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ASSESSMENT OF PLANS AND PROGRAMMES REPORTED UNDER 1996/62/EC – FINAL REPORT

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EXECUTIVE SUMMARY

This report presents findings under the service contract “Assessment of Plans and Programmes reported under 1996/62/EC”, which has been awarded by the European Commission (EC) to the Austrian Federal Environment Agency (Umweltbundesamt).

The Plans and Programmes (P&P) have to be established and implemented under the Council Directive 96/62/EC of 27 September 1996 on ambient air quality assessment and management (Air Quality Framework Directive; AQ FWD) and its Daughter Directives (DD) in case the sum of a limit value and margin of tolerance is exceeded prior to the date for attainment of the limit value. The P&P should ensure that the limit value is achieved within the specified time frame.

The first plans or programmes were due after the sum of the limit value and the margin of tolerance as stipulated in Council Directive 1999/30/EC of 22 April 1999 had been exceeded for sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter and lead in ambient air (first Air Quality Daughter Directive) in 2001. Information on these P&P has to be forwarded to the Commission no later than two years after the end of the year during which the exceedance was recorded.

Within this project an in-depth assessment has been carried out that should help form the basis for improving the effectiveness of the current provisions in the Directives. The study also assesses the difficulties faced by authorities in establishing plans or programmes. One main focus of this report is on traffic-related measures, since highest pollution levels are often recorded at traffic hot spot sites.

Quantitative analysis of all reports on P&P submitted to the Commission

Commission Decision 2004/224/EC stipulates a common reporting format for providing crucial information on the content of the P&P themselves. About 140 reports on plans and programmes (P&P) were available by November 2006. These reports were included in a database; a quantitative analysis of all these reports was performed that yielded information on the main pollutants, their main sources, the characteristics of the zone affected, the zone area and the number of people affected, the type of station as well as the characteristics of the measures (types of measures, costs, timeframe, responsibilities, indicators for monitoring progress etc.).

Reports on P&P were available for the analysis from all Member States that are obliged to submit reports to the Commission, except Greece and Luxembourg.

Most exceedances were reported for PM10 and NO_2, some also for SO_2. An exceedance of the benzene limit values was reported only in one case. In most cases, traffic was identified as the main source for PM10 and NO_2 exceedances, followed by industry, commercial and residential sources. The stations most often concerned were urban traffic sites. The indicator most often mentioned for monitoring progress was air quality measurement.

In-depth analysis of selected P&P

The quantitative analysis of reports on P&P was taken as a basis for an in-depth analysis of selected P&P. In collaboration with the EC, 28 cities and regions for which P&P were available were selected as a first step. These cities were selected because they cover a broad geographical area within Europe from the north to the south, as well as different political structures and situations that might be similar to other regions as well. Finally, 18 out of these 28 P&P were chosen for the in-depth analysis. These included the ones from Graz and Vienna (Austria), Brussels (Belgium), Copenhagen (Denmark), Marseille and Paris (France), Berlin, Munich and Stuttgart (Germany), Bozen and Milan (Italy), the Netherlands, Stockholm (Sweden), Bratislava and Košice (Slovakia), Barcelona and Madrid (Spain) as well as London (UK).

Representatives from these cities and regions[1] were contacted; a questionnaire was submitted to the responsible authorities and either filled in during a telephone interview or by the authorities themselves.

Compliance with limit values

Assessing the effectiveness of the P&P in terms of complying with the limit value by the attainment date was one of the main topics of the in-depth analysis. In the case of PM10 the limit values had to be attained by 2005 already. A comparison with observed PM10 levels showed exceedances in all cities and regions covered by the in-depth analysis that had reported exceedances in previous years. Compliance for 2010 – the attainment date for NO_2 – is expected only for a few of the cities affected by exceedances in the last few years. As established in the interviews with the authorities and during the analysis, the main reasons why compliance was not achieved (in the case of PM10) and most probably will not be achieved (in the case of NO_2) are as follows:

<u>Timing</u>

- Planning (and subsequently also implementation) of measures started too late.
- Some efficient measures need several years of planning. Also, for improvements of public transport, sound plans and substantial funding are necessary.

<u>Implementation problems</u>

- Low acceptance of measures by the public, especially for traffic measures. This leads to low political support for these measures. However, as some examples have shown, well prepared information campaigns and public consultations can lead to much better acceptance.
- High costs of measures versus limited funding. This seems to be the case especially for public transport improvements.
- Legal responsibilities for certain measures are split between different administrative levels or authorities.
- Insufficient collaboration between different administrative levels.

