mean concentration Source: Décret n° 2003-1085 of 12 November 2003.
b) For 3 consecutive hours.
c) 'Green label' vehicles are those with officially recognised low emissions technology or fuels (Décret n° 98-704 of 17 August 1998).
d) Public service vehicles such as the police and ambulance services.

### 3.6.2 Analysis of the environmental impacts

In 1998, following an ozone event whereby the alert threshold was surpassed, the authorities analysed the effectiveness of the plan "ozone." Authorities interviewed 405 Strasbourg residents who used their vehicles regularly (CERTU 2000). This analysis attempted to quantify the public awareness of the episode and their resulting travel choices, i.e. environmental impacts were not assessed. Results are discussed below.

The impact of the measures during the summer 2003 episodes are still being analysed by ASPA within the INTERREG III programme and full results may be available in time. Some preliminary data were available (Riviere 2004) and are discussed and interpreted below.

*Activity*

The extent to which activity (i.e. mode of travel) is changed during pollution peaks is partly a function of public awareness that an episode is occurring and that the plan "ozone" measures are being implemented.

- The 1998 survey found that 83% of residents were aware of the ozone alert mainly through the television and radio media.
- However, despite this only 2.5% of those surveyed changed their travel routine as a result. The remainder of those that used their cars cited longer journey times and less comfort using public transport as the reasons they did not change their mode of transport.

Clearly the ozone alert measures did not cause a significant change in how people travelled during the episode. Note that in 1998 the measures did not include reduced public transport tariffs, which were then added to the plan "ozone" in 1999. With this change a financial incentive to change travel mode was added.

With the reduced public transport tariffs in place, there are indications that more people changed their travel behaviour during episodes in 2003.

- Preliminary results indicate that traffic flow on the major routes into Strasbourg reduced by 13% during ozone information days.

This would represent a far greater success in influencing behaviour than before.

*Emissions*

A number of assumptions have been made to quantify the impact of the plan "ozone" since there are few relevant data. We assume that the observed traffic reduction on the major roads applies equally to all traffic in the CUS area (i.e. a 13% reduction.) We also assume that kilometres driven are proportional to total road transport emissions (in the absence of any data to define emissions more accurately) and that daily emissions are constant all year. The data in Table 12 can be used to estimate the emissions reduction (per day) due to the plan "ozone."

**Table 14 Estimated emissions reduction (t/day) due to plan ozone**

| **Pollutant** | **$NO_x$** | **$PM_{10}$[1]** | **NMVOC** | **$SO_2$** |
|---|---|---|---|---|
| Emissions reduction (t/day) | 3.4 | 0.065 | 1.8 | 0.16 |

1) The mass fraction of $PM_{10}$ from road transport sources that is $PM_{2.5}$ has been reported as 0.9 (TNO 1997 and USEPA 1995) hence the estimated abatement in $PM_{2.5}$ is 0.059 tonnes.

Clearly there are significant uncertainties attached to these values. Firstly, they do not take account of the variable emission rates among different types of road vehicle. Also they do not account for temporal variations in traffic intensity such that the impact would vary according to the day in the week and time of year.

*Air Quality*

There are currently no specific data for the estimated air quality and health benefits. It is hoped that the INTERREG III analysis of the impact of the plan "ozone" during the episodes of summer 2003 will provide more details.

*Ancillary benefits*

There are currently no specific data for the estimated ancillary benefits of the plan "ozone." The INTERREG III analysis of summer 2003 experiences may provide quantitative data on these aspects.

### 3.6.3 Analysis of costs and benefits

Reduced public transport tariffs represent a cost due to reimbursement of monies due to commuters with long-term travel passes and compensation to the travel operators due to their lower income. Indications in Strasbourg are that this cost comes from the public purse and ranged between €4,000-30,000 per day during summer 2003 (Riviere 2004).

The benefits per day estimated using the methods in section 3.2 are presented in Table 15

**Table 15 Quantified benefits of the short-term measures in the Strasbourg "plan ozone".**

| Pollutant | **$SO_2$** | **$NO_x$** | **VOC** | **PM** |
|---|---|---|---|---|
| Emissions reduction (t) | 0.16 | 3.4 | 1.8 | 0.0585 |
| Benefits (Euros 000's)[1] | 0.1 - 0.5 | 27.8 - 54.8 | 1.6 - 5.2 | 5.2 - 10.3 |
| **Total Benefits (Euros 000's)** | **34.7** | **-** | | **70.8** |

1. Benefits are presented as a range, the lower end of which corresponds to the damage costs assessed on the basis of the quantification and valuation of a life year lost. The upper end corresponds to damage costs assessed on the basis of the quantification of number of deaths and valuation based on a value of a statistical life. This range is consistent with CAFE CBA methods.

The comparison of the benefits to the costs (reduced public transport tariffs) is favourable, with a ratio ranging between 1.2-2. There are no data at present to attempt to quantify the impacts (and hence benefits or disbenefits) on ozone. The analysis has also not included the wider costs associated with the public information scheme.

Since the European vehicle fleet is cleaner in terms of pollutant emissions year on year it should be noted that the measures would be less effective in future, i.e. there will be a smaller and smaller emission reduction associated with a constant modal switch during ozone peak episodes and the ratio of benefits to costs will lessen. However, the estimated 13% car to public transport modal switch during 2003 is modest. Continual reinforcement of the measure through information campaigns and further development of the public transport networks could achieve higher modal switch rates. Hence the benefits of the measure could be preserved or increased.

### 3.6.4 Other criteria

***Public and political acceptance***

The French 'loi sur l'air' sets out many guiding principles with regard to improving air quality in France. For example, it imposes the development of communal transport systems and the means of transportation that are economic and less polluting, notably the use of bicycles and journeys taken on foot. In this context, local authorities are directed towards encouraging the use of public transport with political acceptance *forced* by the central law. However, there is no indication that the measures were resisted in Strasbourg. On the contrary the city has invested heavily in transport infrastructure and systems with the aim of reducing the reliance on the car and to create a more sustainable urban mobility with wide social and environmental benefits.

For the public, the acceptance of restrictions on travel by car is determined by the attractiveness and feasibility of the alternatives offered them during an ozone information or alert episodes. In the case of Strasbourg there are now several options; high vehicle occupancy, buying a 'green ticket' vehicle and lowered or waived public transport fares.

However, the choice of the best personal option (and the maximum take-up of the measures) requires information to be distributed well in advance.

- At least a day's notice of an information or alert episode would aid personal choices such as whether to organise a car share or to invest the time to take public transport when these are not the normal travel modes.
- Information on the frequency and duration of ozone alert episodes could help consumers decide on whether to purchase a 'green ticket' approved vehicle or otherwise consider a more permanent travel strategy.

Moreover the acceptance of switching mode to public transport requires that the public have confidence in the level of the service provided. This includes the people who regularly take the public transport network who do not want to experience a worsening of the service on ozone alert days. Hence, there are significant issues of increasing the capacity and frequency of the public transport services during ozone alert episodes, particularly during rush hours.

### 3.6.5 Advantages and limitations of the measure

The analysis indicates that there are advantages associated with this measure. Traffic flow on major urban routes can be significantly reduced leading to reduction in pollutant emissions including those of ozone precursors.

In addition to these benefits some other advantages should be noted.

- The plan "ozone" offers commuters several options which each contribute to the reduction in road traffic – including a financial incentive with lowered or waived public transport fares.
- The measure takes advantage of the permanent public transport networks that the city has invested in and hence does not require additional structural changes.
- The reduced traffic flow could contribute to reducing congestion during rush hours.
- The measure reduces emissions of all transport pollutants so that particulate matter levels should be reduced as well as addressing ozone and $NO_2$ concentrations.

At the same time the following key limitations of the scheme are noted.

- In cases where public transport is operating close to capacity on a normal day then any increase in usage of these modes would have to be accompanied by mitigating measures. For example,
- Spare public transport capacity. One option is to close schools during ozone alert episodes and use the communal school transport within the public transport networks.
- With sufficient pre-warning commuters could spread their journeys over a longer period in the morning and evening to extend the rush hours but without the need for additional capacity.
- As yet the effect on ozone concentrations in Strasbourg due to the scheme is not known. The estimated daily emission reduction of $NO_2$ is 3.4t from a regional total of 39.4t. The estimated daily reduction of NMVOC is 1.8t from a total of 22.9t. These reductions of about 8% of total daily emissions may only have a modest effect on the ozone peak concentration in Strasbourg.

### 3.6.6 Analysis of possibility of extension to other cities

This case study demonstrates that reducing public transport tariffs can play a role in improving air quality during peak ozone episodes. Modal shift towards public transport can contribute to improving air quality in all cities where road transport is a significant source of pollutants particularly where urban ozone levels are controlled by $NO_x$ or VOC emissions. In these areas, then the measure is potentially applicable and would have a positive impact there. However, for some cities, ozone concentrations are determined by regional pre-cursor emissions, and local emissions reduction may not achieve significant improvements (in ozone – though there will be benefits in the pre-cursor emissions). There are some additional barriers to its implementation to note.

There must be significant public transport services and infrastructure within reasonable reach of most affected citizens otherwise there is no true alternative travel option available. Moreover the public transport system should not be operating too close to capacity or should have spare capacity that can be brought into operation quickly. In many cities (e.g. London) the surface rail, underground and bus transportation systems run very close to capacity during morning and evening rush hours so that the influx of significant additional passengers at short notice would be difficult to accommodate safely and efficiently. Moreover, it is not economically viable to have large reserve capacity on these systems that is only occasionally used (i.e. in peak ozone episodes), not least because of the privatised nature of many service providers.

An alternative response is to have commuters spread their journeys over several hours to lessen the impact on the rush hour services. However, this would require a level of organisation and intervention in individual travel choices that appears impractical.

### 3.6.7 Contact for more information (air quality related)

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## 3.7 ROTTERDAM SPEED CONTROL ZONE

### 3.7.1 Description of the scheme objectives

*The Issue*

The Overschie district of Rotterdam, the Netherlands, borders the city ring road. This road (A13) is a designated motorway (national motorway speed limit for cars 120kph) and was considered one of the most congested on the road network carrying more than 150,000 vehicles daily. Along key sections in Overschie, the road passes within 50m of residential and other sensitive land uses such as a school. The level of traffic movements and their congestion at times of peak traffic caused noise and air quality levels to be well above national and EU standards (Kroon 2004).

Dutch-based research (Rijkeboer et al 2003) suggested that:

- Stop-go traffic (a symptom of congestion) results in high vehicular emissions per kilometre.
- High-speed driving decreased fuel economy while increasing vehicular emissions.
- Heavy duty vehicles (HDVs) contributed as much as 50% to total emissions in Overschie while comprising only around 10% of the vehicle movements.

Therefore, authorities considered constant lower speeds and reductions in HDV traffic to be their priorities.

*The Local Response*

To deal with the issues of peak congestion and high speeds under free flowing conditions, the authorities implemented an automatic trajectory speed monitoring system. Cameras and registration plate recognition software (i.e. no barriers) monitored vehicle average speed over a 3.5 km length of the A13 through Overschie. The system strictly enforces a speed limit of 80 kph within the zone.

Since the average speed over a 3.5km distance is monitored, the system discourages speed fluctuations that occur in ‘point check’ systems where radar traps routinely cause rapid deceleration and acceleration profiles in passing vehicles.

### 3.7.2 Analysis of the environmental impacts

The authorities in Overschie devoted significant resources to monitoring the impact of the scheme. They monitored air quality, meteorological and traffic flow measurements for a year before and after the scheme was opened for comparison. This included a significant increase in the spatial resolution of the air quality monitoring during this exercise. In addition detailed dispersion modelling was used to simulate the traffic scheme during the analysis. These activities are highlighted to demonstrate the level of resource investment required to properly evaluate the success of this locally applied measure.

Overall the scheme has had many significant positive impacts (Wesseling et al 2003):

### *Emissions*

The Wesseling study found the following reductions within the scheme:

**Table 16 Estimated emissions reduction (%) due to Overschie scheme**

| **Pollutant** | **$NO_x$** | **$PM_{10}$** | **CO** |
|---|---|---|---|
| Emissions reduction (%) | 15-25 | 25.35 | 21 |

$NO_x$ emissions in the speed control zone are estimated to have reduced by approximately 40 tonnes from a baseline of around 200 tonnes before the scheme was implemented (Havermans 2004). For $PM_{10}$ the estimated reduction was about 3.6tonnes from a baseline of 12tonnes. The mass fraction of $PM_{10}$ from road transport sources that is $PM_{2.5}$ has been reported as 0.9 (TNO 1997 and USEPA 1995) hence the estimated abatement in $PM_{2.5}$ is 3.24tonnes. A CO2 a reduction of approximately 1000 tonnes from a total of 41.6ktonnes is also estimated.

### *Air Quality*

The study found the following average reductions in ambient air quality under westerly wind conditions:

**Table 17 average improvements in air quality due to scheme under westerly wind conditions**

| **Location** | **Improvement in $NO_2$** | **Improvement in $PM_{10}$** |
|---|---|---|
| 50m from roadside | 5μg/m$^3$ | 4μg/m$^3$ |
| 200m from roadside | 3μg/m$^3$ | 1μg/m$^3$ |
| Reduction in contribution from A13 up to 200m from roadside | 25% | 34% |
| Overall air quality improvement up to 200m from roadside | 7% | 4% |

The homogeneity of speed relieving congestion is considered to be more significant in producing these benefits than the overall speed reduction of free flowing traffic.

There are no specific ex ante or ex post data in the studies cited for the estimated health benefits but they should be positive in line with the findings on air quality. It is estimated that 18,000 people may benefit from the measure in terms of improved air quality.

*Ancillary benefits*

The questionnaire response from Rotterdam (Kroon 2004) indicated the following additional benefits:

- Rotterdam estimates an approximate 15% reduction in transport CO2 emissions within the scheme.
- Noise impacts are down 50% within the scheme. It is indicated that around half of this is due to the speed reduction and half due to a quieter road surface.
- Rotterdam reports that collisions within the speed control zone have reduced by 50% although they are cautious in stating that this will be observed in the long-term.
- The homogenisation of speed has been successful and instances of breaking the speed limit have reduced.
- Public perception has changed and road transport is perceived to be less of a nuisance as a result of the scheme.

### 3.7.3 Analysis of costs and benefits

The quantifiable cost of the speed control scheme is dominated by the technology and infrastructure required to enforce the scheme. The capital cost (2004 prices) is estimated to be €1.2million with an associated annual running cost of €50 thousand. It is noted that these amounts are funded by the national public purse and that the amount of annual revenue from fines levied in enforcing the scheme is very small in comparison with the annual cost. As will be discussed below, it is estimated that this scheme should benefit air quality for at least 10 years. Using a social cost discount rate of 4%, the present value of the scheme is estimated to be €1.56million with an annualised value of €192 thousand.

The unit pollution benefits in 2004 estimated using the methods in section 3.2 are presented in Table 18 below.

**Table 18 Quantified annual benefits of the Overshie speed control zone in 2004.**

| Pollutant | **$NO_x$** | **PM** |
|---|---|---|
| Emissions reduction (t) | 40 | 3,24 |
| Benefits (Euros 000's)[1] | 327 - 645 | 289 - 571 |
| **Total Benefits (Euros 000's)** | **616 - 1215** | |

1) Benefits are presented as ranges, the lower end of which corresponds to the damage costs assessed on the basis of the value of a life year lost. The upper end corresponds to damage costs assessed on the basis of the value of a statistical life. This presentation is consistent with CBA methods.

Indications are that, taking assumptions and uncertainties into account, the benefits compare favourably with the annualised costs with a range of ratios in 2004 of 3.2 – 6.3. In future years the benefit will diminish (see further discussion below) as the vehicle fleet includes more modern vehicles with lower emissions. At present there are no data to enable assessment of how the fleet emissions will develop so it is not possible at this time to assess the overall benefits to 2010.

There is one additional cost that is not factored into the above analysis. Journey time through the control zone will increase, with a time penalty cost associated with longer journeys (from lower vehicle speeds). Given the short stretch of road (3.5km) the average increase in journey time would be low, though given the traffic flow on the road, the total costs could be important. These costs would reduce the benefits above when considered in a wider evaluation analysis – though in cases of severe peak congestion there might actually be some benefits from the improved traffic flow. Moreover, counter-balancing these costs would be the additional benefits from lower $CO_2$ emissions, lower noise reductions and from lower accident rates. No information is available on these wider effects.

### 3.7.4 Other criteria

***Public and political acceptance***

Rotterdam indicates (Kroon 2004) that the Government Ministry for Transport initially resisted the scheme and only acceded after strong representations from the Rotterdam city council and the local constituency members of Parliament. There was apparently no resistance from car users or freight transport businesses and overall the press reported a strong feeling among the population that action should be taken to improve the environmental quality. A "primary school was already closed due to nuisance."

This case study is also interesting because it shows the potential synergies between air quality and transport policy – in many cases, it is perceived that there is an conflict between the two, with air quality limit values seen counter to the key transport objectives of managing traffic growth and safety.

### 3.7.5 Advantages and limitations of the measure

This analysis demonstrates that there are strong advantages associated with this measure. Air quality is significantly improved in a residential area, accidents are reduced, and the noise and perceived nuisance of the road traffic have diminished. The traffic flow has improved, easing peak congestion problems. There were no quantitative data available to discuss whether the reduction in congestion within the speed control zone resulted in slower or quicker journey times and hence other economic and public perception benefits. In addition to these benefits some other advantages should be noted.

- The scheme does not put any barrier or tollbooth in the road. It does not limit who uses the road or what type of vehicle they may drive. The absence of costs or restrictions on the speed compliant driver may be a key aspect of its public acceptance.
- The automated system posts fines to punish speed transgressions within two weeks of their occurrence. This system prevents unnecessary use of police or other public resources.
- At 80kph (as opposed to higher speeds) safe gaps between moving vehicles can be smaller, speed differences for merging traffic are lower and hence road capacity can be higher.

- The system may increase congestion at the approaches to the controlled section but this occurs in unpopulated areas where the increased pollution matters less in terms of human health impacts.
- The scheme is effective in dealing with a pollution hot spot especially one involving $NO_2$, $PM_{10}$ and CO pollution.

At the same time the following key limitations of the scheme are noted.

- Heavy-duty vehicles contributed up to 50% of the road emissions before the speed control was implemented. There has been no attempt to change the percentage of these vehicles on the road, and their emissions are not reduced (other than from smoother traffic flow) as the national speed limit for these vehicles is already 80kph.
- In some respects the scheme has transferred congestion in Overschie to the approaches to the speed control zone, where no residents are affected by the increase in emissions. In other situations the location of exposed individuals may make this scheme impossible to implement.
- As the scheme is permanent it will tend to have some beneficial effect in reducing the overall severity or frequency of peak pollution levels. However, the scheme cannot deliver additional emissions savings in the short term and hence may not contribute significantly towards the achievement of short term limit values.
- Although the measure makes significant progress towards the EU air quality limit values, it will not be sufficient on its own to achieve full compliance.

The future road transport fleet will produce lower emissions per vehicle. This may offset the need for the speed control schemes. However, the study authors note that the scheme should benefit Overschie for at least 10 years and so is a useful “bridging solution” during this period.

### 3.7.6 Analysis of possibility of extension to other cities

The authors of the ex-post study note that the effect of a speed control zone must be understood in terms of the specific Overschie traffic composition and traffic flow. At other locations where these are very different the scheme may not be as effective. Dutch researchers are examining the possibility of implementing the scheme in a number of other locations within the country and may be in a position to publish their findings by the end of 2004.

With increasing traffic growth, motorway congestion is a growing phenomenon across the EU. For example several UK local authorities (Sheffield, London Borough of Hillingdon and others) have declared air quality management zones – where exceedence of the air quality limit values are likely - because of the contribution of motorway traffic.

In Overschie it is noted that speed control is a useful bridging solution until such time as the vehicle fleet becomes cleaner in terms of emissions. This aspect of the scheme is widely applicable. Emissions per km are almost independent of speed between 60-100kph but increase rapidly at higher speeds. Therefore an overall reduction in speed on motorways would produce emissions benefits but with the disbenefits of longer journey times.

However, evidence suggests that the reduction in congestion could be the more significant aspect of the scheme. Idling engines have extremely high emissions per km and emissions under high load, low speed, and stop-start conditions are very much higher than under constant optimised speed conditions. While the solutions to congestion are site-specific (simple reduction in speed limit cannot solve all congestion problems) and should be addressed as such, there may be many instances where a speed control zone could reduce or eliminate a pollution hot spot close to main highways.