<u>Technical difficulties</u>

- Difficulty of allocating sources in the case of PM10 and inaccurate emission inventories.
- Underestimation of real world emissions from road vehicles compared to legislative limits, as well as an increase in primary NO_2 emissions from diesel vehicles. This may lead to a significant over estimation of the emission reduction potential of current measures.
- Some measures can only be taken at Community level. There was also uncertainty about the timing and ambition level of some measures (such as stricter EURO standards). As the proposal for EURO 5 (passenger cars and light commercial vehicles) came rather late, it will have practically no effect on NO_2 levels in ambient air by the legal date for compliance in 2010.

[1] The Appendix describes the regions or cities which were selected for an in-depth analysis, with respect to air quality, meteorology and climate. A summary of the P&P and transport plans is given as well.

Other reasons

- High regional background concentrations of PM10. In several cities and regions, these background concentrations are quite high and the scope for local and even regional solutions is limited.
- High overall concentrations. In some cities and regions the limit values are exceeded to such an extent that not even very drastic measures could reduce pollution levels below the limit value.
- Year-to-year variations. Absolute pollution concentrations are strongly influenced by meteorological conditions. In some cases, measures might be sufficient to ensure compliance for average years, but not for years with very unfavourable dispersion conditions.

Cost effectiveness of measures

Currently, data on cost effectiveness of measures is available in a few cases only. Based on expert judgement, respondents named measures in the areas of infrastructure, regulations, tax incentives, traffic restrictions, and information campaigns to be particularly cost effective. Several respondents pointed out that in many cases, measures are seen as more effective if they are implemented at a national or even EU wide level.

A cost-benefit analysis was also carried out for a very limited number of P&P, and individual measures only. Data were available for London, the UK, Madrid and Stockholm. For London the effectiveness of a Low Emission Zone (LEZ) was analysed in detail. Low Emission Zones (LEZ) are areas within a city where access for motor vehicles is restricted. For London, it seems there are no alternatives to a LEZ that are likely to achieve the same benefits.

In Stockholm the costs and benefits have been calculated for a trial phase of a congestion charge scheme. When comparing the net costs of the initial period with the long-term net benefits, it appears that the initial cost would be repaid in the form of social benefits within four years (mostly accounted for by tax revenue and environmental benefits). This is a comparatively short period compared with similar public investments (e.g. infrastructure, public transport), which usually pay off within 15 to 25 years. For Madrid an analysis showed that the measures planned to reduce both NO_2 and PM10 pollution result in total benefits which surpass the costs of these measures.

Integration of transport plans

During the preparation of the P&P, most authorities collaborated closely with the transport planning departments. Because of the importance of transport plans for air quality planning, the in-depth analysis also included the transport plans for those regions where they were available.

It was found that in most of the transport plans included in the analysis, environmental issues were part of the strategy, but that the objectives in this area were often rather vague. Similarly, many of the measures suggested (e.g. improvements of public transport, traffic management), were largely compatible with air quality objectives. Three of the transport plans contained a list of indicators for quantifying the success of measures. For Vienna and Berlin, specific air quality indicators (pollutant concentrations) were defined.

Recommendations for improvement

The results of the in-depth analysis, as well as the experience from other related projects, serve as a basis for recommendations. In addition, a stakeholder workshop was held, attended by air quality experts and practitioners in air quality planning. From the analysis of the P&P and from the stakeholder workshop, the following overall conclusions and recommendations can be drawn:

- In order to comply with the limit values by the attainment date, sound and timely planning is crucial.
- To understand the scale of the problem and to develop and implement measures, mandatory AQ modelling and emission inventories are a prerequisite.
- Information on measures and good practice examples should be made available and shared by all MS. Feedback from the EC on reported P&P should be institutionalised.
- P&P should be harmonised with other national policies and plans.
- Guidelines should be made available for effective air quality planning.
- Reporting of certain information, such as costs, effectiveness of measures, indicators or timing of measures should be extended.
- Exchange of information on P&P should be facilitated by providing user-friendly forms and making all reported forms readily available.

ZUSAMMENFASSUNG

Dieser Bericht enthält die Resultate des Projekts “Beurteilung von Plänen und Programmen nach Richtlinie 1996/62/EC”, das vom österreichischen Umweltbundesamt im Auftrag der Europäischen Kommission (EK) durchgeführt wurde.

Nach der Richtlinie des Rates 96/62/EC vom 27. September 1996 über die Beurteilung und die Kontrolle der Luftqualität (Luftqualitäts-Rahmenrichtlinie) und den entsprechenden Tochterrichtlinien müssen Pläne und Programme (P&P) ausgearbeitet werden, wenn vor dem Zeitpunkt, zu dem ein Grenzwert einzuhalten ist, die Summe aus Grenzwert und Toleranzmarge überschritten wird. Die P&P sollen sicherstellen, dass der Grenzwert zu diesem Zeitpunkt eingehalten wird.

Die ersten Pläne und Programme waren nach Überschreitungen der Summe aus Grenzwert und Toleranzmarge laut Richtlinie des Rates 1999/30/EC vom 22. April 1999 über Grenzwerte für Schwefeldioxid, Stickstoffdioxid und Stickstoffoxide, Partikel und Blei in der Luft (erste Luftqualitäts-Tochterrichtlinie) im Jahr 2001 zu erstellen. Informationen über diese P&P müssen der Kommission innerhalb von zwei Jahren nach Ende des Kalenderjahrs, in dem die Überschreitung auftrat, übermittelt werden.

In diesem Projekt wurde eine detaillierte Beurteilung durchgeführt, die dazu beitragen soll, die Effektivität der derzeitigen Vorschriften in den Richtlinien zu verbessern. In der Studie wurden auch Schwierigkeiten aufgezeigt, die bei der Erstellung von Plänen und Programmen aufgetreten sind. Dazu gehören technische Schwierigkeiten (z.B. Unsicherheiten in den Emissionsinventaren), rechtliche Probleme (z.B. bezüglich der Verantwortung für die Umsetzung effektiver Maßnahmen) sowie Schwierigkeiten mit den in der Richtlinie festgelegten Terminen. Bei den Maßnahmen zur Verringerung der Luftbelastung liegt ein Hauptaugenmerk des vorliegenden Berichts auf Verkehrsmaßnahmen, da die höchsten Konzentrationen oft an verkehrsnahen Messstellen auftreten.

Quantitative Analyse aller P&P, die der Kommission gemeldet wurden

In der Entscheidung der Kommission 2004/224/EC wurde ein gemeinsames Berichtsformat für eine Beschreibung wichtiger Informationen bezüglich der P&P festgelegt. Bis November 2006 standen etwa 140 dieser Berichte zur Verfügung. Die Berichte wurden in eine Datenbank übertragen und in einer quantitativen Analyse wurden die Luftschadstoffe, die Quellen dieser Schadstoffe, Charakteristika der betreffenden Zone, die Fläche der betroffenen Zonen und die Anzahl der betroffenen Einwohner, die Art der Messstation und die Charakteristika der Maßnahmen (Art der Maßnahmen, Kosten, Zeitrahmen, Verantwortlichkeiten, Indikatoren für die Kontrolle des Fortschritts etc.) identifiziert.

Für die Auswertung standen Berichte über P&P aus allen berichtspflichtigen Mitgliedsstaaten, mit Ausnahme von Griechenland und Luxemburg, zur Verfügung.

Die meisten Überschreitungen wurden für PM10 und NO_2 gemeldet, einige auch für SO_2. In nur einem Fall wurde eine Überschreitung des Benzol-Grenzwerts gemeldet. Als Hauptquelle für PM10- und NO_2-Überschreitungen wurde in den meisten Fällen der Verkehr angegeben, gefolgt von Industrie, gewerblichen Quellen und Wohngebieten. Städtische Verkehrsmessstellen sind am öftesten betroffen. Als Indikator für die Fortschrittskontrolle wurden am öftesten Immissionsmessungen genannt.

Vertiefte Analyse ausgewählter P&P

Die quantitative Auswertung der Berichte über P&P diente als Basis für eine vertiefte Analyse ausgewählter P&P. In Zusammenarbeit mit der EK wurden in einem ersten Schritt 28 Städte und Regionen ausgewählt, für die P&P vorhanden waren. Die wichtigsten Kriterien für die Auswahl dieser Städte waren eine große geographische Bandbreite innerhalb Europas von Norden bis Süden, verschiedene politische Strukturen sowie Situationen, die für mehrere Regionen repräsentativ sein können. Schließlich wurden 18 dieser 28 P&P für die vertiefte Analyse herangezogen. Es sind dies die P&P für Graz und Wien (Österreich), Brüssel (Belgien), Kopenhagen (Dänemark), Marseille und Paris (Frankreich), Berlin, München und Stuttgart (Deutschland), Bozen und Mailand (Italien), die Niederlande, Stockholm (Schweden), Bratislava und Košice (Slowakei), Barcelona und Madrid (Spanien) sowie London (Großbritannien).