The indication in Overschie is that public acceptance may be good and political barriers to such schemes may be small. The scheme was mostly acceptable to the public and road users. Freight drivers registered the strongest negative perceptions. The positive outcome of the Dutch scheme to date could help overcome objections elsewhere.

There are no technological barriers to implementing such schemes. Registration recognition software and automated systems of posting infringement notices have been implemented in several instances, for example, the Congestion Charge Zone in London, UK uses a similar system.

### 3.7.7 Contact for more information (air quality related)

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# 3.8 DUBLIN BAN ON SALES OF BITUMINOUS COAL

## 3.8.1 Description of the objective of the scheme

Urban pollution can be reduced through bans on the sale of certain fuel products. The target pollutants tend to be those associated with domestic coal burning i.e. black smoke[7], $SO_2$, $PM_{10}$, and PAHs.

A good example of this type of scheme is the ban bituminous coal sales in Dublin and other urban areas in the Republic of Ireland. There are examples of similar measures that focus on restricting use of certain fuels, such as smoke control orders in the UK, and restrictions in certain urban areas of Greece e.g. Athens, Thessaloniki. The focus of this cases study is the Dublin example, as data exists to make an assessment of the costs and benefits.

McLoughlin 2001 notes that deterioration in air quality in Dublin coincided with the issue of grants to householders to install back boiler systems post-1979 following the oil crisis. This encourage a reliance on bituminous coal that immediately led to increased black smoke levels in the city. Mean winter concentration of black smoke was 90$\mu g/m^3$ during 1981/82 and daily levels that winter were known to reach 1,800 $\mu g/m^3$. Mean winter black smoke concentrations during 1984-90 were 85.4$\mu g/m^3$while those of $SO_2$ in the same period were 40.4 $\mu g/m^3$ (Clancy et al 2002). Data were not available to indicate the levels during this period of $PM_{10}$. This pattern of pollution continued throughout the 1980's until decisive action was finally taken. On September 1st 1990, a ban on the sale, marketing and distribution of bituminous coal was introduced to cover Dublin City and some surrounding areas, to try and reduce this pollution problem. This ban was extended to Cork in 1995 and in accordance with a commitment in "An Action Programme for the Millennium", it was extended to five additional areas in 1998 (Arklow, Drogheda, Dundalk, Limerick and Wexford). Regulations introduced in September 2000 (with effect from the 1st October 2000) further extended the ban to five new areas (Celbridge, Galway, Leixlip, Naas and Waterford).

Specifically, the type of coal than can be sold must meet one of two criteria as set out in the regulations:

- The maximum rate of smoke emissions permitted is 10 grams per hour based on 3.6 kg burned in accordance with British Standard 3841:1994
- Gross calorific value should be no greater than 24 MJ/kg on a moist ash free basis, and maximum volatile matter contents by weight should be no greater than 14% on a dry ash free basis.

[7] "Black smoke" is an indicator of particulate matter in the atmosphere that predates the current focus on $PM_{10}$, $PM_{2.5}$ and ultrafine fractions of this pollutant. Its measurement depended on whole air large volume sampling onto filter paper via a sampling head that excludes particles above an approximate 4micron radius. The severity of the pollution is measured via the reflectance of the sample. In the 1960's when the technique was developed coal was the highly dominant PM source and the reflectance of the sample was calibrated to a mass concentration in air based on the properties of coal. We have assumed that prior to the bituminous coal ban, this was also the dominant source of particulate matter in Dublin's air and hence the relationship between black smoke and mass concentration still apply.

### 3.8.2 Analysis of the environmental impacts

*Emissions*

McLoughlin (2001) presents the change in emission totals prior and subsequent to the ban introduction in the Dublin area. These data are shown in Table 19.

**Table 19 Change in emissions attributed to Dublin fuel ban.**

| Pollutant | 1987 (pre-ban) | 1994/95 (post-ban) | Change (tonnes) | Reduction attributed to ban (tonnes) |
|---|---|---|---|---|
| Smoke[1] | 12,900 | 470 | -12,430 | -8,574 (69%) |
| $SO_2$ | 5,400 | 1,890 | -3,510 | -1,218 (35%) |

1. Note that this is total particulate matter emitted and not 'black smoke' that comprises mainly fine particles.

Source: McLoughlin (2001)

58% of the reduction attributable to the ban was due to switching to non-solid fuels, while 42% was due to switching to smokeless solid fuels. For $SO_2$, the figures were 88% and 12% respectively.

McLoughlin (2001) also calculated a top-down emission inventory, and calculated that the ban had been responsible for 86% of smoke reduction (as opposed to 69%) and 22% $SO_2$ reduction (as opposed to 35%). This top-down approach was not used in subsequent environmental and health benefits analysis.

McLoughlin assumed a smoke emission rate of 35-50kg per tonne of fuel consumed. This corresponds well with data used to quantify smoke emissions in the UK (40kg smoke per tonne of smoky coal consumed in the domestic sector) and the same data source cites the $PM_{10}$ emission rate in this sector as 9.696 kg per tonne of fuel consumed (Dore 2004). The mass fraction of $PM_{10}$ from small combustion processes that is $PM_{2.5}$ has been reported as 0.38 (TNO 1997 and USEPA 1995) hence the estimated abatement from the scheme as $PM_{2.5}$ is 790 tonnes.

Analysis has also been completed (Table 20) of the change in fuel use in Dublin before and after the ban (Clinch 2001). These data illustrate that the ban resulted in many individuals changing over to gas or liquid fuelled heating systems. At the same time a survey of households that were unaffected by the ban (i.e. outside Dublin) showed that there was an underlying trend towards gas and oil fuels but that the ban had accelerated this process by a factor of two.

**Table 20 Change in fuel use pre- and post-Dublin fuel ban**

| Fuel | 1987(pre-ban) (%) | 1994-95 (post-ban) (%) | Change (%) |
|---|---|---|---|
| Oil | 17 | 26 | 9 |
| Gas | 14 | 50 | 36 |
| Back boiler (solid fuels) | 30 | 9 | -21 |
| Open fire (solid fuels) | 39 | 15 | -24 |

Source: Clinch (2001)

Based on the above data, it is clear that the ban had a significant impact on the level of emissions associated with solid fuels (black smoke, PM, $SO_2$), with a significant switch to cleaner fuels.

### *Air quality*

Clancy (2002) indicates that improvements in pollution concentrations after the ban were immediate and permanent. There was a 70-75% drop in black smoke concentrations, with a winter average concentration of 21.5 $\mu g/m^3$ between 1990-1996. Levels of winter mean levels of sulphur dioxide also dropped by around 40% during the same period to 24.9 $\mu g/m^3$. All of the available data for black smoke are shown in Table 21 below.

**Table 21 Black Smoke average seasonal concentrations ($\mu g/m^3$)**

| Season | 1984-90 (pre-ban) | 1990-1996 (post-ban) | Change |
|---|---|---|---|
| Autumn | 62.4 | 18.3 | -44.1 |
| Winter | 85.4 | 21.5 | -63.8 |
| Spring | 39.6 | 10.9 | -28.7 |
| Summer | 14.4 | 8.2 | -6.2 |
| Total | 50.2 | 14.6 | -35.6 |

Source: Clancy (2002)

There were no equivalent pre- and post-ban data on $PM_{10}$ levels available for this analysis.

### *Health Indicators (exposure, mortality and morbidity)*

Clancy (2002) assessed the impact of the Dublin bituminous coal sales ban on death rates. The analysis undertaken showed an average 403 fewer non-trauma deaths after the introduction of this measure, including 120 fewer respiratory deaths, 312 cardiovascular deaths but 29 more deaths from other causes. After adjustment for weather, epidemics and death rates in the rest of Ireland, there were considered to be 116 fewer respiratory deaths, and 243 fewer cardiovascular deaths.

The change in death rates (after adjustment) were calculated over 72 months before and after the introduction of the ban and are presented in Table 22 below.

**Table 22 Change in death rates due to Dublin fuel ban**

| Death rate | Adjusted % change | Reduction in deaths |
|---|---|---|
| Non-trauma | -5.7 | 287 |
| Cardiovascular | -10.3 | 243 |
| Respiratory | -15.5 | 116 |

Source: Clancy (2002)

The paper concludes, after taking account other factors, that 'control of particulate air pollution in Dublin led to an immediate reduction in cardiovascular and respiratory deaths.'

### 3.8.3 An analysis of costs and benefits

The two main actors affected by the fuel ban are the solid fuel supply trade and the consumers.

***Solid fuel supply trade***

The Irish Government notes that although solid fuel sales will decline by 66% between 1990-2010 under business as usual projections there are still approximately 3,000 people employed in the solid fuels trade in Ireland (DEHLG 2001). The Government's expectation was that the ban should not affect these jobs, as the traders would be equally free to switch to selling non-banned solid fuels. However, as has been noted, the ban essentially accelerated the rate at which people switched to competing fuels (gas and oil) so that it is inevitable that the solid fuel market and industry has suffered in the Dublin area. Moreover, until such time as the fuel ban is made national in scope then solid fuel traders in rural areas would be free to continue selling the banned products.

No quantitative data were available to further assess these costs.

***Consumers***

Clinch (2001) found that average weekly household expenditure on energy declined by 13.6% between 1987 (pre-ban) and 1994 (post-ban) in Dublin. However, in areas unaffected by the ban the decline in energy expenditure was 21.1%. This indicates that Dublin residents are bearing higher energy costs due to the ban. This difference was found to be relatively higher average weekly costs in Dublin for gas, oil and solid briquette use.

In a distributional economic analysis Clinch (2001) showed that it was mainly wealthier Dublin residents who switched to gas (with a relatively large initial expenditure on a new heating system) while poorer ones were forced to choose oil (lower conversion costs for existing systems). The very poorest households carried on burning non-banned solid fuels and had to bear a long-term increase in costs for these more expensive fuels. On the contrary, those who switched to gas heating systems would be expected to make long-term savings in their energy expenditure. To mitigate this impact the Government provides a weekly smokeless fuel allowance (€3.81) to qualifying households during winter months. The additional national cost of these payments was estimated to be €20.316million (DEHLG 2001).

***Benefits***

McLoughlin (2001) undertook a very simple benefits analysis and calculated health benefits of €19.4-20.7 million due to the ban. The following table presents an updated analysis consistent with the CAFE CBA approach described in Section 3.2 of this report. This approach uses the emissions estimates above, rather than the estimated health benefits from the ex post study of Clancy.

**Table 23 benefits (CAFE CBA method) of the Dublin fuel ban**

| Pollutant | $SO_2$ | | | PM | | |
|---|---|---|---|---|---|---|
| Emissions reduction (t) | 1218 | | | 790 | | |
| Benefits (Euros 000's)[1] | 1064 | - | 3540 | 70464 | - | 139092 |
| **Total Benefits (Euros 000's)** | **71528** | | **-** | | | **142631** |

1) Benefits are presented as ranges, the lower end of which corresponds to the damage costs assessed on the basis of the value of a life year lost. The upper end corresponds to damage costs assessed on the basis of the value of a statistical life. This presentation is consistent with CBA methods.

Additional benefits would also have occurred from the ban – particularly the reduction in local building soiling from the reduction in black smoke. This would increase the benefits above.

The analyses above demonstrate that the balance of benefits to costs is favourable to very favourable for this measure. The benefits quantified by McLoughlin (2001) for Dublin alone balance the estimated national supplementary fuel payments (DEHLG 2001). The CAFE CBA analysis also shows a favourable ratio of benefits to costs.

### 3.8.4 Other evaluation criteria

***Public and political acceptance***

No specific information has been found on the acceptability of this measure, as used in the Republic of Ireland. A key factor was the transfer to other fuels was already underway, and this could have meant that this measure was more acceptable. In an analysis by Clinch (2001), the importance of current trends in the fuel market was outlined.

The trend of moving to gas and oil was already well established, with a declining use of solid fuels. It is believed that the ban acted as a catalyst, in providing the incentive for consumers to move to gas and oil sooner rather than later, thereby speeding up fuel switching. This is an important point when considering the effectiveness of this measure – a gradual switch was already being made to other cleaner, more efficient fuels.

Political acceptance will largely be determined by the economic consequences of a ban, the availability of alternative fuels for consumers and the reliance of the residential sector on the fuel product to be banned. However, in many European countries (as was the case in Ireland), the importance of solid fuels is decreasing, with a switch to cleaner fuels such as natural gas. This existing trend in many countries will make this measure more acceptable in general terms.

For the public, the price of alternative fuels for heating, and the levels of assistance for making such a transition will largely determine acceptability.

*GHG reduction*

The extent of GHG reduction will be primarily dependent on the transfer to a given fuel. Switching to alternative solid fuels with similar or higher carbon contents will not lead to any significant reductions. However, a switch to lower carbon fuels such as oil and particularly natural gas will mean additional benefits for GHG reduction.

Data in Table 20 define the extent of fuel switching after the fuel ban was implemented. Assuming each household needs to generate an equivalent amount of heat (i.e. uniform consumption of heat energy) then a mean domestic sector carbon emission factor can be derived from fuel carbon emission factor data (IPCC 1996)[8]. Pre-ban the derived mean carbon emission factor is 23.38 tC/TJ and post ban it is 19.05 tC/TJ. This indicates a decrease of approximately 18.5% in the Dublin domestic sector carbon emissions. If, as has been noted, the ban accelerated the underlying trend towards natural gas and oil in the domestic sector by a factor of approximately 2, then approximately half of the carbon emission reduction estimated may be attributable to the fuel ban. This would significantly increase the benefits above.

*Others*

There may be some quality of life issues with switching to fuels such oil and gas, and away from the use of solid fuels. These may include:

- Reduced handling of fuels due to constant supply (through pipe network), and automated feed of fuel.
- Reduced fuel prices, as natural gas / oil tend to be cheaper than solid fuels (based on heating value and because they are burned more efficiently). The initial investment in a new heating system would of course need to be made.

Mcloughlin (2001) undertook a cost benefit analysis of the coal ban and concluded that households that switched to oil or gas as opposed to an alternative solid fuel were better off over a 20-year time frame.

### 3.8.5 Advantages and limitations of the measure

Potential advantages of this measure include:

- Significant decreases in levels of air pollution. The synergistic combination of particulate matter and $SO_2$ has historically been a source of severe acute pulmonary disorder among vulnerable groups such as the elderly. The ban has had a large impact in reducing these impacts, other respiratory impacts (see the CAFE CBA analysis) and the chronic mortality impacts from particulate matter.

[8] Fuel specific emission carbon factors. Natural gas = 15.3 tC/TJ, "other oil products" = 20.0 tC/TJ and average coal = 25.85 tC/TJ.

- Low additional costs of switching to other types of solid fuels (due to the smokeless fuel allowance payments) and other fuels e.g. gas / oil, though this has involved a transfer payment.

- Relatively low cost of enforcement due to enforcement of SALE restriction as opposed to FUEL USE prohibition.

Limitations of this measure include:

- Restrictions are only on the sale of bituminous coal in the specified urban areas – this type of regulatory approach does not ban the actual consumption so long as it has been purchased elsewhere. The restriction is on the marketing, sale and supply of bituminous coal.

- The Irish Government (DEHLG 2001) notes that some alternative solid fuels have higher sulphur content than bituminous coal. Therefore, the Government in it's proposed ban on this fuel is also proposing a ban on such higher sulphur fuels in order to ensure an overall reduction in ambient levels of this pollutant.

### 3.8.6 Analysis of possibility of extension to other cities

Such a measure could be further extended to other cities across Europe that have similar pollution problems associated with the burning of solid fuels. Pye 2004 considered this issue in a report to the Commission on the costs and environmental effectiveness of options for reducing air pollution from small scale combustion sources.

This study found that several new Member States, in particular Poland, and to a lesser extent, the Czech Republic have significant levels of solid fuel consumption, although generally not in the largest urban areas which have seen large scale conversion to natural gas combustion in the last 15 years. Further reductions in solid fuel use are predicted as gas supply infrastructure continues. However, many regions may continue to use solid fuels, particularly in those areas which gas infrastructure may not reach for a number of years. Therefore, site-specific problems will persist for several more years at least. Even in the other Member States problems may still persist in some areas, which continue to use solid fuels but the inventories are not sufficiently detailed to be certain about the number or distribution of these locations or the population exposed. Therefore, there is an uncertain potential for measures eliminating smoky fuels (as in Dublin) to produce benefits at many sites across Europe.

***Enabling transition to alternative fuels***

If a specific fuel is going to be banned, two key considerations will be necessary:

- Are there affordable alternative fuels that will be appropriate replacements?

- Will this disproportionately affect lower income groups?

Alternative fuels may not be readily available in a given urban area e.g. due to the lack of gas infrastructure, which could make the transfer to another fuel difficult. Transferring to other alternative solid fuels will also only be possible by the availability of such products on the market.

Many lower income groups may be more reliant on solid fuels than higher income groups due to not having the available finances to invest in alternative fuel technologies. Consideration may need to be given as to how to reduce the financial burden on lower income groups from such a measure. The costs of assistance for the authorities could be considerable.

As illustrated in the analysis by Clinch (2001), the fuels that consumers switched to (as an alternative to bituminous coal) by socio-economic group were also considered. Higher income groups tended to switch to gas (where initial investment costs were higher), whilst lower income groups were more likely to switch to smokeless solid fuels and peat briquettes (which did not tend to involve significant investment costs), and oil.

***Acceptability***

This issue has already been covered in this case study but is probably worth reiterating. Coal may have been used for many years; cultural factors can therefore make a transition to another type of fuel difficult. A sales ban in urban areas does not necessarily prevent households purchasing bituminous coal in other areas of the country, and using it in solid fuel appliances.

There may also be issues of acceptability for industry, with the coal trade losing significant business. However, they would still be able to sell alternative solid fuels so might not actually be disadvantaged too significantly.

In general terms, the barriers to introducing such a measure to other cities appear to be few. The key issues will be the ability of householders to transfer to other fuels, based on availability of alternative fuels and costs incurred, and the overall acceptability of such a measure, both by the population and the implementing authorities.

### 3.8.7 Contact for more information (air quality related)

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## 3.9 FURTHER CASE STUDIES

A number of additional case studies have been considered, though in less detail than the examples due to data limitations. These additional examples are:

- Small combustion cleaner fuel and energy efficiency programme in Krakow, Poland
- Temporary/permanent bans on pre-Euro vehicles/scrappage subsidies.

# 3.10 KRAKOW CLEAN FOSSIL FUELS AND ENERGY EFFICIENCY PROGRAM

## 3.10.1 Description of the objective of the scheme

Until the early 1990's Krakow in Poland experienced high levels of $SO_2$ and PM pollution due to solid fuel use in low level sources (domestic and institutional space and water heating systems). This group of sources was estimated to contribute up to 40% of total ambient pollutant levels. Between 1991-2000 a cost-effective five point fuel replacement and energy efficiency programme was instituted to alliviate the pollution. The areas of interest of the programme were 1)Energy Conservation and Extension of Central Station District Heating 2)Replacement of Coal- and Coke-Fired Boilers with Natural Gas-Fired Boilers 3)Replacement of Coal-Fired Home Stoves with Electric Heating Appliances 4)Reduction of Emissions from Stoker-Fired Boiler Houses 5)Reduction of Emissions from Coal-Fired Home Heating Stoves (Butcher 2001). Work proceeded by quantifying the number, location and technology of solid fuel using combustion sources. This database then allowed the potential impact and applicability of energy efficiency and clean technology measures to be assessed in order to prioritise those most cost-effective measures.

## 3.10.2 Analysis of the environmental impacts

The programme had a very significant impact on the sources and air quality in Krakow. The number of boiler houses using solid fuel decreased by 75% from a baseline of 1133. The number of homes burning solid fuel reduced from the baseline of 100 000 homes by 22%.

*Emissions*

The changes in these sectors resulted in a 70% reduction in annual solid fuel use across the city (a saving of over 330kt). The estimated emissions abatement this brought is presented in the following table.

**Table 24 Estimated annual emissions reduction due to clean fuel and energy efficiency program**

| Pollutant | Particulate matter | $SO_2$ | $NO_x$ | CO | $CO_2$ |
|---|---|---|---|---|---|
| Total annual emission abatement (t) | 1171 | 1594 | 297 | 2267 | 67 645 |

*Air quality*

Prior to the programme annual mean $PM_{10}$ concentration was over 100μg/m$^3$ and would rise higher than 150μg/m$^3$ during winter months when fuel use was at its maximum. Krakow would also experience $SO_2$ up to 3.5 times higher than local limit values.

Overall the clean fuel and energy efficiency programme led to PM10 levels being halved and SO2 concentrations reducing by 60%. Benefits were particularly large in the city centre where the reductions in these two pollutants were 60% and 65% respectively. As a result the long term limit values were not exceed during 1998 and should stabilise at these levels. Short term limit values are still exceeded during the heating season but to a far lesser extent.

*Health Indicators (exposure, mortality and morbidity)*

The available reports do not present any indicator data to demonstrate the success of the measure in terms of human health.

### 3.10.3 An analysis of costs and benefits

*Costs*

The total cost of the programme is estimated to have been $58million funded centrally (including a $20 million contribution from the USA). This is equivalent to EU 53,5million at 2000 prices. These costs represent capital to fund programme research, administration and equipment costs in some cases. It is estimated that the energy efficiency projects within the programme reduced operating costs by up to 30% in those sources affected but there are no estimates of this in monetary terms so it is not possible to quantify the overall costs.

*Benefits*

Assuming that the particulate matter abatement is in the form of $PM_{10}$ and that the mass fraction of $PM_{10}$ from small combustion processes that is $PM_{2.5}$ is 0.38 (TNO 1997 and USEPA 1995) then the estimated abatement from the scheme as $PM_{2.5}$ is 445 tonnes. Hence using the CAFE CBA methods the total benefit may range between EU 43,5-87,8million. Therefore the benefit to cost ratio in this case ranged between 0.8-1.6 without taking fuel cost savings into account.

### 3.10.4 Advantages and limitations of the measure

Potential advantages of this measure include:

- Energy efficiency measures often represent a reduced operating cost and hence are economically attractive.
- Initial detailed assessment of the baseline situation in terms of combustion source type, number and location allowed a cost-effective and well-planned programme to be implemented.
- The measure achieved large health benefits and contributed very significantly towards compliance with limit values.

Limitations of this measure include:

- Significant central funds were required to facilitate the conversion to cleaner fuels which otherwise would not have happened so rapidly.

- Access to gas supply infrastructure and fuel availability were key factors allowing the conversion from solid fuel use.

### 3.10.5 Analysis of possibility of extension to other cities

The programme implemented in Krakow could potentially be transferred to other cities with similar fuel use profiles – i.e. many low level solid fuel combustion sources. However, while local knowledge on the location of such towns or cities may be well developed this information is not well characterised at the European level. There is evidence that other than Poland the Czech Republic also has significant numbers of towns where solid fuel use is still prevalent. The extent to which energy efficiency and fuel conversion measures could produce emissions abatement at other locations is therefore still unknown although Member States reporting on "plans and programmes" may improve this situation in future (Pye 2004).

Two key factors that allowed the programme to be implemented rapidly and successfully were central funds (i.e. national government level) to pay for fuel conversion and project administration and secondly the availability of natural gas fuel and infrastructure. Without cost-effective access to this cleaner fuel then the benefits of such programme are reduced.

## 3.11 TEMPORARY OR PERMANENT BANS ON OLDER VEHICLES (CARS)

The study has reviewed some of the scheme to ban, or to encourage the replacement, of older vehicles (e.g. pre-Euro vehicles). This is important because these vehicles have disproportionately high emissions, per vehicle km travelled.

### 3.11.1 Scrappage Schemes

There has been widespread use of scrappage schemes at an international level. These are summarised in the table below. Most schemes fall into two categories:

- *Cash-for-scrappage*. Reward for a scrapped car, whatever the replacement decision taken by the consumer
- *Cash-for-replacement*. Reward for a scrapped car, conditional upon a specific type of replacement, for example a new car. Sometimes the reward is based on a tax reduction for new vehicle purchase, rather than a direct subsidy.

| Country | Period | New cars only? | Subsidy per car – Local | Subsidy per car (Euro) | Eligible vehicles |
|---|---|---|---|---|---|
| Canada – British Colombia | | No | C$750 if replacing with new car,<br>C$500 if replacing second hand car,<br>or public transport pass (worthC$1000) | 534<br>356<br>711 | Pre-1983, must have recently failed inspection |
| Denmark | 1994-1995 | No | Average Euro 800 per car | 1005 | |
| France | 1994-1996 | Yes | 1994-95: Fr5000<br>1995-96: Fr7000<br>(Fr5000 for small car) | 992<br>1388 | 94-95: Cars > 10 years old<br>95-96: Cars > 8 years old |
| Greece | 1991-1993 | Yes | Average Euro 3400 per car by tax reductions on new vehicles | Average 4272 | "Old petrol cars" |
| Hungary | Sept 1993 (short) | No | Ft100,000 off of range of five low emission vehicles, or free transit pass for owners and families | 728<br>(or pass) | Two-stroke vehicles |
| Ireland | 1995-1997 | Yes | I£1000 for new cars only | 1550 | Majority of cars scrapped were 10-12 years old |
| Italy | 1997-1998 | Yes | 1997: L1.5m-L2m, depending on engine capacity of replacement, 1997-98 L1.25 million if fuel consumption of new vehicles between 7 and 9 litres per 100km, L1.5m if less than 7l/100km. Higher incentives for alternative fuel vehicles. | 1997:<br>869 to 1158<br>1997-98:<br>668 to 801 | |
| Norway | 1996 | No | NKr5000 on any replacement vehicle | 767 | Over 10 years old |
| Portugal | Started 2/12/00 | | | | |
| Spain | 1994 on | Yes | Pta 85000-100000 | 678 to 798 | Over 10 years old |
| Sweden | 1976 on | No | Orig.: flat rate 300 SEK, 1998: 500<br>2001:<br>Base rate 700 SEK,<br>7-16yr old cars SEK 1200,<br>+16 yr old cars, SEK 1700 | <br><br>75<br>129<br>182 | Over 7 years old |

In most cases, the eligibility is for vehicles built before a certain age – usually around 10 years or older. In some cases this is for vehicles that have failed an inspection and maintenance test, but that are capable of being driven to the scrap yard. More details on schemes are presented in the box below.

**Box 2. European Experience with Scrappage Schemes**

**Denmark** Introduced in 1994 and running until the end of June 1995, the Danish vehicle scrappage scheme offered a bonus of DKr6500 for anybody scrapping cars over 10 years old. Over the duration of the scheme, 100,000 vehicles were scrapped, marginally over 6% of the fleet. 11% of these vehicles were replaced with new models, 19% with second-hand cars over 10 years old, but few households bought no replacement vehicle (the scheme did not provide a free public transport pass option). Hydrocarbon and NOx emissions were reduced by between 0.6% and 1.0% as a result of the scheme.

**France** ran its first vehicle scrappage scheme from February 1994 to June 1995. This scheme offered an incentive of FF5,000 to owners scrapping cars that were over 10 years old, as long as the vehicles were replaced with new models. A second scheme, running from October 1995 to September 1996 offered an incentive of FF7000, and the minimum age of eligible vehicles was lowered to 8 years (this was reduced to FF5000 for smaller cars). Over the period which the two scheme ran, a total of 1.56 million cars were scrapped (without the schemes it was estimated that only 0.7 million would have been scrapped – therefore net scrapping of 0.86m due to the scheme. A total of 8% of the fleet were scrapped in 1996.

**Hungary** Introduced in 1993 and limited to Budapest, the scheme was directed solely at eliminating the high numbers of old and highly polluting two-stroke vehicles that operated in the city at the time. The bonus paid out for scrappage was Ft100,000, provided that the scrapped vehicle was replaced with one of five environmentally friendly models chosen by the government. Owners of vehicles could alternatively chose a free, one year public transport pass for themselves and their families if they did not replace their car. Incentives were also introduced for replacing old trucks and buses, or for the re-engining of these vehicles.

**Ireland** A car scrappage scheme was introduced in June 1995 with a bonus of I£1000 in the form of a reduction on the registration tax of new cars. The schemes was original intended to run only until December 1996, but was extended until the end of 1997. The numbers of cars scrapped was as follows: 1995: 5140 cars, 1996 19400 cars, 1997 35000 cars. The number of cars scrapped compared to a fleet size of 990,000 cars in 1995,which grew to 1,134,000 cars in 1997. The majority of cars scrapped were 10-12 years old.

**Italy** A scheme was introduced in January 1997. The government funded bonus ranged from L1.5m to L2m (depending on engine capacity of the replacement vehicle, which had to be a new vehicle. Expired in September 1997, but extended for four months with fixed bonus of L1.5m. 1.128m cars were retired under the scheme – about 4% of the fleet. A second scheme ran from February 1998 to September 1998 with an incentive of L1.25m or L1.5m depending on whether the fuel consumption of the new vehicle was between 7 and 9 litres per 100km or less than 7 litres per 100km. From October 1997 bonuses were given if the replacement vehicles were fuelled by LPG, methane or electricity. For electric vehicles there is a scrappage incentive of L3.5m with no expiry date for the scheme. A motorcycle scrappage scheme also operated in 1998, for one year.

**Norway** A scheme introduced in 1996 incentivised the scrapping of vehicles older than 10 years. The incentive was NKr 5,000. There was no compulsory replacement, and other second-hand cars replaced most cars. An extra 150,000 vehicles were scrapped (7% of the fleet) – against the national annual scrapping rate.

**Spain** introduced a scheme in April 1994 providing a bonus for people scrapping a car over 10 years old and replacing it with a new car (very similar to the French scheme). The bonus was Pta85000-100000. The scheme was renewed in October 1994 and ran until June 1995 with the minimum scrappage age lowered to 7 years. The number of vehicles scrapped and replaced under the schemes was 211,000 and 146,000 for 1994 and 1995 respectively (11.5% and 7.4% of the fleet). It is thought that 199,000 vehicles would have been replaced anyway in 1994, with the scheme having a negative result in 1995 with 25000 less vehicles being scrapped. The scheme was continued and a further incentive was given in the form of lowered new vehicle registration tax in 1996. The scheme was made permanent from 1997.

It can often difficult to differentiate between the vehicles scrapped as part of the scheme, against those that would have been scrapped anyway (though the additional money may also have implied replacement with vehicles with a better environmental performance). Nonetheless, the number of vehicles scrapped in many schemes is large. Denmark scrapped 100,000 vehicles over 10 years old; in France 1.6m cars were scrapped (without the schemes it was estimated that only 0.7m would have been scrapped); in Norway 150,000 vehicles over 10 years old were scrapped (7% of the fleet) over and above the national annual scrapping rate.

However, the overall effect of these schemes can be merely to increase demand for newer cars (be they new or second hand). As an alternative, some schemes specifically offer public transport passes. Such an approach ensures the most positive environmental outcome from these scrappage schemes. The only scheme that has sought to both remove a specific range of the dirtiest vehicles and make a transfer to public transport was the Hungarian (Budapest) scheme – designed to remove highly polluting two-stroke vehicles and replace these with either a choice of low-pollution vehicles or a public transport pass. A similar approach would be possible for European cities, with pre-Euro vehicles.

***Cost effectiveness of scrappage schemes***

The European Council of Transport Ministers (ECMT) and the World Bank[9] have both conducted reviews of vehicle scrappage schemes. The ECMT report states that:

> "When the selection of vehicles to be retired is made carefully, cash for scrappage schemes may achieve useful emissions reductions at a reasonable cost (i.e. at a cost comparable to the main alternatives for reducing fleet emissions)".

The report continues by stating that the cash-for-replacement schemes implemented so far have been less successful. This is primarily because in order to receive the financial incentive for scrapping their vehicle, owners were required to purchase a new car. As the majority of older vehicles targeted by such schemes are owned by low-income groups, the schemes which place a requirement of purchasing a new vehicle tend to exclude the largest group of people that own gross-emitting vehicles. The World Bank report came to the same conclusions regarding cash-for-replacement schemes, quoting the low take-up rate of incentives in the Hungarian scheme, and the low percentage of new replacement vehicles purchased in the Danish, French, and Italian schemes (around 10% of replacement vehicles were new).

There are also a number of other cost categories that have not been considered here. These include the effects on the second hand car market, the risk of deadweight costs to subsidise people who were going to scrap their vehicles anyway, and potential environmental issues from shortening of car lifetimes).

***Estimated impacts of scrappage schemes on emissions and air quality***

[9] South Asia Urban Air Quality Briefing Note No. 8, "Can vehicle scrappage programs be successful?", World Bank Energy Sector Management Assistance Program, August 2002

Such schemes can be very effective in improving the average emissions performance of the national vehicle fleet, but it should be noted that there are potential disadvantages to such schemes. If such schemes are permanently in operation or are repeated over time, they shorten the average life of a vehicle, and consequently increase the amount of energy used in vehicle construction, dismantling, and reprocessing operations (ECMT, 1999).

Data on the performance of some of the schemes implemented to date indicates that urban hydrocarbon and NOx emissions can be reduced by anything between 0.6% (Denmark) and 10% (Greece). The performance of the scheme will depend on the year of introduction and the proportion of older vehicles in the fleet in the specific location.

### 3.11.2 Voluntary Schemes

There have been other schemes introduced to try and encourage the removal of pre-Euro vehicles from the fleet, for example Berlin introduced a voluntary ban on pre-Euro cars, though it is not clear how successful the scheme was in reducing pre-Euro vehicles and emissions improvements.

### 3.11.3 Permanent ban

We have found no examples of permanent bans on cars, e.g. in environmental zones or low emission zones across Europe. This would be a potential way forward, putting in place a scheme to remove older (pre-Euro) vehicles from the fleet. Note the London LEZ feasibility study found that targeting cars in general in a LEZ scheme had very low cost-effectiveness, but it identified pre-Euro cars as the one area where this might be justified. The analysis predicts that these pre-Euro vehicles will only comprise 0.9 % of the total car kilometres driven in London in 2007, but will be responsible for 4.5% of all NOx emissions from cars, and 1.7% of all road transport NOx emissions in London. These vehicles would also be cost-effective to target because of the low capital value of these vehicles. However, there are also additional concerns from absolute bans on older cars. Targeting cars would have potential inequality effects, because this would predominantly affect low-income households: for example,, almost half the cars owned by households in the lowest income group in the UK are over 10 years old, compared with less than 20% of those owned by the highest income group. A scheme that aimed to exclude older vehicle, would predominantly affect car ownership for low-income groups and would potentially exacerbate social exclusion.

## 3.12 SUMMARISED RESULTS OF THE DETAILED CASE STUDIES

This report has presented the results of detailed investigation of experiences associated with 5 planned or implemented measures for addressing different local and peak pollution issues.

Apart from the Congestion Charge scheme (for which air quality improvements were a secondary consideration) the measures investigated appear positive in that benefits roughly balance or are clearly greater than the associated costs.

Table 25 presents the summarised results of the detailed case studies.

The significance of these findings in the context of the Thematic Strategy on Air Quality will be discussed in Section 4 of the report.

**Table 25 Summarised results of the case studies**

| **Measure** | **Main aims** | **Key indications of success in the CAFE context**[1] | **Ratio of air quality benefits to costs**[2] | **Key advantages and limitations** | **Key transferability issues** |
|---|---|---|---|---|---|
| London congestion charge control zone | Reduce congestion in the central urban zone with some secondary improvement in air quality. | The relief of congestion is the main aim of the measure but secondarily evidence indicates a 12% reduction in $NO_x$ and $PM_{10}$ from road traffic sources in the zone in 2003. | 1:100 (but a net total benefit once other impacts are taken into account)) | ☺ Travel time benefits since congestion is reduced<br>☺ Generates funding for public transport investment<br>☺ Achieves safety and environmental benefits<br>☺<br><br>☹ High capital cost<br>☹ | **!** Diverted traffic must be rerouted to avoid greatly increasing congestion outside the charge zone<br>**!** Good public transport services must be available to the users of the zone<br>**!** May only be feasible for large urban centres due to high capital and operating costs<br>! Potential negative perception surrounding additional taxation and impacts on local businesses to be overcome. |
| London low emission control zone | Accelerate the take-up of cleaner vehicle technology in Heavy Goods Vehicle up to 2010s.<br>Reduce the number of people exposed to $NO_2$ and $PM_{10}$ levels above the EU limit values within the zone. | A forecast 1.5% reduction in total $NO_x$ emissions and a 9.1% reduction in total $PM_{10}$ emissions in 2007.<br>Compliance with EU $NO_2$ annual mean limit value for an additional 4.3km$^2$ in 2007<br>Compliance with phase II annual mean $PM_{10}$ limit value for an additional 14km$^2$.<br>Health benefits for individuals resident in these hot spots. | Range of 2.5:1-1.3:1 (annual running costs only) | ☺ Measure addresses air pollution directly and offers significant contribution towards achieving limit values by compliance date.<br>☺ Although only moves forward improvements that would occur anyway, appears to be cost-effective method of achieving large benefits.<br>☺ The London scheme would impact a large percentage of the national HGV fleet hence benefits would be experienced nationally. | ! There is a trade off between the levels of non-compliance, the revenues generated, and the air quality benefits of a scheme.<br>! Widely applicable in densely populated urban hot-spot areas.<br>! LEZ rules should consider the most significant sub-sector. E.g. where HGVs are not the issue then other parts of the fleet would need to be addressed. A different set of costs and acceptability criteria would apply.<br>!Cost-effectiveness declines with smaller vehicles. Benefits greatest for HGV schemes, then vans. Low cost-effectiveness for cars. |

| Measure | Main aims | Key indications of success in the CAFE context[1] | Ratio of air quality benefits to costs[2] | Key advantages and limitations | Key transferability issues |
|---|---|---|---|---|---|
| | | | | ☹ Not self-financing<br>☹ Potentially significant costs on vehicle operators, particularly specialist vehicle operators. | |
| Strasbourg short term public transport measures within the "plan ozone" | Mitigate peak $O_3$ and $NO_2$ levels in the urban zone through switching transport modes. | Most of the population is aware of the need and objectives of the plan<br>Indications that up to 13% daily traffic flow can occur when the measure is implemented<br>Indications that several tonnes of daily $NO_x$ emissions are therefore reduced so that air quality improvements are likely to be very small. | 1.2-2.4 | ☺ Takes advantage of existing public transport networks at little extra cost.<br>☺ Measure is aimed at reducing ozone peaks but also contributes to reducing congestion and all vehicle emissions.<br><br>☹ So far very modest changes in emissions and air quality improvement is likely to be small.<br>☹ No evidence yet that peak ozone levels are affected. | ! Requires well-developed and integrated public transport networks and ability to increase capacity on days of peak pollution.<br>! Adequate warning is required to enable commuters to make their travel choices and hence maximise the impact of the measure.<br>! The geographical and photochemical properties causing ozone peaks is variable with location. Therefore the applicability of this measure should be studied for each potential location. |
| Rotterdam motorway speed control zone | Reduce motorway emissions and hot-spot exposure through reducing congestion at times of peak traffic and slowing maximum speeds | Within the 3.5km control zone emissions have reduced by<br>$NO_x$ 15-25%<br>$PM_{10}$ 25-35%<br>CO 21%<br>Overall air quality improvements within 200m of the motorway were improved by<br>$NO_2$ 7% | 3.2-6.3 | ☺ No technology barriers and relatively low cost.<br>☺ Good benefits within traffic pollution hot spot.<br>☺ Road capacity can be increased.<br><br>☹ Doesn't affect HDV speeds and this sector contributes 50% to emissions | ! The homogenisation of traffic flow is more important than the reduction speed in terms of emissions.<br>! Scheme is highly location specific.<br>! Congestion must be relieved but not relocated to worsen exposure elsewhere.<br>! Provided journey times are not increased significantly there could be a high level of acceptance for such |

| Measure | Main aims | Key indications of success in the CAFE context[1] | Ratio of air quality benefits to costs[2] | Key advantages and limitations | Key transferability issues |
|---|---|---|---|---|---|
| | | $PM_{10}$ 4%<br>Also significant benefits in reducing noise, $CO_2$ emissions and accidents | | on the road.<br>☹ Benefits will diminish with time.<br>☹ Uncertain effects on travel times | schemes. |
| Dublin smoky solid fuel ban | Reduce exposure to seasonal harmful levels of smoke, $PM_{10}$ and $SO_2$ | Immediate and permanent air quality benefits post-ban. Smoke and $SO_2$ levels are now well within EU limit values. 69% reduction in Dublin smoke emissions and 35% reduction in $SO_2$ emissions. Direct ex post analysis found 116 fewer respiratory deaths, and 243 fewer cardiovascular deaths. | 3.6-7.1<br>Based on cost of fuel allowance payments. | ☺ Very large air quality and associated health benefits.<br>☺ Low enforcement costs<br>☺ Low overall additional costs to energy consumers.<br><br>☹ Until the measure is implemented nationally it is possible to still purchase the smoky fuel in non-banned areas and then to consume it as before.<br>☹ Unequal fuel costs falling on the poorest consumers.<br>☹ Equal competition is maintained within the solid fuel trade but this trade becomes less competitive compared to alternatives such as oil or gas. | ! Potentially significant in other locations where smoky solid fuel is widely used.<br>! Should consider implementing the measure over a wide area to discourage non-compliance with the aims of the measure.<br>! Alternative fuels must be available and economic.<br>! Economic relief through additional fuel payments may be necessary for the poorest sectors of society.<br>! There may be historical fuel preference barriers to overcome. |

1) Based on questionnaire survey returns, additional investigation of available quantitative data.