Vertreter dieser Städte und Regionen wurden kontaktiert[2]; ein Fragebogen wurde den verantwortlichen Behörden zugesendet und entweder mit Hilfe von Telefoninterviews oder von den Behörden selbst ausgefüllt.

Einhaltung der Grenzwerte

Ein Hauptpunkt der vertieften Analyse war die Beurteilung der Effektivität der Pläne und Programme bezüglich der Einhaltung der Grenzwerte zum Einhaltezeitpunkt. Im Fall von PM10 mussten die Grenzwerte bereits im Jahr 2005 eingehalten werden. Ein Vergleich mit der gemessenen PM10-Belastung zeigte Überschreitungen in allen Städten und Regionen der vertieften Analyse, die in vorhergehenden Jahren Überschreitungen gemessen hatten. Für 2010 – den Einhaltezeitpunkt für NO_2 – wird nur für wenige Städte, die von Überschreitungen in den letzten Jahren betroffen waren, mit einer Einhaltung gerechnet. Als Hauptgründe für die Nichteinhaltung (für PM10) bzw. die voraussichtliche Nichteinhaltung (für NO_2), lassen sich aufgrund der Interviews und der Analyse folgende Punkte identifizieren:

Zeitliche Planung

- Die Planung (und folglich auch die Umsetzung) der Maßnahmen begann zu spät.
- Einige effiziente Maßnahmen benötigen eine mehrjährige Planung. Auch für Verbesserungen im öffentlichen Verkehr sind eine solide Planung und umfangreiche Finanzierung nötig.

Probleme bei der Umsetzung

- Geringe Akzeptanz von Maßnahmen in der Öffentlichkeit, besonders im Bereich Verkehr. Dies führt zu geringer politischer Unterstützung für diese Maßnahmen. Einige Beispiele zeigten jedoch, dass gut vorbereitete Informationskampagnen und Einbezug der Öffentlichkeit zu einer viel größeren Akzeptanz führen.
- Hohe Kosten der Maßnahmen, verbunden mit beschränkten finanziellen Mitteln. Dies erscheint besonders bei Verbesserungen des öffentlichen Verkehrs der Fall zu sein.
- Die rechtliche Verantwortung, bestimmte Maßnahmen umzusetzen, ist auf unterschiedliche administrative Ebenen oder Behörden verteilt.
- Keine ausreichende Zusammenarbeit zwischen verschiedenen administrativen Ebenen.

Technische Schwierigkeiten

- Schwierigkeiten bei der Zuordnung der Quellen im Fall von PM10 und ungenaue Emissionsinventare.

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[2] Im Appendix sind die Regionen oder Städte, die für die detaillierte Analyse ausgewählt wurden, bezüglich Luftqualität, Meteorologie und Klima beschrieben. Eine Zusammenfassung der P&P und der Verkehrspläne ist ebenfalls enthalten.

- Unterschätzung der tatsächlichen Emissionsfaktoren von Kraftfahrzeugen im Vergleich zu den gesetzlichen Grenzwerten sowie Zunahme der primären NO_2-Emissionen von Dieselfahrzeugen. Dies könnte zu einer signifikanten Überschätzung des Emissionsreduktionspotenzials bei derzeitigen Maßnahmen führen.
- Einige Maßnahmen können nur auf Ebene der EU umgesetzt werden. Es herrschte auch Unsicherheit bezüglich des Zeitplans und des Zielniveaus einzelner Maßnahmen, wie etwa strengere EURO-Standards. Da sich der Vorschlag für EURO 5 (PKW und leichte Nutzfahrzeuge) verzögerte, wird er praktisch keine Auswirkungen auf die NO_2-Konzentrationen bis zum gesetzlich festgelegten Einhaltedatum im Jahr 2010 haben.