2) Values based on CAFE CBA methods and interim values as at January 2005 unless otherwise specified. Ratios are given for the first year of operation of each scheme. In the case of the transport-based measures the benefits would diminish relatively in later years as the European legislation controlling vehicle emissions has greater impact. Costs are for the capital and operational cost of the scheme only and do not include wider costs to operators, businesses, etc.

# SECTION 4 – POLICY RECOMMENDATIONS

## 4.1 INTRODUCTION

The key objective of this project task was to summarise the lessons learned from the project and to use this information to address the following issues in relation to the thematic strategy on air pollution (for short-term and local air pollution issues):

- Future evaluation of national/regional air quality "plans and programmes"
- Range of instruments or combination to be promoted
- Future European legal framework
- Implementation of the subsidiary principle
- Applicability and limitation of measures to other European areas
- Areas of further research

The remainder of this section is structured as follows:

- The first section sets out relevant background to action dealing with **short-term pollution** issues;
- The second section sets out relevant background to action dealing with **local pollution** issues;
- The third section summarises the findings of the survey results;
- The final section brings together the study findings and recommendations and considers measures in light of the six key issues above.

Note in the following sections, we distinguish between **short-term** pollution peaks i.e. very high peak concentrations for short periods of time for which there are short-term limit values (e.g. 1 hour average limit values), and **local pollution** i.e. ambient urban pollution and long-term air quality hot-spots, for which there are annual mean limit values.

## 4.2 SHORT TERM POLLUTION ISSUES AND RESPONSES

### 4.2.1 The significance of short term peaks on human health

Short-term pollution peaks are significant in terms of human health impacts. The current EU standards for ambient air quality, set to protect human health, reflect the differing averaging periods and related limit values that are considered appropriate for acute exposure of each pollutant. There are currently short-term limit values (24 hour exposure periods or less) for ozone, $PM_{10}$, $NO_2$, $SO_2$, CO and smoke. Appendix 3 tabulates these standards. The need for limit values for $PM_{2.5}$ is currently the subject of debate in the EU.

The World Health Organisation (WHO) recently undertook a systematic review of the health impacts of air pollution (WHO 2004a,b). The box below summarises the WHO comments on the problem pollutants reported in the project survey in relation to short-term objectives. The key problem pollutants in Europe (that exceed short-term objectives) are ozone and $PM_{10}$ during summer peaks, and $NO_2$ and $PM_{10}$ during winter peaks.

***Ozone***

WHO noted that there is ample evidence that short-term exposure to peak ozone levels is associated with "transient reduction in lung function, increased reporting of respiratory and eye symptoms and with increased responsiveness to inhaled allergens." The discomfort and morbidity effects are different from those associated with long-term ozone exposure such as reduced lung function. The relative public health significance of these effects have not been analysed but research finds near-linear relationships between day-to-day variation in peak ozone and health endpoints even at low exposure levels. Since the accumulation of exposure to ozone is important and WHO found no strong evidence to suggest that there is a threshold to effects it may be concluded that many days or permanent exposure to mild concentrations may represent a larger health burden than those few days of pollution peaks.

***Nitrogen dioxide***

The WHO review panel noted that experimental evidence suggests increased bronchial responsiveness to allergens in the presence of short-term peaks of $NO_2$ but WHO notes that this is due to exposure to concentrations that are unlikely to be reached in the ambient environment. It is concluded that short term exposure is still of some concern although no analyses of the relative significance of short and long term exposures have been reported. WHO found no new evidence to strongly argue for a change to either the averaging period or the guideline value for short term exposure (1 hour mean of $200\mu g/m^3$).

***Particulate Matter***

The WHO review panel found that short-term exposure to ambient levels of PM has been reported to result in lung inflammation other respiratory symptoms and adverse cardiovascular effects and hence increases in medication usage, hospital admission and, ultimately, mortality. However, an analysis on the relative significance of these impacts compared with those due to long-term exposure found that the chronic health burden is clearly greater than the short-term effects. In discussing this issue WHO took care to note that the short term impacts still "consist of very large numbers of attributable deaths and cardiovascular and respiratory hospital admissions in Europe." [note in this context, short-term relates to the analysis of time series studies assessing the mortality and morbidity impacts of the short-term (acute effects) exposures, whereas long-term relates to cohort studies which examine age-specific death rates in study groups of individuals followed up over prolonged periods (i.e. many years).]

Evidence led WHO to conclude that fine particles (commonly measured as $PM_{2.5}$) "are more hazardous than larger ones (coarse particles) in terms of mortality and cardiovascular and respiratory endpoints in panel studies. The production of fine particles is especially associated with certain combustion emissions such as road vehicle exhaust and also the products of domestic solid fuel burning. Hence there is a high potential for large fractions of the European population to be exposed to elevated fine particle levels particularly from road transport sources.

However, WHO is still concerned that coarse particles also have health impacts and so should continue to be controlled. Hence it was recommended that air quality guidelines for $PM_{2.5}$ be further developed and that reconsideration of public health protection guidelines for $PM_{10}$ is warranted. Due to observed effects from short-term PM exposures, WHO recommends that the 24 hour exposure guidelines be maintained.

### 4.2.2 The formation and extent of short-term peaks in Europe

In order to discuss the applicability of different measures for addressing short-term pollution peaks, it is necessary to consider the extent of the problem in Europe, and the key factors in formation of short-term peaks.

Ambient levels of pollutants can achieve high peak levels under specific time-limited meteorological conditions such as summer high pressure photochemically active situations and winter thermal inversions. Particular problems tend to arise with specific topographical situations (such as poorly dispersed street canyons or a larger air-shed bordered by mountains).

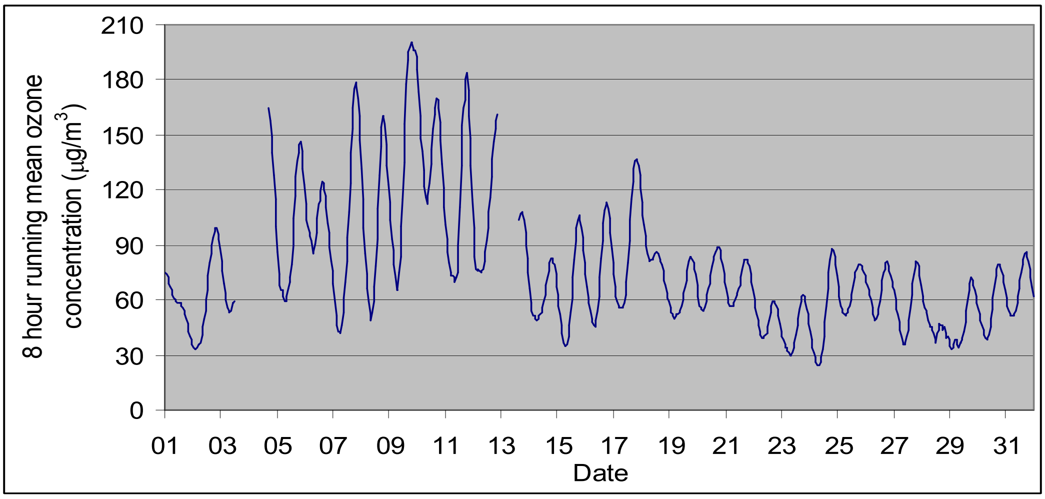
Ozone is more frequently a summer problem since its formation is promoted by high pressure and photochemically active conditions. Winter peaks frequently involve $PM_{10/2.5}$, $NO_2$, $SO_2$ and smoke again due to atmospheric stability manifested in thermal inversions but also potentially due to increased heating needs during winter months (these pollutants are all associated with fuel combustion both in the road transport and domestic sectors).

#### Ozone

Ozone is a secondary pollutant, and its concentration depends on atmospheric and topographic conditions, as well as the location of ozone precursor emissions. Ambient levels of ozone form photochemical reactions between the precursor pollutants oxides of nitrogen and volatile organic compounds. The mechanism is complex and as a peak episode can develop over several days (often reacting with other pre-cursor species as it is transported), the developing episode can be transported large distances from the original source of the precursor.

Because of the factors above, the concentrations of ozone vary significantly over time. The ozone levels at a rural UK site during the summer of 2003 are shown below in the figure below – exceedences of the human health limit value for ozone were frequent and widespread across Europe during this period. This figure is presented to illustrate the scale of temporal ozone variations at a rural site. .

**Figure 14 Ozone concentration recorded at Harwell, UK during August 2003**




Source: UK Air Quality Archive (www.airquality.co.uk)

Peak concentrations may last for hours or days depending on atmospheric conditions.

However, it is possible due to atmospheric re-circulation under high-pressure conditions for an ozone episode to occur in close proximity to the emissions sources. This is more typical in more southern Member States, where air recirculation has been shown to have a significant role in creating peak ozone levels.

Monitoring data shows that the EU short-term limit values are frequently exceeded in many locations and instances across Europe. The maximum levels of ground level ozone and the frequency of peak episodes have reduced over the last decade (e.g. EEA, 2003). However, the trend in the health-based indicator (the short term limit value of 120μg/$m^3$ as an 8-hour mean that can be exceeded up to 25 times per year) is flat. As a consequence more than 10% of all sites in the European AirBase rural and urban background networks have reported non-compliance with this indicator every year between 1996-2000. During 2000, 275 stations in 12 European countries (comprising southern but also central and eastern countries) reported levels exceeding the limit value. This included 135 cities with a combined population of 18.5million. Up to 6million of these inhabitants experienced exceedence of the limit value for more than 50 days.

More recently during the summer of 2003, 69% of $O_3$ monitoring stations in the EU reported that the information threshold was exceeded at least once and for an average of 3.5 hours at a time (EEA 2003). A particularly severe heatwave episode characterised by strong insolation covered much of Europe for this period (note 2003 was an exceptional meteorological year). A particular problem occurs when air is trapped and stagnates in valley regions. The EEA report indicates that under such conditions the resulting pollution peaks are currently widespread and frequent. In fact had it not been for summer storm activity to some extent mixing the lower atmosphere in 2003 the peak levels attained may have been even higher.

However, weather conditions were less favourable for peak episodes formation during 2004 and it is fewer exceedences were observed - even though emitting ozone precursors may have not been significantly different from the previous year.

One of the key conclusions from the above summary is that the year-to-year variation in peak ozone levels and exceedence of the limit values is particularly dependent on weather conditions. For regional ozone formation, this also means it is difficult to respond to short-term pollution peaks with local measures (as it is not local pre-cursors that may be the source of the problem).

Commission Decision of 19 March 2004 provides guidance for implementation of the Ozone Daughter Directive, which is the key legislation setting out the short term limit value that must be complied with in Member States.

- For Nordic countries and Ireland, as conditions do not currenlty lead to reported exceedences of the limit value, there is no need to prepare short term action plans to combat pollution peaks.
- For North-western and Central European Member States, peak episodes are due to regional scale formation and transport (as described above) and so short term actions at the site of the peak have very limited effectiveness. In such cases actions would need to be taken to reduce emissions of precursor emissions over a very large upwind area for several days in advance of the forecast conditions leading to an episode. Accurate forecasting of this nature would

currently be very challenging and the scale of actions required may not be cost effective. For these Member States the long- term reduction of precursor pollutant emissions ($NO_X$ and VOC) is considered the most effective strategy to reduce the occurrence and severity of peak episodes.

However, there are some areas that have local ozone formation, particularly southern-European areas, and there is more potential for localized short-term action plans to significantly reduce exposure to peak levels.

**$PM_{10}$**

Ambient PM concentrations are the combination of natural sources, primary particulate emissions, and secondary inorganic and organic particulates (e.g. nitrates and sulphates). The secondary formation of Th $PM_{10}$ occurs on a regional scale and under certain meteorological conditions, this can lead to high ambient PM concentrations and peak episodes (e.g. as in 2003) that lead to exceedances of the short term limit value (daily concentration of 50μg/$m^3$ not to be exceeded more than 35 times per year), particularlyin locations close to major sources such as roads, industrial sites or areas of significant domestic solid fuel use which add on an additional primary PM increment. The EEA (2003) analysis reports widespread exceedence of the limit values between 1997-2000 (EEA 2003). During 2000 more than 50% of all traffic hotspot stations in AirBase reported exceedence of the limit value. This comprises many locations across most Member States and approximately 28million urban and rural inhabitants.

For the secondary PM fraction, only permanent measures applied on a regional scale will reduce this fraction. Without such measures, only very large reductions in the primary fraction emissions at the actual locations where exceedences occur could bring about compliance with the limit value (and even then in exceptional meteorological years, there might still be exceedances. The formation of secondary PM will reduce with the implementation of the National Emissions Ceiling Directive, but even with this legislation in place, the CAFE baseline still shows that Europe will have a PM problem.

Local atmospheric conditions and source profiles can contribute to pollution peaks. Thermal inversions are frequent occurrences during winter months in Europe. At the same time residential heating need is increased during winter and if solid fuels are used then the local contribution to $PM_{10}$ (and $PM_{2.5}$) levels can be higher than normal. There is more potential to target the impact of these emissions sources at a local level.

**$NO_2$**

There has been a downward trend in reported exceedences of the short term indicator (one hour average of 200μg/$m^3$ not to be exceeded more than 18 times per year) between 1997-2000 (EEA 2003). Rural background peak levels are well below those found in urban areas, but even here and at roadside locations over 90% of AirBase sites have reported compliance with the limit value since 1998. During 2000 just 3 urban background sites and 26 roadside stations reported exceedences. These locations are generally the largest cities in Member States. Note although $NO_2$ as a short-term peak pollutant has decreased, it is still a problem in relation to local pollution (see later section). Because $NO_2$ is formed locally, there is more opportunity to influence peak levels on an urban scale.

## 4.3 LOCAL POLLUTION ISSUES AND RESPONSES

### 4.3.1 The significance of local hotspots in terms of human health

Human health impacts are the key aspect of localised hot-spot pollution, and there are currently long term (annual mean) EU limit values for$PM_{10}$, $NO_2$, lead and benzene. Appendix 3 tabulates these standards. The need for additional limit values for $PM_{2.5}$, PAHs and some heavy metals is currently the subject of debate in the EU.

WHO examined acute and chronic health impacts in its systematic review (WHO 2004a,b) and the box below summarises the comments on key pollutants. In the survey it was the pollutant $NO_2$ and $PM_{10}$ that exceed their long term objectives most often[10], though it is PM which is the key pollutant in human health impacts.

**$NO_2$**

The WHO systematic review noted that there is uncertainty over the direct impacts of exposure to $NO_2$ at current EU ambient concentrations. However, evidence remains that long-term exposure to $NO_2$ at higher concentrations than the long-term limit value (annual mean of 40μg/m$^3$) has adverse effects. In the absence of sufficient information to justify a change in the guideline value WHO recommended the annual average guideline value should be retained or even lowered. The working group also noted, "a longer-term guideline value is also supported by the evidence on possible direct effects of $NO_2$, and on its indirect consequences through the formation of secondary pollutants."

**$PM_{10}$**

WHO's analysis found that the chronic health burden from particles is significantly greater than short-term effects and the chronic effects of particulate matter are the dominant health burden presented by the ambient pollutant concentrations currently experienced in Europe. Further evidence led WHO to conclude that fine particles (commonly measured as $PM_{2.5}$) "are more hazardous than larger ones (coarse particles) in terms of mortality and cardiovascular and respiratory endpoints in panel studies. The production of fine particles is especially associated with certain combustion emissions such as road vehicle exhaust and also the products of domestic solid fuel burning. Hence there is a high potential for large fractions of the European population to be exposed to elevated fine particle levels particularly from road transport sources.

However, WHO maintained that coarse particles also have health impacts and so should continue to be controlled. Hence it was recommended that air quality guidelines for $PM_{2.5}$ be further developed and that reconsideration of public health protection guidelines for $PM_{10}$ is warranted. Due to the observed effects from long-term PM exposures, WHO recommended that the annual mean exposure guideline be maintained.

WHO also noted that the hot spot issue relates to the position of receptors with respect to specific pollutant sources and how this differs geographically. In highlighting specific population groups the systematic review cited those exposed to unusually large amounts of air pollutants (i.e. those living or working in hot spots) as being more than usually vulnerable due to their exposure rather than an innate or acquired susceptibility to pollutants.

They cite a number of studies where increased health effects due to $NO_2$, $PM_{10}$ and other pollutants have been associated with living near busy roads. They note that ultra fine particle ($PM_{0.1}$) levels are especially elevated close to busy roads and that evidence suggests they have a higher toxicological potential than coarser PM fractions due to their large total surface area and composition rich in metals and organics.

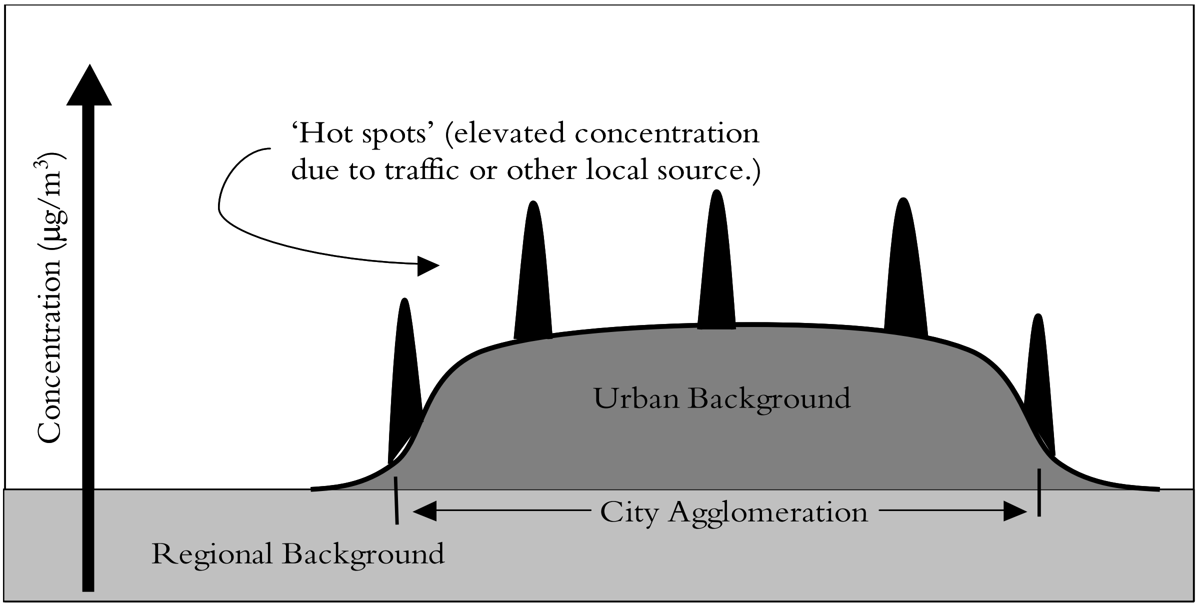
### 4.3.2 The formation and extent of local hot-spot pollution in Europe

In order to discuss the applicability of different measures for addressing local pollution, it is necessary to consider the extent of the problem in Europe, and the key factors in formation of hot-spots.