Andere Gründe

- Hohe regionale Hintergrundkonzentrationen von PM10. In mehreren Städten und Regionen sind die Hintergrundkonzentrationen bedeutend und der Spielraum für lokale und auch regionale Lösungen ist beschränkt.
- Hohe gesamte Konzentration. In einigen Städten und Regionen werden die Grenzwerte in einem Ausmaß überschritten, dass auch sehr drastische Maßnahmen die Belastung nicht unter den Grenzwert senken können.
- Variationen von Jahr zu Jahr. Absolute Schadstoffkonzentrationen werden stark von meteorologischen Bedingungen beeinflusst. In einigen Fällen könnten die Maßnahmen ausreichen, um die Grenzwerte in durchschnittlichen Jahren einzuhalten, jedoch nicht in Jahren mit ungünstigen Ausbreitungsbedingungen.

Kosteneffektivität der Maßnahmen

Daten zur Kosteneffektivität von Maßnahmen sind derzeit nur in wenigen Fällen vorhanden. Aufgrund von Expertenschätzungen bezeichneten die Befragten Maßnahmen in den Bereichen Infrastruktur, Rechtsvorschriften, Steueranreize, Verkehrsbeschränkung und Informationskampagnen als besonders kosteneffektiv. Mehrere Befragte wiesen darauf hin, dass in vielen Fällen Maßnahmen effektiver erscheinen, wenn sie auf nationaler oder EU-weiter Ebene umgesetzt werden.

Eine Kosten-Nutzen-Analyse wurde ebenfalls nur für eine beschränkte Anzahl von P&P bzw. für einzelne Maßnahmen durchgeführt. Daten waren aus London, Großbritannien, Madrid und Stockholm vorhanden. Für London wurde die Effektivität einer „low emission zone“ (LEZ) im Detail analysiert. LEZ sind Gebiete in einer Stadt, in denen die Zufahrt für Motorfahrzeuge eingeschränkt ist. Für London ergab die Abschätzung, dass keine Alternative dasselbe Nutzenniveau wie die LEZ bringen kann.

In Stockholm wurden Kosten und Nutzen für eine Citymaut-Versuchsphase bestimmt. Ein Vergleich der Nettokosten der Anfangsperiode mit dem Netto-Langzeitnutzen zeigt, dass die ursprünglichen Kosten innerhalb von vier Jahren durch Nutzen für die Gesellschaft (hauptsächlich Steuereinnahmen und Umweltnutzen) ausgeglichen würden. Dies ist ein relativ kurzer Zeitraum im Vergleich zu ähnlichen öffentlichen Investitionen (z.B. Infrastruktur, öffentlicher Verkehr), die normalerweise Amortisationszeiten von 15 bis 25 Jahren aufweisen.

Für Madrid zeigte eine Analyse, dass für die geplanten Maßnahmen zur Reduktion sowohl der NO_2- als auch der PM10-Belastung der gesamte Nutzen die Kosten dieser Maßnahmen übersteigt.

Integration von Verkehrsplänen

Die P&P wurden größtenteils in enger Zusammenarbeit mit den Abteilungen für Verkehrsplanung durchgeführt. Da Verkehrsplanung auch für die Luftqualitätsplanung von großer Bedeutung ist, wurden die Verkehrspläne der Städte und Regionen der vertieften Analyse berücksichtigt, falls diese verfügbar waren.

Es zeigte sich, dass Umweltziele Teil der meisten Verkehrsstrategien sind, allerdings sind diese oftmals nur sehr vage festgelegt. Auch ist ein Gutteil der in den Verkehrsplänen vorgeschlagenen Maßnahmen (z.B. Verbesserung des öffentlichen Verkehrs, Verkehrsmanagement etc.) im Allgemeinen mit den Luftqualitätszielen kompatibel. In drei der verfügbaren Verkehrspläne wurde eine Liste an Indikatoren angeführt, mit denen der Erfolg der Maßnahmen quantifiziert wird. Die Verkehrspläne aus Wien und Berlin beinhalten auch Luftqualitätsparameter als Indikatoren.