Regional background levels, for example at rural background sites, are generally indicative of the overall emissions activity within a region both from natural and anthropogenic sources. These levels are enhanced in urban areas from local emission sources, which are concentrated in these areas because of human activities.

In urban areas, limit values may be exceeded when in close proximity to specific stationary or mobile sources , i.e. at a hot-spot. These hot-spots can be common where air is poorly dispersed. With larger urban areas, exceedances may extend over a large fraction of the city, due to the concentration of total activity and emissions. The figure below illustrates how concentrations build in proximity to human activity to create permanent pollution "hot-spots."

**Figure 15 Schematic diagram, illustrating features of pollution hot-spots**




Based on figure from Lutz 2003

The two key pollutants of concern are $PM_{10}$ and $NO_2$.. Within this project, permanently implemented actions, taken in or around hot-spots, to reduce pollution levels are those defined as local measures.

Atmospheric conditions have an important role in creating pollution peaks. This can arise at a local level, but also from regional pollution. Therefore year-to-year variation can increase or decrease the degree of exceedances in any one location.

[10] WHO noted that in practice there is no urban hot spot issue associated with ozone since exceedences are frequently over large areas rather than associated with smaller hotspots.

**$PM_{10}$**

During 2000, 11 of 273 urban background sites within the AirBase network reported that the $PM_{10}$ limit value (40μg/$m^3$ annual mean) was exceeded, as well as an additional 24 of 128 road traffic sites. Higher levels of exceedence were reported for all previous years back to 1997 and there is a downward trend. Proximity to industrial, road transport or other combustion sources particularly within urban areas, led to these exceedences of the limit value (EEA 2003).

It should be noted that the project survey identified 16 European respondents who stated they had a long term $PM_{10}$ or $PM_{2.5}$ problem. Unless there is a high degree of correspondence between those locations reporting to the AirBase network and the survey respondents then European $PM_{10}$ hotspots may be much more frequent and widespread than the EEA data suggest.

A large fraction of ambient background $PM_{10}$ concentration comprises naturally sourced material and secondary particulate matter. Background levels can be a significant proportion of the concentrations in urban limit. At these locations even modest enhancements in the ambient level for example close to road traffic can increase levels above the limit value. This situation presents two key issues.

- Firstly the issue of the secondary fraction formation and transport requires that permanent measures applied on a regional scale are required to reduce this fraction. The National Emissions Ceiling Directive (a permanent EU-scale measure) should contribute towards the reduction in the secondary fraction.

- Secondly, without such measures, only very large cuts in the primary fraction emissions at the actual hotspot locations could bring about compliance with the limit value.

There are currently far fewer $PM_{2.5}$ monitors although this will probably be addressed in the Thematic Strategy. However, it is highly likely that locations that suffer excess levels of $PM_{10}$ due low level combustion sources and transport will also experience adverse levels of $PM_{2.5.}$

**$NO_2$**

The long-term limit value for $NO_2$ (annual mean of 40μg/$m^3$) is exceeded much more commonly than the short term (hourly) limit value. During 2000, around 10% (61 locations) of all urban background stations in the AirBase network reported exceedence of the limit value, while around 50% (177 locations) of roadside sites reported the same exceedence. (EEA 2003). These locations are found throughout the Member States but Northern Italian cities appear to experience very high urban background levels. The EEA estimates that at least 45 million inhabitants across the EU are potentially exposed to these reported levels.

A significant fraction of $NO_2$ is formed as a secondary pollutant due to photochemical and other atmospheric processes (the proportion of direct $NO_2$ emissions from combustion is generally low). The potential for $NO_2$ formation is related to total emissions of NOx (or oxides of nitrogen) such that it is emissions of NOx that need to be managed to control $NO_2$ levels. The important point to note is that there is a non-linear relationship between NOx and $NO_2$ levels. In general the lower the total NOx level, the greater the proportion that is manifested as $NO_2$.

In practice this means that measures to reduce $NO_2$ by a modest amount may have to deliver a much greater overall reduction in NOx emissions and levels. The $NO_2$ formation process can operate on a small geographical scale where dispersion conditions are not good but frequently is observed operating on a total urban scale. Hence measures to control $NO_2$ will frequently need to be implemented over a larger area than the one comprising the hotspot. Nevertheless, $NO_2$ is essentially a local pollutant, and local action can be effective in tackling exceedances.

In addition to the large and widespread health burden from local and short term pollution issues we have highlighted, we note that evidence suggests there are social equity issues associated with this pollution. People living in hot-spots may be statistically more vulnerable and economically disadvantaged.

## 4.4 THE SURVEY RESULTS

The study set out to contact over 180 people worldwide relevant to the objectives of this project, based on known previous work, relevant contact points or literature searches. Where it was possible to make initial contact, respondents were surveyed via a questionnaire. From this survey, 58 different respondents or sources of relevant material from 23 different countries were identified and entered into the database. This comprised 35 questionnaire responses and 24 additional experiences identified from the literature. Section 2 of this report presents the results in detail.

Many responses to the survey were incomplete so that it is not straightforward to interpret the results. In many cases it can only be stated that some fraction of respondents have taken one action or another rather than state the absolute share that have taken that action. For example, at least 50% of respondents have some form of emissions inventory or air quality management plan in place to aid policy making. Furthermore at least one third are coordinating their air quality management strategy with transport infrastructure, public transport and spatial development strategies.

It is clear from these data that $NO_2$ and $PM_{10}$ are the pollutants of concern most frequently cited in hot-spots, $O_3$ and $PM_{10}$ peaks are the main concern during summer and $O_3$ and $NO_2$ are the most frequently cited winter issues. The number of short-term measures designed at pollution peaks in summer or winter are low, given the frequency of these events. 76% of the measures were focussed on long-term hot-spots. Coincidentally 76% of all the respondents cited that their locality was mainly urban in character. In 50% of these cases the hot-spot extends over an area somewhat bigger than just a few streets and in an additional 28% the problems are stated to extend over the whole urban area.

80% of short term measures found were introduced to reduce emitting activity in some way and half aim to physically remove sources. In 86% of cases for which there were data, the measures are focussed on managing emissions from cars and in 32% of cases the focus is also heavy duty vehicles. Short-term measures focusing on industry were found for 25% of cases surveyed. It is clear that transport dominates short-term measures introduced.

In many of the cases the respondents state that these pollution issues cannot be solved (in terms of compliance with the EU standards) by local action alone. That is they believe that additional national or international measures will be necessary. This is found particularly true of ozone and the phase II standards for $PM_{10}$.

### 4.4.1 Policy responses to pollution peaks: survey findings

The discussion above identifies two separate responses to peak pollution episodes.

1. Where regional scale formation processes or high rural background levels are dominant then action at a regional scale would be required.

2. Where more local scale formation or the local source contribution is dominant then there is potential for more localised action to be effective.

Respondents in the project survey represent both of these cases. However, it is the second of these that is most relevant for local measures and responses.

In most cases in the survey, respondents state that they could not significantly influence peak levels as these were either due to infrequent weather conditions or were outside their immediate control. Correspondingly, most respondents believe that additional national or European-scale measures are required to achieve compliance with all short-term limit values.

In some areas (e.g. London), respondents thought that the most effective way they could address peak concentrations was through permanent local measures contributing to the overall improvement of air quality. This has been reflected in some of the more ambitious plans in this city (see case studies on Congestion Charging and Low Emissions Zone – the first already implemented and the second planned for 2007) – discussed in more detail in the local pollution section.

For short-term peaks, most responses were in the form of constraints on activity. The survey identified a basket of regulatory, economic or voluntary measures towards this.

- 80% of short-term measures found in the survey reduce emitting activity while half aim to physically remove sources.

- In 86% of cases the measures are focussed on managing emissions from cars and in 32% of cases the focus is also heavy-duty vehicles.

- Only 25% of short term measures focus on industry or other stationary sources.

This shows a clear trend in targeting measures towards the transport sector. We highlight the some care must be taken in interpreting the values above: the survey response rate was low, particularly from southern Member States. This may underestimate the potential for local ozone peaks where atmospheric recirculation is a problem.

Information on ozone problems should be well documented, as the Commission Decision guidance on the Ozone Directive requires authorities (in locations where peaks occur) to have access to information on:

- The formation and transport regime that applies in their region
- Forecasts of peaks occurring several days in advance
- Knowledge of the key activities that would need to be restricted.

However, these require significant resources and expertise. Evidence from France (Paris and Strasbourg) and Italy in the survey show the full engagement of the **regional** authorities responsible for monitoring pollution: such authorities have access to some forecasting tools. In very few other cases was there an indication that the local air quality managers had access to such tools.

The Commission Decision regarding guidance on the ozone Directive concluded that, "A regional strategy would be substantially more efficient than individual local measures and the combination of transport, industry and household-based measures is required several days in advance of a peak or throughout the peak pollution season to achieve the highest possible reductions." Not surprisingly, the survey did not find a focus on local measures to deal with regional episodes.

There were a few examples to mitigate peak ozone. The Strasbourg plan ozone is a set of measures implemented when the *information* or *alert thresholds* for ozone are surpassed. The measures were described in the case study section. It should be noted that the plan also includes a raft of regulatory, economic and voluntary measures focussing on several activities and not just road transport[11]. Below the alert threshold, compliance with the measures is voluntary and evidence suggests that traffic circulation has been reduced by approximately 13% on major routes when the information threshold is surpassed.

This type of short term action plan is also seen but implemented using different measures in other French cities (e.g. Paris) and in Italy. The limited data on the Paris experience indicate a similar level of success (although over a much bigger urban area) to that found in Strasbourg. No ex-post data were available via the survey on the success of the compulsory measures (e.g. alternate traffic circulation) in events where the alert level has been exceeded. It should be noted that the French cities cited are more likely to require regional scale action plans to deal with their ozone problems according to the Commission Guidance, so that small mitigation of peak episodes may be expected from these experiences.

There was one other category of PM control that was restricted to Scandinavia – for addressing short-term PM peaks. Finland and Sweden experience peak road dust episodes that are caused by dry conditions and arise from studded vehicle tyres. The conditions lead to the re-suspension of dust into the atmosphere. Usual responses have been to try to enforce the switch away from studded tyres during the summer months and more frequent street cleaning. Recently however, these countries have experimented with a salt solution spray, which dampens and binds the street dust to become less easily suspended. This technique may be able to reduce peak $PM_{10}$ by 40% at an annual cost of approximately €1.1million (2004 prices). Possible drawbacks may

[11] In the Strasbourg and Alsace region, agriculture is a highly significant source of ozone precursors, yet available evidence suggests that this sector is not adequately targeted in the plan ozone.

include adverse pollution of groundwater due to the salt solution. Further investigation is taking place.

### 4.4.2 Policy responses to local hotspots: Survey results

***Road Transport Sector***

One of the more common approaches for addressing urban emissions is to improve the emissions technology of vehicles, particularly public transport fleets. Older vehicles of this type are frequently among the worst polluters and there are many alternative technologies to technical options such as retrofitting existing vehicles or buying new vehicles. Moreover, in several countries there are central sources of funding to subsidise some of these changes. Targeting public transport fleets can be a cost-effective and highly visible way to reduce urban transport emissions. Issues of fleet size and available resources influence how far and how fast these authorities can act: Aalborg quotes investment to get a fleet of Euro IV compliant buses as soon as possible, whereas London requires existing buses to be compliant to the Euro II standard with a retrofitted particulate trap by 2005.

No data were found in the project survey to allow discussion on the relative cost-effectiveness of the different technologies, though this information is documented elsewhere.

The second approach to controlling hot-spot impacts is via zoning. For example such zones may ban vehicles, either permanently or for specific times of day (e.g. with a pedestrian or Home Zone). They may apply restrictions on certain classes of vehicle such as private cars with few occupants or older heavy goods vehicles (e.g. with low emission zones, also called environmental zones). Or they can enforce certain behaviour in a zone such as vehicle speed. The project survey found several examples (either planned or implemented) of each of these zone types and the London and Rotterdam experiences were assessed in detail using the available data for the case studies.

These assessments show that significant emissions reductions are possible using such schemes. The London Congestion Charge is estimated to have reduced $NO_x$ and $PM_{10}$ emissions in the central zone by 12% while the proposed London Low Emission Zone may bring a 3% reduction in $NO_x$ and a 19% reduction in $PM_{10}$ from road transport by 2010 over the whole of London.

On a smaller scale the motorway speed control zone in Rotterdam demonstrates that significant benefits can be achieved for a particular exposed population with little noticeable impact on the polluter. In this case it is the homogenisation of traffic flow to reduced congestion at peak periods that is considered to be the main reason for the emissions reduction, rather than the reduction in peak speeds. For situations of this type the specific location of exposed individuals, the emission source and its characteristics are critical to success (and it is not suggested that congestion or adverse exposure to air pollutants can be solved everywhere using such speed zones). However, the results at this location are positive enough for the Netherlands to be considering other locations where such schemes could be applicable.

A key aspect of zone–type measures is that there is good potential for significant wider benefits. Noise and safety benefits have been noted in the Rotterdam speed control zone. Noise benefits are also predicted for the low emission zone (though there are potential noise increases from the congestion charging zone). There are potential additional benefits in travel time in cases when there is congestion relief – clearly also in the case of the congestion charging scheme Despite the success of the above measures

Despite the success of these particular measures, it is stressed that they are extremely site specific. Their success is determined by local characteristics and it is not possible to assume these schemes would be successful in all other urban locations.

In each of the road transport measures noted above there is also another key limitation. The schemes only bring forward improvements in fleet emissions that will occur in time anyway. However, according to recent data (EEA 2003b) there will still be a significant time period before all of these improvements will have taken effect. .

Table 26summarises these data.

**Table 26 Estimated share of pre-accession EU-15 vehicle fleet corresponding to different technologies in 2002**

| | Vehicle engine technology | | | |
|---|---|---|---|---|
| Vehicle type | Conventional[1] | Euro I | Euro II | Euro III |
| Passenger cars | 22% | 24% | 38% | 18% |
| Trucks | 52% | 12% | 34% | 2% |
| Buses & Coaches | 58% | 14% | 24% | 4% |

1) Vehicles not fitted with 3-way catalist

These data demonstrate that there is still a considerable share of the fleet where emissions are only at Euro I standard or lower and they mask significant geographical variations such as the fact that Portugal and Spain lag well behind Member States such as the Netherlands and Austria in the cleaner technologies penetrating into the fleet.

In this context, local measures encourage the quicker uptake of the later Euro standards could be considered ‘bridging’ measures to help locations that would otherwise not comply with the EU standards by 2010. However, year-on-year the benefits attributable to such schemes will diminish. This raises two points:

- There is a limited window of opportunity to implement these measures while they are still relatively cost-effective.
- An alternative is to periodically toughen the regulation within the zone to keep bringing forward vehicle improvements. For example within a low emission zone, one can periodically include new class of vehicle within the regulations and change their minimum emissions requirements. Even so, it is likely that if measures are implemented later, they will have ‘diminishing returns’, because they are reducing

emissions down relative to cleaner fleet. This has implications for the cost-effectiveness (and even more so, the benefit to cost ratio) for measures.

*Other Sectors*

Within the EU, industry is highly regulated through the Integrated Pollution Prevention and Control Directive. This legislation and its precursors have ensured very significant improvements in the local air quality and other environmental impacts of these sectors. The project survey found few examples of specific industry-focussed measures within Europe.

More evidence was found of measures to reduce emissions from the use of fuels in the commercial and residential sectors. Several authorities cite efforts to improve energy efficiency in these sectors. Surveyed measures include those where the quality of fuel is controlled.. This was investigated in one of the case studies, in Dublin, where there was a ban on the sale of bituminous coal. This led to an immediate 69% reduction in smoke emissions, 35% reduction in $SO_2$ emissions and large improvement in the ambient concentrations of these pollutants. It has been estimated that this has resulted in 116 fewer respiratory deaths, and 243 fewer cardiovascular deaths. This measure works well since it regulates a small number of fuel suppliers rather than many fuel consumers. The downside is there are potential loopholes through which the fuel users can purchase banned fuels outside of the controlled zone. However, it appears that such instances are very rare and overall the ban has a very high level of compliance. The fuel ban has now been implemented in all large urban areas of Ireland and a national ban is being considered.

As in the case of some road transport based measures the Dublin fuel ban brought forward changes that were occurring anyway. There was a trend away from solid fuels to gas and many people took the opportunity of the ban to bring forward this change.

It should be noted that the survey found no measures specifically targeting $PM_{2.5}$ pollution. Rather respondents assume that measures to reduce $PM_{10}$ emissions from either low level combustion sources or from road transport also target the finer particles. While this is a reasonable assumption in many cases future monitoring and research will demonstrate whether such measures are effective enough to achieve a future $PM_{2.5}$ limit value.

## 4.5 RELATING THE RESULTS TO THE KEY ISSUES FOR THE THEMATIC STRATEGY

The following sections assess the six key issues raised for the study, and outlined in the introduction. Within each section, we outline the key recommendations.

### 4.5.1 Future evaluation of national/regional air quality "plans and programmes"

The study has aimed to evaluate short-term and local measures 'ex post', i.e. after their introduction, to consider the effectiveness of measures, their costs and benefits, and what this might mean for future policy.

One of the key conclusions we have found is that with a few exceptions there is a lack of 'ex post' data available, which hampers the evaluation process. Indeed, it has been extremely difficult to find reliable and consistent data on the ex ante and ex post costs, and the ex ante and ex post benefits (particularly in relation to emissions and air quality), of local measures. Moreover, where data does exist, it is not disaggregated sufficiently, and does not account for the baseline conditions (i.e. with a counter-factual analysis to separate out the effect from the measure from other policies or changes).

The survey included several questions requesting details of the costs and effectiveness of different control measures. In the majority of cases little or no quantitative information was provided. In some cases, full or partial cost-effectiveness or cost-benefit analyses had been done and these reports were taken into account within the project. It remains the case that in most situations this type of analysis is rare. In addition only 9% of measures were stated to be complete, 49% are ongoing hence there are very limited ex-post data available.

At least 1/3 of respondents attempt to monitor the success or otherwise of the measures. In most of these cases respondents cited continuous air quality monitoring to judge whether their control measures were being successful. With year to year variation in meteorology, shifting background conditions and existing trends in the emissions profiles of sectors such as transport it is clearly very difficult to identify the effect of a specific local measure from anything other than a long-term monitoring time-series. For the ex post analysis, as well as monitoring data, an 'evaluation' needs to be made to clearly separate out the effect of the measure from the background changes – the key point of such an evaluation is to find out what would have happened in the absence of the measure, and so to correctly attribute the benefits that have arisen from the measure alone.

For example the London LEZ feasibility study includes in-depth ex-ante air quality modelling, benefits and economic analyses of the impacts of this measure. If the scheme goes ahead the enforcement system would also be the main mechanisms for monitoring its success. In another example, the motorway speed control zone in Rotterdam was also simulated ex-ante and a much expanded air quality monitoring network was installed both before and after the measure was implemented to clearly evaluate its effects. The Netherlands are considering the use of this measure at other locations on their motorway network again via ex-ante simulations.

Reasons for the relative lack of this type of analysis may include the following:

- Resource constraints
- Lack of local regulatory need
- Lack of expertise

Respondents regularly cited all three issues in their comments attached to their survey responses. There is a paradox that local air quality managers frequently ask for more detail on the costs and effectiveness of different measures while being unable to offer this data for the measures they have implemented.

In some countries there are regulatory pressures to provide this type of information. The legal framework of UK Local Air Quality Management includes the requirement, in situations where the national air quality objectives are likely to be exceeded, to at least consider cost-effectiveness of different measures in Air Quality Action Plans. However, the requirement does not extend to full analysis but rather an overall consideration of the affordability and feasibility of a measure in comparison with a general assessment that the measure should have some positive effect on air quality. In the USA, State Implementation Plans for managing air quality must include a highly regulated analysis of the location and scale of emissions reductions that must be achieved in order to achieve the relevant air quality standards. This point is also picked up further in a later section.

We conclude that further work is needed to investigate the full costs and benefits, and the role toward meeting EU limit values, for such measures. We highlight the creation of the database in this study as an important starting point, but recommend that further effort is needed to maintain and improve the database, and more emphasis given on the consistent collection of ex post data on schemes across Europe. This will beneficial to improve the understanding of which measures are successful, and their potential transferability.

This is one of the more important conclusions from the study, and leads to one of the main research recommendations in a later section on the future European framework.