Empfehlungen zur Verbesserung

Die Resultate der vertieften Analyse und die Erfahrungen aus anderen vergleichbaren Projekten dienten als Basis für die Empfehlungen. Außerdem wurde eine Veranstaltung mit Experten und Praktikern aus Luftreinhaltung und Luftqualitätsplanung abgehalten. Aus der Analyse der P&P und aus der Veranstaltung ergaben sich die folgenden Schlussfolgerungen und Empfehlungen:

- Für eine Einhaltung der Grenzwerte zum festgelegten Zeitpunkt ist eine gründliche und rechtzeitige Planung entscheidend.
- Eine obligatorische Luftqualitätsmodellierung und Emissionsinventare sind Voraussetzung, um Gebiete mit erhöhter Belastung zu identifizieren und um Maßnahmen zu entwickeln und umzusetzen.
- Information über Maßnahmen und erfolgreiche Praxisbeispiele sollte zur Verfügung gestellt und zwischen allen Mitgliedsstaaten ausgetauscht werden. Rückmeldungen von der Europäischen Kommission an die Mitgliedsstaaten sollten institutionalisiert werden.
- P&P sollen mit anderen nationalen Verfahren und Plänen harmonisiert werden.
- Es sollen Anleitungen für effektive Luftqualitätsplanung zur Verfügung gestellt werden.
- Die Berichtspflicht für bestimmte Informationen wie Kosten, Effektivität von Maßnahmen, Indikatoren und Zeitraum der Maßnahmen soll ausgebaut werden.
- Der Informationsaustausch bezüglich P&P soll durch anwenderfreundliche Formulare und rasche Veröffentlichung aller eingereichten Informationen erleichtert werden.

SOMMAIRE

Ce rapport final présente les résultats du projet (contrat de service) "Évaluation de plans et programmes dans le cadre de 1996/62/CE", qui a été commissionné à l'Agence Autrichienne Fédérale de l'Environnement (Umweltbundesamt) par la Commission Européenne.

Les édits plans et programmes (P&P) doivent être établis et implémentés conformément à la Directive Cadre sur la Qualité de l'Air Ambiant (96/62/CE) et ses directives filles (DF), si, avant un délai fixe, la somme de la valeur limite et de la marge de tolérance soit dépassée. Les P&P doivent garantir que les valeurs limites soient atteintes dans un délai fixe.

Les premiers plans et programmes étaient dus en 2001, après un dépassement de la somme de la valeur limite et de la marge de tolérance de DF1 (1999/30/CE). Toute information concernant ces P&P doit être transmise à la Commission au plus tard deux ans suivant la fin de l'année où le dépassement a été enregistré.

Dans le cadre de ce projet, une évaluation détaillée devait être effectuée pour faciliter l'amélioration de l'efficacité de certaines clauses des directives. En outre, le projet a évalué les difficultés rencontrées par les responsables au cours de la mise en place des différents P&P. Parmi ces difficultés comptent des obstacles techniques (par exemple, incertitudes dans les registres des émissions polluantes), des problèmes législatifs (par exemple, concernant la répartition des responsabilités pour la mise en œuvre de mesures efficaces) et souvent des problèmes avec les délais prescrits par les directives. Tant que des concentrations très élevées sont souvent mesurées aux endroits de mesurage avec un trafic intense, la plupart des mesures dans ce rapport pour l'amélioration de la qualité d'air concernent le transport routier.

Analyse quantitative de tous les rapports concernant P&P soumis à la Commission

La décision de la Commission 2004/224/CE fixe des modalités de transmission d'informations importantes sur les P&P. En novembre 2006, environ 140 rapports sur P&P étaient disponibles. Ces rapports ont été inclus dans une base de données; et une analyse quantitative a été effectuée pour identifier les polluants principaux, leur sources communes, les caractéristiques de la zone affectée, la région de la zone et le nombre de personnes affectées, le type de la station ainsi que les caractéristiques des mesures entreprises (type de mesures, coûts, emploi du temps, responsabilités, indicateurs pour le suivi du progrès etc.).

A l'exception de la Grèce et de Luxembourg, tous les Etats-membres assujettis ont transmis leurs rapports sur les P&P.

Selon les rapports, la plupart des dépassements concernent PM10 et NO_2, quelques-uns aussi SO_2. Des dépassements de benzène n'ont été rapportés que dans un seul cas. Dans la plupart des cas, le transport routier a été identifié comme source principale des dépassements de PM10 et NO_2, suivi par l'industrie, l'artisanat et les zones résidentielles. Les sites les plus affectés sont les stations de mesure du trafic urbain. Le monitoring de la qualité de l'air ambiant a été l'indicateur utilisé le plus souvent pour le suivi du progrès.