**Recommendation 1. Evaluation of Measures**. Further work is needed to investigate the full costs and benefits, and the role toward meeting EU limit values, of local measures. We highlight the creation of the database in this study as an important starting point, but recommend that further effort is needed to maintain and improve the database, and more emphasis given on the consistent generation and collection of ex post data on schemes across Europe, particularly under counter-factual scenarios (that look at what would have happened in the absence of the measure). This will improve the understanding of which measures are successful, their transferability, etc.

### 4.5.2 Range of instruments or combination to be promoted

The survey result show a board range of instruments are planned or in place.

Many authorities (73% of cases) are attempting to **reduce polluting activity**. This group of measures include efforts to reduce inefficiency in using resources. For example encouraging transport modal switch or otherwise reducing the number of vehicle kilometres driven.

In 52% of cases surveyed the measures aim at **removing pollution sources** so that they contribute less to emissions in exposed zones. Zone controls on certain categories of vehicle or fuel use come within these cases.

**Emission source technology** improvements account for 47% of cases surveyed and these measures include effort to modernise vehicle fleets or combustion sources. The disadvantage of these types of measures compared to the previous two classes is that they do not permanently address the level of activity or the location of emissions. Eventually, should activity continue to grow unhindered then environmental gains due to cleaner technologies will decline. In addition many of these cases address emissions from a small number of vehicles rather than the whole fleet. There are insufficient data to state how effective such limited technical measures would be in these cases.

In many cases, the measures address more than one of these issues. For example the London low emission zone would simultaneously ban older heavy goods vehicles from a large zone and encourage the uptake of cleaner emissions technologies for those operators that still wish to circulate in that zone.

The measures also include a broad range of implementation approach.

**Command and control** measures still appear to be the most widely used instruments. Outright bans on the sale of certain categories of fuel (for example in Dublin) or on entry into specific zones through management of traffic flow are overall easier to enforce to a high level of compliance. Other attempts have been less successful in the past. The attempt to introduce 'alternate traffic circulation[12]'in Athens has been considered unsuccessful partly due to difficulties in enforcement. However, this type of measure is still used during pollution peaks elsewhere (e.g. Mexico City). However, more recent examples, for example Swedish environmental zones, have made significant progress in transport related controls.

The survey found evidence that more sophisticated strategies involving **economic instruments** are becoming considered. At the national scale such measures are already well-established. The most notable example is the London Congestion Charge Zone, though this is not an environmental based charge (though it does demonstrates that this approach can be successful). This scheme has succeeded in significant congestion reduction and indications of emissions reductions in the central zone of London. The Congestion Charge Zone was designed to raise revenue to invest directly in public transport in the long term. Its success has been such that less revenue is being generated than expected.

In another example, the Strasbourg plan ozone, implemented during peak episodes, provides several choices to consumers including reduced public transport tariffs to improve the attractiveness of these travel modes.

In many cases the survey respondents cite lack of available funding as a key reason why large and effective measures are not implemented more widely. The costs of the measures, particularly the starting capital costs are frequently accounted in million Euros. To be fully self-financing, fines or other revenue streams such as registration costs may be prohibitively high in all but the largest scale schemes.

**Voluntary measures** such as the short-term action plans cited by several respondents appear to have had limited or no discernable success. From available data it appears that such instruments have not achieved the level of uptake required to remove pollution peaks or hot-spots.

One key to the enforcement of more recent schemes is that automated technology is available to register and identify the status of vehicles under real traffic flow conditions. Database and

[12] This is a widely attempted scheme whereby vehicles typically have odd and even registration plates. Permission to circulate (either permanently or during pollution peaks) alternates daily between the different parts of the fleet.

telecommunications technologies allow the automated delivery of fines to those who transgress the zone. The combination of strong enforcement systems with the measure is a powerful combination. However, the infrastructure for such scheme is not cheap, and this may constrain such schemes to larger cities.

The detailed case studies have shown that each of these measures have been successful in reducing emissions, and have made some progress towards meeting the EU limit values, in some cases quite significantly. When the benefits of the schemes are evaluated, using the methodology from the CAFE CBA project, they all have surplus benefit to cost. The overall conclusion is that these schemes are considered cost-effective for improving air quality in relation to air quality limit values. Their benefit to cost ratios are similar or better than for the introduction of European wide air quality policies. This provides some initial support for these measures as an alternative to further national based legislation, both in relation to helping to address urban hot-spots, and also for achieving population weighted pollution reductions (and health benefits).

However, the case study analyses show that these local measures are often not sufficient to meet the EU limit values on their own: they therefore complement further European wide air quality policy, rather than replace it.

Moreover, the schemes have been found to be extremely site-specific. It is not possible to make general assumptions that the benefits will be transferable to other sites. In fact, this point is made several times in the original study material. We can recommend that a number of measures look promising, but it is not possible to recommend their wide-scale adoption across Europe (even if the legislation allowed this).

We have also examined what lessons can be learnt from the successful schemes – in terms of their acceptability. We have found a number of important conclusions on acceptability, summarised in the box below.

***Acceptability of measures***

Clearly the acceptability of different measures will vary with the individual, business, sector or city affected. Overall, in cases where the population is aware of air quality problems, there is an acceptance that an action of some sort must be taken. Many of those surveyed indicated that they have taken steps to develop control measures in an inclusive way so that industry and the public can have an influence.

From the examples in the database and in particular the detailed assessments, acceptability of road transport focussed measures can be increased when:

- Costs falling on individual commuters are seen to be non-excessive and that revenue generated is streamed into relevant investments such as improving public transport services.
- Measures do not cause a significant increase in travel times.
- A number of options are offered under the measure (e.g. payment of an access charge, use public transport or investment in a cleaner vehicle).
- The public transport alternatives to car use are acceptable (e.g. capacity, frequency of service and pricing levels).

Low acceptability is strong among those sectors of society where the economic effects of measures fall unequally (although these groups do not often have adequate input into the consultation process). Specific amelioration measures can be introduced to over come this. Within Dublin the poorest householders could not afford to convert to the long-term cost-effective gas central heating due to the high capital costs. They therefore faced increased fuel costs for alternative solid fuels. In response the Government granted a weekly energy allowance among qualifying households to cover this additional expenditure. Although the relief payments amount to several million Euros annually, the benefits of the measure are much greater.

In larger schemes the unequal way costs fall can be more problematic. The London Low Emissions Zone would regulate the minimum emissions requirements of heavy goods vehicles and the costs of upgrading the whole fleet to comply has been estimated to be £45-116 million for the first phase. There are some national grant schemes in place (which help fund retrofit technology), and there are also annual road tax rebates for such vehicles. One other key factor in this scheme was that industry can adapt if there is adequate warning of the timing of the scheme, with specific details to allow companies to plan. This lead to a conclusions that schemes should be well characterised before they are implemented, and have clear guidance on their implications for business and individuals available several years in advance.

There is also another important issue here. The most effective schemes from the information gathered, in reducing emissions and reducing air quality hot-spots appear to be those schemes directly focused on air quality improvements. This includes measures such as low emission zones, motorway speed restrictions, smoky fuel use, etc in urban areas. Many traditional local transport schemes are less effective in achieving emissions or air quality improvements, though this is not surprising because these schemes are aimed at other problems (e.g. congestion). However, these latter schemes have other benefits (e.g. travel time benefits, reduced accidents, etc) which are often their primary objective. We recommend that further consideration is needed on achieving the right balance at local level between actions that concentrate on local measures aimed at improving local air quality, and/or those that give the greatest benefits consistent with improving the urban environment more generally (i.e. towards overall urban sustainability that improves congestion, accidents, noise, air quality, etc). The inter-relationship between these aspects is also highlighted as a research priority, and we identify the potential links between CAFE and the 'Urban' Thematic Strategy in this area.

Finally, we also have found that the improvements in air quality from many local road transport measures will decline in future years, as the traffic fleet becomes cleaner (even accounting for traffic growth). This means that the same measure will have less effect if introduced in 2007 than if introduced in 2000. The ranking of measures will also change over time, depending on the scheme type, and whether it affects certain vehicles in the fleet, or modal shift more generally.

**Recommendation 2. Range of measures to be promoted**. Many measures have been introduced across Europe. The most successful appear to have come from regulation (rather than voluntary approaches), predominantly implemented through command and control policy. However, there is more use of economic instruments for local measures – though the data here is not sufficient to allow a comparison of the costs and benefits of the two approaches. Where economic instruments have been attempted authorities often ensure that revenue generated is put back into transport infrastructure as this is seen as important in gaining acceptability for the measures.

What is clear from the analysis is that local measures targeting short-term pollution or hot-spots are extremely site specific. It is difficult to recommend specific measures or combinations of measures. The study does indicate that many local measures targeting air quality specifically can be cost-effective, but that other measures may have greater benefit to cost ratios when wider urban sustainability objectives are included. The study has found that the local acceptability of schemes is important, and has found a number of good practice examples that have ensured good acceptability.

As a final point, the survey and analysis shows that local measures are not enough, on their own, to meet the EU limit values. There is a need for ongoing European wide legislation to reduce background levels and precursor species. Viewed in this context, local and short-term measures complement existing European wide policy – they are not an alternative to it.

### 4.5.3 Future European legal framework

The responses have been used to consider the future European legal framework. There are two issues here:

- How well does the existing legal framework work?;
- What additional legal measures could be introduced to improve the framework?

The existing legislation sets out a framework for addressing local air pollution. The Commission Decision of 20 February 2004 set out the arrangements for the submission of information on plans or programmes required under Council Directive 96/62/EC. Forms 1-4 in this decision require member states to declare areas where there is a likelihood that the EU limit values will not be achieved and Forms 5-7 require the states to list the additional measures they will be taking and their effects. In particular, in each case of limit value exceedence and additional measure, this calls for details of:

- An implementation timetable
- Indicators for monitoring progress
- The funding allocated and the total cost
- Estimated effect of the measure on air quality

In effect this project survey to a large extent overlaps with the reporting of plans and programmes. The survey has shown that the information being gathered varies in quality significantly and the rate at which Member States are reporting under this obligation indicates systematic problems in deriving this information. There might be informational benefits in encouraging local measures by formalising obligations for local air quality managers to contribute more information to an experience database (such as the CAFEAIR database developed for this project). This would achieve strategy aims such as improving and sharing knowledge, simplifying (or unifying) reporting requirements, and improving transparency. Member State reporting obligations on plans or programmes could be more strongly enforced to this end.

**Recommendation 3. Future European Legal Framework.** We find little evidence to suggest that the current EU legal framework for air quality is inadequate overall. However, we do recommend that more effort at Member State to identify areas where short term action plans may be effective and also to implement better reporting under Commission Decision for the submission of information on plans or programmes required under Council Directive 96/62/EC. This should aid the dissemination of more and better data on the effectiveness of measures.

The Commission Decision could be clarified in some cases as follows:

- The Air Quality Framework Directive Annex IV requires details including maps, emission inventories and location specific aspects (i.e. topography, trans-boundary contributions and atmospheric formation) of exceedences. The current Decision may not reinforce these particular requirements sufficiently.
- The Decision does not require source information that is adequately disaggregated. Road Transport is a single sector with no distinction made for different vehicle types or ages.
- The Decision does not define what it means by 'significance' in ranking the importance of different sources or the spatial scale over which the measures operate.

In terms of disseminating best practise we believe there would be merit in a system of formal guidance notes (similar to BREFs developed under the IPPC Directive). Among the issues guidance should include consideration of the diminishing cost-effectiveness of static road transport based measures and the site-specific factors that determine how effective measures could be in given locations. Furthermore guidance could put emphasis on monitoring other indicators than ambient air quality to determine the actual cost-effectiveness of individual measures. Better indicators for such analysis include; numbers of sources converted to cleaner operation, modal shift in terms of vehicle kilometres, improved travel time where congestion is relieved and traffic flow counts.

The NECD has a clear focus on regional scale issues rather than more localized ones. In view of the lack of good ex post data highlighted above it is unlikely that Member States can currently use their reporting of plans and programmes to demonstrate additional progress towards compliance with this Directive. Also, since so many hot-spots and short term problems cannot be solved by local action alone reviews of the NECD should consider the extent to which more stringent emissions ceilings can contribute to driving down background contributions and hence increase the future effectiveness of local measures in achieving the limit values.

### 4.5.4 Implementation of the subsidiary principle

Under the existing framework EU member states are legally accountable to achieve the air quality standards. Within the member states there is variety in how this responsibility is discharged. Evidence from some countries indicates a high degree of central control over all aspects of the air quality management. Others (e.g. UK) have devolved certain responsibilities to a very local level reasoning that the local authorities are best placed to make site specific decisions.

One immediate question that arises is 'whether a focus on local level action would be warranted in all locations'? The surveys provide some interesting analysis here, and suggest a number of limitations with this approach:

- The survey shows that there is a critical need for guidance and expertise on the feasibility, costs and effectiveness of measures. Measures that have been implemented may not have gone through the same rigorous appraisal process as European policies, and so they are not necessarily the most cost-effective or efficient.

- The survey has identified difficulty in the regional coordination of effort between individual authorities. In cases where pollution is regional in scale (e.g. ozone peaks in Northern or central European Member States this level of coordination would be crucial.

- The survey has found competition from other needs for limited resources to plan, fund and monitor the measures.

- The survey has found different political realities may prioritise rapid economic growth above environmental protection. Decisions to create zones that curb activity can appear unpopular and hence require strong leadership.

National level funding, leadership and management of the pollution issues can overcome some of these problems. The UK and French environment ministers provide guidance to the regions and smaller governmental bodies on their responsibilities in managing air quality. Further action to improve public awareness, and re-enforce the benefits of improving air quality might also be important.

Technical issues aside the survey found that many local public authorities actually do have legal powers to implement many local measures autonomously by applying local traffic or planning control orders. The extent to which this is possible with some measures varies widely across Member States. For example public transport is mainly provided by private operators in the UK not always in partnership with the public authority. The ability to force improvements to the provision of more transport is not straightforward in such cases. Other increasingly important examples are Europe's airports many of which are privately operated and which currently do not have the same high level of environmental scrutiny or regulation than does industry for example. At Heathrow airport, UK while the local authority is nominally charged with attempting to regulate the air quality impacts the national government has had to intervene to re-state clearly the airport operator's environmental obligations that must be achieved before allowing further growth of air transport.

From those surveyed, the three key reasons for lack of progress dealing with hot-spots at the local level are

1) lack of adequate information on the costs, effectiveness and wider impacts of measures they might implement and

2) lack of resources to implement large but effective schemes.

3) Lack of local regulatory power

All three of these issues could be dealt with to some extent by increasing engagement with specific hot-spot or pollution peaks problems at the Member State level.

**Recommendation 4. Subsidiary.** The particular situation and level at which decisions are made within each member state is a result of cultural and historical evolution so that we find it difficult to suggest a single consistent localised legal framework throughout the EU to deal with pollution peaks and hot-spots. However, we find that the issues of lack of expertise, resources and regulatory powers could be overcome by greater national level engagement with the specific locations experiencing hot-spots or peak pollution.

### 4.5.5 Applicability and limitation of measures to other European areas

Pollution hot-spots and peaks are highly site specific. The source activity, fuels and technology, their location relative to exposed receptors as well as specific meteorological and topographic factors combine to create a more or less unique pollution issue at a given location and time. Correspondingly, successful measures to tackle these hot-spots must be designed with these site-specific factors in mind.

Nevertheless, there may be some approaches that would help in the identification of ***potentially*** suitable measures between locations. One way of approaching this problem is to identify locations that have similar profiles, i.e. those of similar size, significant sectors, activity levels, population density and atmospheric properties. To illustrate, certain types of large-scale urban transport measures are only applicable in large urban agglomerations.

To some extent networks of this kind have already arisen in the EU. Representatives of London, Paris, Berlin and other cities have formed conferences and workshops to examine each other's pollution issues and their responses. The database developed in this project will also aid this process. It allows a variety of searches to find other locations that share pollution characteristics. Authorities should be encouraged to continue to add and revise entries in the database to strengthen this function. It is clear from this discussion that at least some level of ex ante and ex post analysis of the each hot-spot or peak pollution problem and its causes is necessary.

**Recommendation 5. Transferability.** As highlighted above, local measures are extremely site-specific. It is dangerous to make broad assumptions about the transferability of measures from sites across Europe. However, there are approaches that would help in the identification of potentially suitable measures between locations. One way of approaching this problem is to identify locations that have similar profiles, i.e. those of similar size, significant sectors, activity levels, population density and atmospheric properties. Reporting of progress under plans and programmes or otherwise continuing to develop the CAFEAir database may increase the potential to identify possibly transferable measures.

### 4.5.6 Areas of further research

The new data gathered within this project are a significant addition to current understanding with regard to experience of pollution peaks and/or hot-spots. It has also provided useful detailed case studies on a number of the more positive measures. Following this and the discussion in this report, this section considers what future work may be required.

The lack of good costs and effects data for measures that have been implemented has been mentioned several times. Within this project this knowledge gap was found regularly at the local authority level but also at much higher levels of regulation. It is very difficult to give specific guidance on measures where these data are lacking. We believe that it is key to the success of any long-term strategy for implementing local or short-term measures that resources are devoted to researching these data.

For those measures where these data exist there are now indications of how successful they can be in individual locations. While acknowledging the transferability issues discussed previously it may be useful to assess how much impact they might have if applied in other urban locations, in particular taking into account variations in time (i.e. that measures will be implemented in later year).

Finally, it would be interesting to investigate some of the potential measures identified here in European wide analysis, to investigate their potential for EU air quality policy. Ideally, the modelling of these schemes needs to be undertaken using detailed city emissions inventories and local models (e.g. under a similar level of detail to CityDelta). Indeed, the use of this local approach is the only way to assess short-term pollution[13]. We believe it would be extremely useful to undertake a series of modelling studies in a number of major European cities, looking at the site-specific impacts of different short-term and local measures. This would allow some consideration of the transferability of measures between locations.

There may also be some potential to investigate the use of the European wide models (RAINS and TREMOVE) with specific scenarios. This could include, for example, introducing

[13] the European wide RAINS and TREMOVE models are not designed to look at short-term pollution, and usually work with metrics of annual pollution.

congestion charging and/or low emissions zones in all metropolitan areas within the TREMOVE model.

**Recommendation 6. Future Work.**

We believe there would be benefits in assigning resources to continually update the CAFEAir database (or equivalent means) to gather 'ex post' data allowing the effectiveness of measures to be assessed.

We believe it would be extremely useful to undertake a series of modelling studies in a number of major European cities, looking at the site-specific impacts of different short-term and local measures. . This would allow some consideration of the transferability of measures between locations.

We also believe there may be some (limited) potential to use the European wide models to investigate sets of measures across Europe, to investigate how local measures can contribute to EU air quality policy.

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| Wesseling et al 2003 | Air quality impact study of the 80kph speed control on the A13 in Overschie, Wesseling JP, Hollander K, Teeuwisse S, Keuken MP and Spoelstra H (TNO-MEP) Gense R and van de Burgwal E (TNO-WT) Hermans L Th M, Voerman JWT, Kummu PJ and van den Elshout JHH (DCMR), TNO Report 2003/258, 2003. |
| WHO 2004a | Health Aspects of Air Pollution – results from the WHO project "Systematic Review of Health Aspects of Air Pollution in Europe", WHO, June 2004. |
| WHO 2004b | Health Aspects of Air Pollution – answers to follow-up questions from CAFÉ, Report on a WHO working group meeting Bonn, Germany, 15-16 January 2004. |
| Wicks 2003 | CAFE Target Setting and Policy Assessment Working Group, The Air Quality Thematic Strategy - First Ideas, 12 September 2003- P. Wicks |

# Appendices

## CONTENTS

# Appendix 1
# Survey questionnaire

CONTENTS

# Implementing measures to deal with temporary or local air pollution problems - questionnaire

The purpose of this questionnaire is to gather information on implementing measures to **prevent or reduce short-term pollution peaks or to reduce localised pollution 'hot-spots'**. The completion of this questionnaire should take about 15 minutes. You can fill in the questionnaire electronically, or print it and fill it in by hand. Please send the completed questionnaire, preferably by e-mail, or fax **not later than Monday 7 June 2004,** to: e*mail: ccp@iclei-europe.org; fax: 0049 761 3689279; telephone: 0049 761 368920.* **Thank you in anticipation of your support.**

**IF RETURNING BY FAX OR POST, PLEASE WRITE CLEARLY AND IN BLOCK CAPITALS**

## SECTION 1: CONTACT INFORMATION & STATE OF WORK

**Question 1**

Are you the liaison for air quality information in your local authority? No ☐ Yes ☐

*If you have answered **NO** then do not continue and please forward this questionnaire to the correct person.*

*If you have answered **YES** then please continue by completing the following table.*

| | | |
|---|---|---|
| First Name: | Family Name: | Function (Job Title): |
| Organisation (Full Title): | Address (Street Name & Number): | City/Town: |
| Postal Code: | Country: | Webpage: |
| Phone: | Fax: | Email: |

**Question 2**

Which of these categories best describes your local authority? *Please tick*

Urban ☐ Semi-urban ☐ Rural ☐

**Question 3**

What is the approximate land area of your local authority? ☐ And the population? ☐

**Question 4**

Is your local authority taking action to improve air quality? *Please tick* No ☐ Yes ☐

*If you have answered **YES** then please continue to question 5 immediately below.*

*If you have answered **NO** then please continue to Section 5 of the questionnaire.*

**Question 5**. Do you have an emissions inventory or an air quality action plan for your authority? *Please tick.*

Emission inventory ☐ Action plan ☐ Neither ☐

*If you have either an inventory or action plan or both please use the box below to provide report references and/or a website where they are available*

**Question 6**. Are your actions integrated with other key plans and strategies? *Please tick relevant boxes below.*

Transport infrastructure ☐ Public transport ☐ Spatial development ☐ Environmental strategy ☐ Other ☐

*For a response of "other" please provide details in the box below*

**Question 7**

Do the actions aim to prevent or reduce a short-term (peak) air quality problem? *Please tick* No ☐ Yes ☐

*If you have answered **YES** then please continue at Section 2 of the questionnaire on the next page*

**Question 8**

Do the actions aim to prevent or reduce a long-term air quality problem? *Please tick* No ☐ Yes ☐

*If you have answered **YES** then please continue at Section 3 of the questionnaire*

**SECTION 2: LOCAL MEASURES FOR DEALING WITH POLLUTION PEAKS**

This section deals with measures that help **prevent or reduce short-term pollution peaks**. This includes measures with the objective of improving air quality *and also* measures not having the *direct* objective of improving air quality but still having a significant impact on air quality. **It does not deal with measures taken at national or European levels**. Please answer the following questions with as much quantitative information as possible.

**Question 1.**

How advanced are your actions for dealing with pollution peaks? *Please tick a box*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Still planning | ☐ | Ready to implement | ☐ | Actions are ongoing | ☐ | Actions are completed | ☐ |

**Question 2**. Which measure would have most success in preventing or reducing peak pollution? *Please use the box below to provide a name and a brief description of the measure. If you wish to provide information on more than one measure please make a copy of this section and complete it as relevant.*

| |
|---|
| |

**Question 3**. Which of the following descriptions apply? *Please tick*

| | | | |
|---|---|---|---|
| The measure is short term aiming to prevent pollution peaks before they occur | ☐ | The measure is short term aiming to reduce pollution peaks when they occur | ☐ |

**Question 4**. On the basis of what information would the measure be implemented and who would make the decision? *Please use the box below for your answer*

| |
|---|
| |

**Question 5**. Which of the following categories describes how the measure influences air quality? *Please tick.*

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Supports decision-making | ☐ | Removes pollution sources | ☐ | Reduces polluting activities | ☐ | Improves the pollution source technology | ☐ | Other | ☐ |

*For a response of "other" please provide details in the box below*

| |
|---|
| |

**Question 6**. Which of the following activities does the measure influence, and how?

| *Activity* | *Please tick here* | *Please provide as much specific detail as possible (for example vehicle classification and emissions limit)* |
|---|---|---|
| Road freight transport | | |
| Road private transport | | |
| Industrial combustion | | |
| Industrial processes | | |
| Small-scale heating (institutional/commercial/agricultural) | | |
| Domestic heating (single dwellings) | | |
| Off-road transport & mobile machinery | | |
| Domestic combustion (non-heating) | | |
| Other | | |

**Question 7**. Please provide quantitative details in the boxes below of the estimated effect of the measure on key parameters. *Please include the baseline year from which the change is estimated*

| | |
|---|---|
| Emissions to air? | |
| Air quality? | |
| Other environmental impacts? (e.g. noise ) | |

**Question 8**

Would the measure improve air quality across the whole authority? No ☐ Yes ☐
*Please tick*
*If your answer is* ***NO*** *please use the boxes below to approximate the effect of the measure in terms of:*
Area? ☐ Population? ☐

**Question 9.** How and when is the success of the measure monitored and what are the criteria? *Please use the box below for your answer.*

☐

**Question 10**

Does the measure operate wholly or partially via an economic instrument? *Please tick* No ☐ Yes ☐
*If the answer to this question is YES please use the box below to provide details of the instrument*

☐

**Question 11.** What is the estimated cost of the measure? *Please use the boxes below to answer.*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Currency | | Capital costs | | Annual recurring costs | | Year that costs were estimated | |

**Question 12**

Is a cost-benefit or cost-effectiveness report available? *Please tick* No ☐ Yes ☐
*If the answer to this question is YES please use the box below to provide details of the report reference and/or a website where it is available.*

☐

**Question 13**

Is the measure enforced through either national or more localised legislation? *Please tick* No ☐ Yes ☐
*If you have answered* ***YES*** *then please use the box below to provide details of this legal basis of the measure.*

☐

**Question 14**

Was the measure developed in partnership with regulators, businesses, residents or other stakeholders? *Please tick* No ☐ Yes ☐
*If the answer to this question is YES please use the box below to provide details of the stakeholder participation*

☐

**Question 15**

Is your local authority also taking action to reduce a long-term air quality problem? *Please tick* No ☐ Yes ☐
*If you have answered* ***YES*** *then please continue at Section 3 of the questionnaire*
*If you have answered* ***NO*** *then please continue at Section 4 of the questionnaire*

**SECTION 3: LOCAL MEASURES FOR DEALING WITH LONG-TERM POLLUTION**

This section deals with measures that help **prevent or reduce localised pollution (i.e.'hot-spots')**. This includes measures with the objective of improving air quality *and also* measures not having the *direct* objective of improving air quality but still having a significant impact on air quality. **It does not deal with measures taken at national or European levels**. Please answer the following questions with as much quantitative information as possible.

**Question 1.**

How advanced are your actions for dealing with long-term pollution? *Please tick a box*

| Still planning | ☐ | Ready to implement | ☐ | Actions are ongoing | ☐ | Actions are completed | ☐ |
|---|---|---|---|---|---|---|---|

**Question 2**. Which measure would have most success in preventing or reducing peak pollution? *Please use the box below to provide a name and a brief description of the measure. If you wish to provide information on more than one measure please make a copy of this section and complete it as relevant.,*

| |
|---|
| |

**Question 3**

Does the measure aim to reduce long-term pollution in the whole of the polluted zone? *Please tick* No ☐ Yes ☐

*If your answer is **NO** please use the boxes below to approximate the effect of the measure in terms of:*

Area? ☐ Population? ☐

**Question 4**. Which of the following categories describes how the measure influences air quality? *Please tick.*

| Supports decision-making | ☐ | Removes pollution sources | ☐ | Reduces polluting activities | ☐ | Improves the pollution source technology | ☐ | Other | ☐ |
|---|---|---|---|---|---|---|---|---|---|

*For a response of "other" please provide details in the box below*

| |
|---|
| |

**Question 5**. Which of the following activities does the measure influence, and how?

| *Activity* | *Please tick here* | *Please provide as much specific detail as possible (for example vehicle classification and emissions limit)* |
|---|---|---|
| Road freight transport | | |
| Road private transport | | |
| Industrial combustion | | |
| Industrial processes | | |
| Small-scale heating (institutional/commercial/agricultural) | | |
| Domestic heating (single dwellings) | | |
| Off-road transport & mobile machinery | | |
| Domestic combustion (non-heating) | | |
| Other | | |

**Question 6**. Please provide quantitative details in the boxes below of the estimated effect of the measure on key parameters. *Please include the baseline year from which the change is estimated*

| | |
|---|---|
| Emissions to air? | |
| Air quality? | |
| Other environmental impacts? (for example greenhouse gas emissions ) | |

**Question 7**. How and when is the success of the measure monitored and what are the criteria?
*Please use the box below for your answer*

**Question 8**

Does the measure operate wholly or partially via an economic instrument? *Please tick* No ☐ Yes ☐

*If the answer to this question is YES please use the box below to provide details of the instrument*

**Question 9**. What is the estimated cost of the measure? *Please use the boxes below to answer.*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Currency | | Capital costs | | Annual recurring costs | | Year that costs were estimated | |

**Question 10**

Is a cost-benefit or cost-effectiveness report available? *Please tick* No ☐ Yes ☐

*If the answer to this question is YES please use the box below to provide details of the report reference*

**Question 11**

Is the measure enforced through either national or more localised legislation? *Please tick* No ☐ Yes ☐

*If you have answered **YES** then please use the box below to provide details of this legal basis of the measure*.

**Question 12**

Was the measure developed in partnership with regulators, businesses, residents or other stakeholders? *Please tick* No ☐ Yes ☐

*If the answer to this question is YES please use the box below to provide details of the stakeholder participation*

**Now please continue to Section 4 of the questionnaire.**

## SECTION 4: YOUR AIR QUALITY PROBLEM

**Question 1**. Which pollutant(s) has your local authority experienced problems with and when? *Please tick as appropriate in columns 1-3 below*

**Question 2**. Which pollutant(s) has your local authority experienced problems with and when? *Please tick as appropriate in columns 4-6 below.*

**Question 3**. Which pollutant(s) has your local authority experienced problems with and where in your authority? *Please tick as appropriate in columns 7-9 below.*

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| | This year | During previous years | Expected in the future | Winter peak episodes | Summer peak episodes | Long term problem | A few streets or houses | A larger zone | The whole authority |
| Ozone ($O_3$) | | | | | | | | | |
| Sulphur dioxide ($SO_2$) | | | | | | | | | |
| Nitrogen dioxide ($NO_2$) | | | | | | | | | |
| Benzene ($C_6H_6$) | | | | | | | | | |
| Particulate matter less than 10microns ($PM_{10}$) | | | | | | | | | |
| Particulate matter less than 2.5 microns ($PM_{2.5}$) | | | | | | | | | |
| Polyaromatic hydrocarbons (PAHs) | | | | | | | | | |
| Carbon monoxide (CO) | | | | | | | | | |
| Lead (Pb) | | | | | | | | | |
| Other(s) *Please list:* | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

**Question 4**. Please indicate how difficult it will be to achieve the following European values or proposed values in your authority? *Please insert one of the following values in the last column on the right. 1=difficult without additional national-scale actions, 2=achievable with additional local-scale actions, 3=easily achievable.*

***Note: If your authority is not within the European Union please go to question 5***

| **Pollutant** | **Standard or proposed standard** | **Criteria** | **Insert value here** |
|---|---|---|---|
| Ozone ($O_3$) | Target value for the protection of human health | *maximum daily 8-hour mean of 120μg/m³ not to be exceeded on more than 25 days a calendar year averaged over 3 years from 1/1/2010* | |
| | Target value for the protection of vegetation | *May to July AOT40 value of less than 18000μg/m³-h averaged over 5 years* | |
| | Long term objective for the protection of human health | *maximum daily 8-hour mean within a calendar year of 120μg/m³ from 2020* | |
| | Long term objective for the protection of vegetation | *May to July AOT40 value of less than 6000μg/m³-h from 2020* | |
| | Information threshold | *1 hour mean of 180μg/m³* | |
| | Alert threshold | *1 hour mean of 240μg/m³ measured or predicted over 3 consecutive hours at locations representative of the zone or agglomeration from now* | |
| Sulphur dioxide ($SO_2$) | Hourly limit value for the protection of human health | *1 hour mean of 350μg/m³ not to be exceeded more than 24 times a calendar year by 1/1/2005* | |
| | Daily limit value for the protection of human health | *24 hour mean of 125μg/m³ not to be exceeded more than 3 times a calendar year by 1/1/2005* | |
| | Limit value for the protection of ecosystems | *calendar year and winter mean of 20μg/m³ from now* | |
| | Alert threshold | *500μg/m³ measured over 3 consecutive hours at locations representative of the zone or agglomeration from now* | |
| Nitrogen dioxide ($NO_2$) | Hourly limit value for the protection of human health | *1 hour mean of 200μg/m³ not to be exceeded more than 18 times a calendar year from 1/1/2010* | |
| | Annual limit value for the protection of human health | *calendar year mean of 40μg/m³ from 1/1/2010* | |
| | Annual limit value for the protection of ecosystems | *calendar year mean of 30μg/m³ from now* | |
| | Alert threshold | *500μg/m³ measured over 3 consecutive hours at locations representative of the zone or agglomeration from now* | |
| Benzene ($C_6H_6$) | Limit value for the protection of human health | *calendar year mean of 5μg/m³ from 1/1/2010* | |

| Pollutant | Standard or proposed standard | Criteria | Insert value here |
|---|---|---|---|
| Particulate matter less than 10microns ($PM_{10}$) | Stage 1 24-Hour limit value for the protection of human health | *24 hour mean of 50μg/m$^3$ not to be exceeded more than 35 times a calendar year from 1/1/2005* | |
| | Stage 1 Annual limit value for the protection of human health | *calendar year mean of 40μg/m$^3$ from 1/1/2005* | |
| | Stage 2 24-Hour limit value for the protection of human health | *24 hour mean of 50μg/m$^3$ not to be exceeded more than 7 times a calendar year from 1/1/2010* | |
| | Stage 2 Annual limit value for the protection of human health | *calendar year mean of 20μg/m$^3$ from 1/1/2010* | |
| Carbon monoxide (CO) | Limit value for the protection of human health | *maximum daily 8-hour mean of 10mg/m$^3$ from 1/1/2005* | |
| Lead (Pb) | Annual limit value for the protection of human health | *calendar year mean of 0.5μg/m$^3$ from 1/1/2005 or calendar year mean of 1.0μg/m$^3$ from 1/1/2005 close to historically contaminated sites* | |
| PAH (Benzo[a] pyrene) | Proposed assessment threshold and annual limit value for the protection of human health | *calendar year mean of 1ng/m$^3$ in the total $PM_{10}$ fraction exceeded in 3 of the last 5 years at locations representative of the zone* | |
| Arsenic | Proposed assessment threshold | *calendar year mean of 6ng/m$^3$ in the total $PM_{10}$ fraction exceeded in 3 of the last 5 years at locations representative of the zone* | |
| Cadmium | Proposed assessment threshold | *calendar year mean of 5ng/m$^3$ in the total $PM_{10}$ fraction exceeded in 3 of the last 5 years at locations representative of the zone* | |
| Nickel | Proposed assessment threshold | *calendar year mean of 20ng/m$^3$ in the total $PM_{10}$ fraction exceeded in 3 of the last 5 years at locations representative of the zone* | |

**Question 5**. Do other local air quality standards apply in your local authority? (For example national standards) If so please provide details of these standards and how difficult you think it will be to achieve them. *Please insert one of the following values in the last column on the right. 1=difficult without additional national-scale actions, 2=achievable with additional local-scale actions, 3=easily achievable.*

| Pollutant | Standard or proposed standard | Criteria (for example: averaging period, threshold value, allowable number of exceedences and compliance date) | How achievable is the standard? |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

**Question 6**. What are the main sources contributing to air pollution in your authority? *Please insert one of the following values in relevant columns. 1= dominant source contributing around 40% or more, 2= significant source contributing between 10-40%, 3= minor source contributing less than 10%.*

| | Road vehicles | | | | | Industrial combustion | Industrial processes | Domestic combustion | | | Sources that are outside your area. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Heavy goods vehicles | Buses & taxis | Vans | Petrol cars | Diesel cars | *(Specify here)* | *(Specify here)* | Coal | Oil | Wood | *(Specify here)* |
| Ozone ($O_3$) | | | | | | | | | | | |
| Sulphur dioxide ($SO_2$) | | | | | | | | | | | |
| Nitrogen dioxide ($NO_2$) | | | | | | | | | | | |
| Benzene ($C_6H_6$) | | | | | | | | | | | |
| Particulate matter less than 10microns ($PM_{10}$) | | | | | | | | | | | |
| Particulate matter less than 2.5 | | | | | | | | | | | |

| | Road vehicles | | | | | Industrial combustion | Industrial processes | Domestic combustion | | | Sources that are outside your area. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Heavy goods vehicles | Buses & taxis | Vans | Petrol cars | Diesel cars | *(Specify here)* | *(Specify here)* | Coal | Oil | Wood | *(Specify here)* |
| microns ($PM_{2.5}$) | | | | | | | | | | | |
| Polyaromatic hydrocarbons (PAHs) | | | | | | | | | | | |
| Carbon monoxide (CO) | | | | | | | | | | | |
| Lead (Pb) | | | | | | | | | | | |
| Other(s) *Please list* | | | | | | | | | | | |

*Now please continue to the final Section of the questionnaire.*

**SECTION 5: SUGGESTIONS**

**Question 1**. Use the following categories to make suggestions for actions at the European Union level to help your air quality management activities.

| |
|---|
| a. Additional or improved European legislation aimed at…. |
| b. The possibility of increased EU funding to… |
| c. Additional research or guidance on… |
| d. Other… |

**Question 2**. Please use the space below to identify any experiences or measures you have heard about in other countries or regions that you would like to bring to our attention. Also any additional comments you may have regarding short-term and local measures or your experiences in local air quality management.

| |
|---|
| |

Please send the completed questionnaire, preferably by e-mail, or fax **not later than 7 June 2004,** to: e*mail: ccp@iclei-europe.org; fax: 0049 761 3689279; telephone: 0049 761 368920.* THANK YOU FOR YOUR CO-OPERATION. YOUR ANSWERS WILL BE CONSIDERED CAREFULLY AND ARE VERY VALUABLE TO GUIDE THE FURTHER WORK.

# Appendix 2
# Database manual

CONTENTS

# CAFEAir - User Guide

## INTRODUCTION

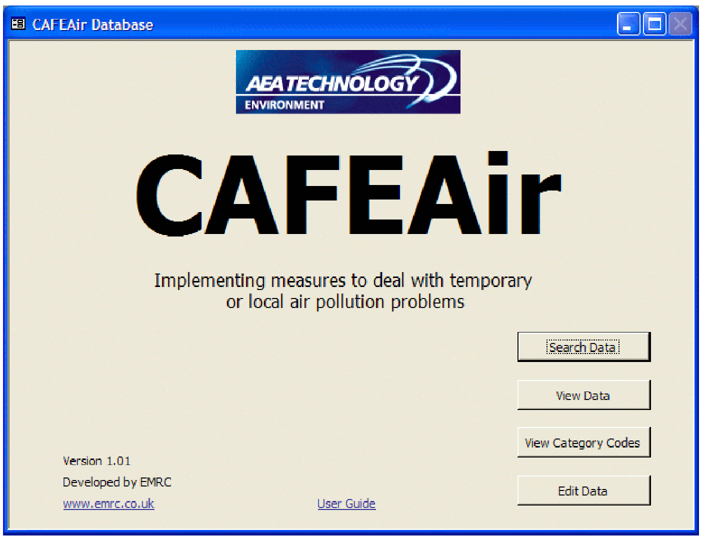
The CAFEAir database contains information on measures implemented by various authorities to prevent or reduce short-term pollution peaks or to reduce localised pollution 'hot-spots'. This data is held within a Microsoft Access 2000 format database with forms and reports available for searching and viewing the records.

The database and its associated MS Word documents must all be placed in the same folder.

The remainder of this document describes how to view and search the database.

## OPENING THE DATABASE

Either start Microsoft Access, select File – Open from the menu bar, and then navigate to CAFEAir.mdb. Or double click on CAFEAir.mdb from within Windows Explorer. You will then be presented with the CAFEAir Startup Form.




Clicking on the 'User Guide' hyperlink will allow you to view this document in Word (providing you have Word installed and associated with .DOC files).

Clicking on the 'Search Data' button will enable you to specify criteria and search the database for matching authority and measure details. There is also the option to print a report of the results.

Clicking on the 'View Data' button lets you view all the authority and measure records in the database. From here you can also view the case studies.

Clicking on the 'View Category Codes' enables you to view and print information on all the Standards, Sector and Typology Codes defined in the database. These reports contain additional descriptive information which is not included on other forms or reports due to lack of space.

Clicking on the 'Edit Data' button lets you edit all the authority and measure records in the database. This feature is password protected.

The following sections describe searching and viewing records in the database.

# SEARCH DATA

The search options provide ways of searching for authorities and measures. The pollution and location searches find matching authorities and all the measures associated with them. While the measure search finds only matching measures, but will also display information about the associated authority.

## POLLUTION SEARCH

On selecting the 'Pollution Search' you will be presented with a form to enable you to enter your search criteria. This allows you to search for authorities with an air quality problem due to a particular pollutant. You may also refine your search by including either the season in which the problem occurs, or the sector(s) which contribute to the problem and their level of contribution.

First you should select the pollutant you are interested in from the drop-down list at the top of the form (Step 1). You also have the option to search for authorities either with pollution peaks during a particular season or from a particular contributing sector (Step 2).

If you select 'Seasons in which problem occurs' then you can specify the seasons of interest (Step 3A). The sector options in Step 3B will not be available to you. If you select more than one season then the search will return authorities affected by the selected pollutant in any one (or more) of the specified seasons. If, for example, you are interested in winter pollution peaks for all pollutants then clear the pollutant box (Step 1) and only select 'Winter Peak Episodes' in Step 3A. Finally, when you have set your criteria, click the 'Search' button (Step 4).

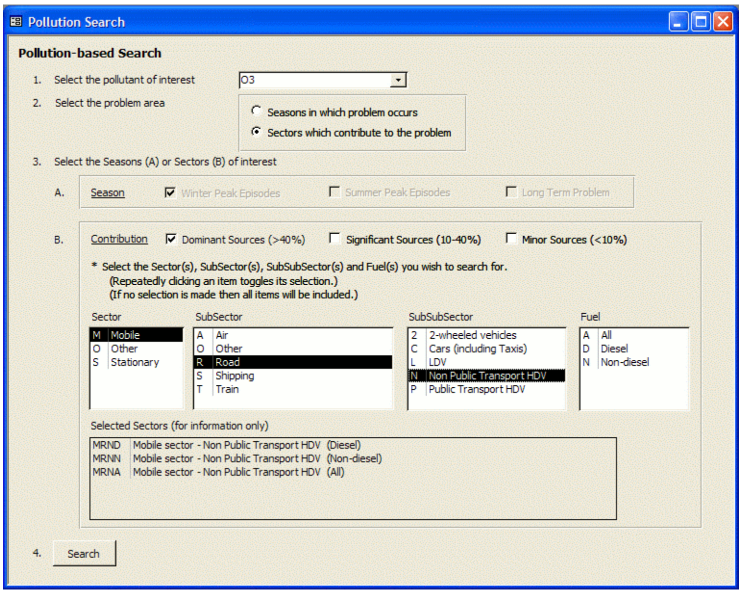
If you select ‘Sectors which contribute to the problem’ then you can specify the sectors of interest (Step 3B). The season options in Step 3A will not be available to you. You can select the level of contribution that you are interested in, in a similar manner to the season selection described above.

To select the sectors of interest, use the four list boxes towards the bottom of the form. These list boxes show the available codes, with a brief description of each code. For a complete list of sector codes use the ‘View Category Codes’ button on the main CAFEAir form.

Clicking on an item in the ‘Sector’ list box will select it and update the ‘SubSector’ list box with the subsectors associated with the selected sector. More than one sector may be selected, and clicking on a selected sector will deselect it. Continue by selecting the required subsector(s), subsubsector(s) and fuel. The ‘Selected Sectors’ box at the bottom of the screen shows all the codes that will be included in the search. It is for information only and does not allow codes to be selected from it.

The screen shot below shows the following search criteria :-

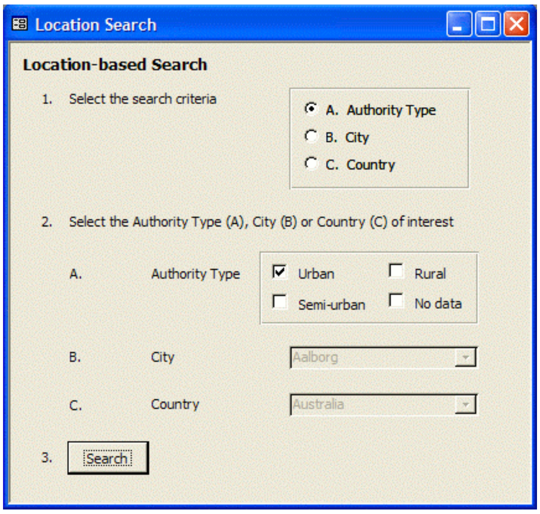
- Pollutant is $O_3$
- Problem area is contributing sectors
- Contribution level is dominant
- Sector code is M (Mobile)
- SubSector code is R (Road)
- SubSubSector code is N (Non Public Transport HDV)
- Fuel codes are A (All), D (Diesel) and N (Non-diesel)




Thus the sectors which will be included in the search are MRNA, MRND and MRNN. If no items are selected in a particular list box then all codes in that list box (and consequently also any list boxes to its right) will be included in the search. So if, for example, you were interested in the pollution contributed of all Mobile-Road sectors then you would only need to select the Sector code 'M' (Mobile) and the SubSector code 'R' (Road). Leaving the SubSubSector unspecified would result in all the associated SubSubSector and Fuel codes being included in the search, the 'Selected Sectors' box would list all the codes included in the search. Finally, when you have set your criteria, click the 'Search' button (Step 4).

## LOCATION SEARCH

On selecting the 'Location Search' you will be presented with a form to allow you to enter your search criteria. This allows you to search for authorities of a certain type or in a certain location.

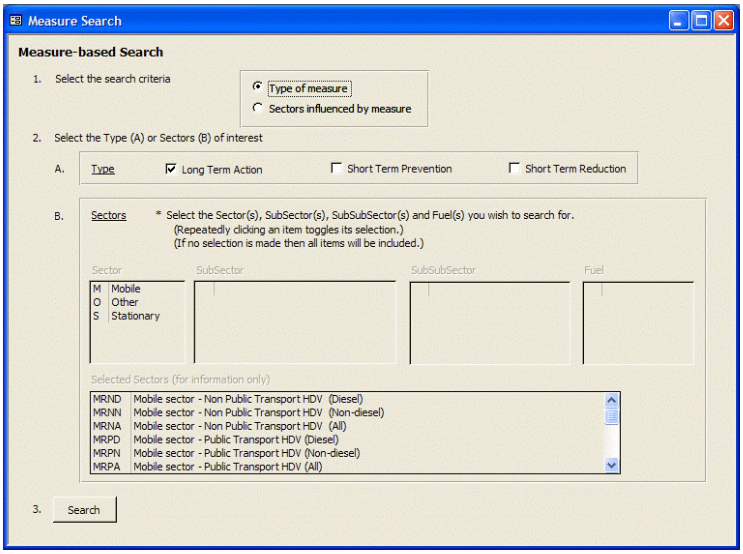


First select the type of search criteria, ‘Authority Type’, ‘City’ or ‘Country’ (Step 1). Your selection here will determine which part of Step 2 is available to you. If you selected ‘A. Authority Type’ then use the check boxes in Step 2A to specify the type(s) of authority you wish to search for. If you selected ‘B. City’ then use the drop down list box in Step 2B to select the city of interest. If you selected ‘C. Country’ then use the drop down list box in Step 2C to select the country of interest. Finally, when you have set your criteria, click the ‘Search’ button (Step 3).

## MEASURE SEARCH

On selecting the ‘Measure Search’ you will be presented with a form to allow you to enter your search criteria. This allows you to search for measures of a certain type or that influence a certain sector.

First select the type of search criteria, ‘Type of measure’ or ‘Sectors influenced by measure’ (Step 1). Your selection here will determine which part of Step 2 is available to you. If you selected ‘Type of measure’ then use the check boxes in Step 2A to specify the type(s) of measure you wish to search for. If you selected ‘Sectors influenced by measure’ then use the ‘Sector’, ‘SubSector’, ‘SubSubSector’ and ‘Fuel’ list boxes in Step 2B to specify the sector(s) of interest, in a similar manner to that described for the Pollution Search above.

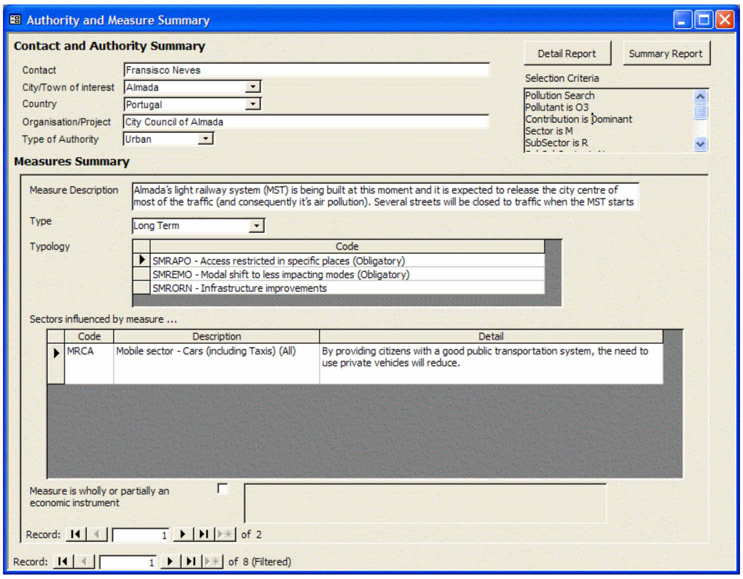



Finally, when you have set your criteria, click the ‘Search’ button (Step 3).

## SEARCH RESULTS

When selecting your search criteria the options presented to you are derived from the complete set of valid options and codes defined in the database, so it is possible that there may not be a match within the authority or measure records. In which case a message box will be displayed to inform you that no matching records were found.

However, should one or more records matching your specified criteria be found a form similar to the one below will be used to display the search results.




This form shows a sub-set of authority and measure data, but allows you to step through (using the navigation buttons at the bottom of the form) the authority and/or measure records that matched the search criteria. The number to the right of the navigation buttons show how many records were retrieved, and '(Filtered)' is displayed if this is a subset of records.

Authority searches, i.e. pollution and location searches, will display all measures associated with each selected authority. While measure searches will only display those measures that match the search criteria, although information on the authority that each measure is associated with will also be shown.

The box labelled 'Selection Criteria', at the top right of the form, contains information on the type of search performed and the selection criteria that were specified. The two buttons above this box allow you to produce reports of the search results, and the selection criteria are also included in these reports.

Clicking the 'Summary Report' button produces a report containing the same set of information that is shown on the form. While clicking the 'Detailed Report' button produces a report that contains all the fields associated with the authority and measure records selected.

The reports are initially previewed on the screen, but may be printed by selecting File – Print from the Access menu bar.

# VIEW DATA

The view data options allow you to view all the data associated with the authority and measure records in the database, or the detailed assessment documents.

## AUTHORITY AND MEASURE RECORDS

Clicking the 'Contact Details' button displays a form showing the contact details and state of work for each authority. Clicking the 'Air Quality Details' button displays a form showing information on the air quality problems of each authority. Clicking the 'Measure Details' button displays a form showing all the data associated with each measure in the database.

You can use the navigation buttons at the bottom of the forms to step through the records. The number to the right of the navigation buttons shows the number of records available. You may also use the standard Access filter and sort facilities (under Records on the menu bar), or Find (under Edit on the menu bar), to quickly locate individual records.

## DETAILED ASSESSMENTS

Clicking the 'View Assessments' button displays a list of hyperlinks to the detailed assessments available. They are held as Word documents, so you must have Word installed and associated with .DOC files. Clicking on a hyperlink will then open the associated assessment in Word.

# VIEW CATEGORY CODES

In order to try and reduce the complexity of the database forms and reports some data has had to be encoded. The 'View Category Codes' options allow you to view and print the structure and full descriptions of these shorthand codes. Each option previews a report to the screen. The report may be printed by selecting File – Print from the main menu bar.

Clicking the 'View Standards' button displays a report showing the pollutant, standard short hand (used on forms and reports), standard description and standard criteria for each air quality standard defined in the database.

Clicking the 'View Sector Codes' button displays a report describing the set of valid sectors (and their codes) that are defined in the database.

Clicking the 'View Typology Codes' button displays a report describing the set of valid typology codes that are defined in the database.

# EDIT DATA

The edit data options allow you to edit the data associated with the authority and measure records in the database, using similar forms to those that allow you to simply view the data. But access to this feature is password protected and you should request a password from the supplier of this database if you wish to edit its contents.

## AUTHORITY AND MEASURE RECORDS

Clicking the 'Contact Details' button displays a form showing the contact details and state of work for each authority. Clicking the 'Air Quality Details' button displays a form showing information on the air quality problems of each authority. Clicking the 'Measure Details' button displays a form showing all the data associated with each measure in the database.

These forms allow you to add and delete records as well as amend those that are already there. You can use the navigation buttons at the bottom of the forms to step through the records. The number to the right of the navigation buttons shows the number of records available. You may also use the standard Access filter and sort facilities (under Records on the menu bar), or Find (under Edit on the menu bar), to quickly locate individual records.

# Appendix 3
# EU standards and WHO recommendations

**CONTENTS**

| Pollutant | Existing Standard or proposed standard | Criteria for existing or proposed standards | Comments from WHO working group review[14] |
|---|---|---|---|
| Ozone ($O_3$) | Target value for the protection of human health | *maximum daily 8-hour mean of 120µg/m³ not to be exceeded on more than 25 days a calendar year averaged over 3 years from 1/1/2010* | WHO concluded that recent studies had strengthened evidence that there are short-term $O_3$ effects on mortality and respiratory morbidity and provided new evidence of long-term $O_3$ effects although this is sometimes inconsistent. WHO also observed that this evidence did not strongly suggest that there is a threshold within the total population for the observed health effects.<br><br>Since evidence shows that effects accumulate over several hours an 8-hour averaging time is still preferred to a 1 hour averaging time for the short-term guideline .WHO noted that the "relationship between long term $O_3$ exposure and health effects is not yet sufficiently understood to allow for establishing a long-term guideline." |
| | Target value for the protection of vegetation | *May to July AOT40 value of less than 18000µg/m³-h averaged over 5 years* | |
| | Long term objective for the protection of human health | *maximum daily 8-hour mean within a calendar year of 120µg/m³ from 2020* | |
| | Long term objective for the protection of vegetation | *May to July AOT40 value of less than 6000µg/m³-h from 2020* | |
| | Information threshold | *1 hour mean of 180µg/m³* | |
| | Alert threshold | *1 hour mean of 240µg/m³ measured or predicted over 3 consecutive hours at locations representative of the zone or agglomeration from now* | |

[14] Health Aspects of Air Pollution with Particulate Matter, Ozone and Nitrogen Dioxide, Report on a WHO Working Group, Bonn, Germany, 13–15 January 2003.

Health Aspects of Air Pollution – answers to follow-up questions from CAFE, Report on a WHO working group meeting, Bonn, Germany, 15–16 January 2004

| Pollutant | Existing Standard or proposed standard | Criteria for existing or proposed standards | Comments from WHO working group review[14] |
|---|---|---|---|
| Sulphur dioxide ($SO_2$) | Hourly limit value for the protection of human health | *1 hour mean of 350µg/m³ not to be exceeded more than 24 times a calendar year by 1/1/2005* | Evidence suggests that control of ambient exposures to this pollutant should continue. |
| | Daily limit value for the protection of human health | *24 hour mean of 125µg/m³ not to be exceeded more than 3 times a calendar year by 1/1/2005* | |
| | Limit value for the protection of ecosystems | *calendar year and winter mean of 20µg/m³ from now* | |
| | Alert threshold | *500µg/m³ measured over 3 consecutive hours at locations representative of the zone or agglomeration from now* | |
| Nitrogen dioxide ($NO_2$) | Hourly limit value for the protection of human health | *1 hour mean of 200µg/m³ not to be exceeded more than 18 times a calendar year from 1/1/2010* | WHO noted that the significance of direct impacts of $NO_2$ on human health at current EU ambient concentrations is still uncertain. However, evidence remains that long-term exposure to $NO_2$ at higher concentrations than this has adverse effects. In the absence of sufficient information to justify a change in the guideline value WHO recommended the annual average guideline value of 40 µg/m3 should be retained or lowered. The working group also noted, "a longer-term guideline value is also supported by the evidence on possible direct effects of $NO_2$, and on its indirect consequences through the formation of secondary pollutants."<br><br>No new evidence appeared to support the need to change the 1-hour guideline value which was therefore recommended to be retained. |
| | Annual limit value for the protection of human health | *calendar year mean of 40µg/m³ from 1/1/2010* | |
| | Annual limit value for the protection of ecosystems | *calendar year mean of 30µg/m³ from now* | |
| | Alert threshold | *500µg/m³ measured over 3 consecutive hours at locations representative of the zone or agglomeration from now* | |
| Benzene ($C_6H_6$) | Limit value for the protection of human health | *calendar year mean of 5µg/m³ from 1/1/2010* | Evidence suggests that control of ambient exposures to this pollutant should continue and that 1,3 butadiene could also be considered in this context. |

| **Pollutant** | **Existing Standard or proposed standard** | **Criteria for existing or proposed standards** | **Comments from WHO working group review**[14] |
|---|---|---|---|
| Particulate matter less than 10microns ($PM_{10}$) | Stage 1 24-Hour limit value for the protection of human health | *24 hour mean of 50μg/m$^3$ not to be exceeded more than 35 times a calendar year from 1/1/2005* | Evidence led to the conclusion that fine particles (commonly measured as $PM_{2.5}$) "are more hazardous than larger ones (coarse particles) in terms of mortality and cardiovascular and respiratory endpoints in panel studies. However, there is still concern about the health effects of coarse particles so that they should also continue to be controlled. Furthermore WHO noted that studies "have been unable to identify a threshold concentration below which ambient PM has no effect on health."<br>Hence it was recommended that air quality guidelines for $PM_{2.5}$ be further developed and that reconsideration of public health protection guidelines for $PM_{10}$ is warranted. Due to observed effects from both short-term and long-term ambient PM exposures, WHO recommends 24 hour and annual average exposure guidelines to be maintained. |
| | Stage 1 Annual limit value for the protection of human health | *calendar year mean of 40μg/m$^3$ from 1/1/2005* | |
| | Stage 2 24-Hour limit value for the protection of human health | *24 hour mean of 50μg/m$^3$ not to be exceeded more than 7 times a calendar year from 1/1/2010* | |
| | Stage 2 Annual limit value for the protection of human health | *calendar year mean of 20μg/m$^3$ from 1/1/2010* | |
| Carbon monoxide (CO) | Limit value for the protection of human health | *maximum daily 8-hour mean of 10mg/m$^3$ from 1/1/2005* | Evidence suggests that control of ambient exposures to this pollutant should continue. |
| Lead (Pb) | Annual limit value for the protection of human health | *calendar year mean of 0.5μg/m$^3$ from 1/1/2005 or calendar year mean of 1.0μg/m$^3$ from 1/1/2005 close to historically contaminated sites* | Evidence suggests that control of ambient exposures to this pollutant should continue. |
| PAH (Benzo[a] pyrene) | Proposed assessment threshold and annual limit value for the protection of human health | *calendar year mean of 1ng/m$^3$ in the total $PM_{10}$ fraction exceeded in 3 of the last 5 years at locations representative of the zone* | Evidence suggests that control of ambient exposures to this pollutant could be considered. |

| **Pollutant** | **Existing Standard or proposed standard** | **Criteria for existing or proposed standards** | **Comments from WHO working group review**[14] |
|---|---|---|---|
| Arsenic | Proposed assessment threshold | *calendar year mean of 6ng/m³ in the total $PM_{10}$ fraction exceeded in 3 of the last 5 years at locations representative of the zone* | Evidence suggests that control of ambient exposures to heavy metals could be considered. |
| Cadmium | Proposed assessment threshold | *calendar year mean of 5ng/m³ in the total $PM_{10}$ fraction exceeded in 3 of the last 5 years at locations representative of the zone* | |
| Nickel | Proposed assessment threshold | *calendar year mean of 20ng/m³ in the total $PM_{10}$ fraction exceeded in 3 of the last 5 years at locations representative of the zone* | |