Analyse détaillée de P&P sélectionnés

L'analyse quantitative des rapports des P&P a servi de base pour une analyse détaillée de P&P sélectionnés. En collaboration avec la Commission Européenne, 28 villes et régions disposant de P&P ont été présélectionnées. Les critères principaux pour la sélection de ces villes étaient le recouvrage géographique aussi vaste que possible de l'Europe du nord au sud, le recouvrage de structures politiques et de situations similaires à d'autres régions.

Enfin, 18 de ces 28 P&P ont été considérés pour l'analyse détaillée. Il s'agit de Graz et Vienne (Autriche), Bruxelles (Belgique), Copenhague (Danemark), Marseille et Paris (France), Berlin, Munich et Stuttgart (Allemagne), Bozen et Milan (Italie), les Pays-Bas, Stockholm (Suède), Bratislava et Košice (Slovaquie), Barcelone et Madrid (Espagne) ainsi que Londres (Grande-Bretagne).

Des représentants de ces villes et régions[3] ont été contactés; un questionnaire a été soumis et remplis soit par les autorités en charge eux-mêmes, soit par le moyen d'interviews téléphoniques.

Conformité aux valeurs limites

Un point capital de l'analyse détaillée était l'évaluation de l'efficacité des P&P par rapport à la conformité aux valeurs limites à la date fixée. Dans le cas de PM10, les valeurs limites devaient être atteintes déjà en 2005. Une comparaison avec les niveaux de PM10 enregistrés a montré des dépassements dans toutes les villes et régions, objet de l'analyse détaillée, qui avaient mesuré des dépassements dans des années précédentes. Pour l'an 2010 – la date fixée pour NO_2 – une conformité n'est envisagée qu'en quelques villes qui ont déjà été affectées par des dépassements dans le passé. La conformité n'a pas pu être achevée (dans le cas de PM10) et probablement ne sera pas achevée (dans le cas de NO_2) pour les raisons suivantes, identifiées au cours des interviews et des analyses entrepris:

<u>Délais</u>

- La planification (et par conséquent la mise en œuvre) des mesures a commencé trop tard.
- Certaines mesures efficaces nécessitent une planification pluriannuelle. Ainsi, l'amélioration du trafic public requiert une très bonne planification et un financement considérable.

<u>Problèmes de la mise en oeuvre</u>

- Faible acceptation des mesures par le public, notamment dans le secteur trafic. Cela a abouti à un faible support politique à ces mesures. Cependant, comme affiché par quelques exemples, une meilleure acceptation peut être achevée par le moyen de campagnes d'information bien préparées et de consultations avec le public.
- Coût élevé des mesures combiné d'un financement limité. Cela paraît être le cas notamment lorsqu'il s'agit d'améliorations du transport public.
- Les compétences et responsabilités pour la mise en oeuvre de certaines mesures sont réparties entre plusieurs niveaux administratifs et autorités différentes.
- Collaboration insuffisante entre les différents niveaux administratifs.

<u>Difficultés techniques</u>

- Difficultés avec l'allocation des sources (dans le cas de PM10) et des registres imprécis d'émissions.
- Sous-estimation des facteurs d'émissions de véhicules routiers par rapport aux normes législatives ainsi qu'une augmentation des émissions primaires de NO_2 des véhicules diesel.

[3] Annexe A décrit les villes et les régions sélectionnées pour l'analyse détaillée en ce qui concerne la qualité de l'air, le climat et les conditions météorologiques. Un sommaire des P&P et des plans trafic est également compris.

Cela peut aboutir à une surestimation significative du potentiel de réduction de certaines mesures actuelles.

- Certaines mesures ne peuvent être entrepris qu'au niveau communautaire. Aussi, il y avait une incertitude concernant les délais et les objectifs de certaines mesures (comme par exemple des normes EURO plus rigoureuses). Puisque la proposition pour EURO 5 (véhicules passagers et véhicules commerciales légers) est venue en retard, cette norme n'aura pratiquement aucun effet sur les concentrations de NO_2 dans l'air ambiant jusqu'à 2010, l'an d'observation.

Autres raisons

- Hautes concentrations de fond de PM10 au niveau régional. Dans plusieurs villes et régions, les concentrations de fond sont assez importantes et par conséquent la marge pour des solutions locales et même régionales est limitée.
- Hautes concentrations globales. Dans certaines régions et villes, les dépassements des valeurs limites sont d'une telle ampleur, que même des mesures drastiques ne pourraient baisser les niveaux de pollution jusqu'au dessous de la valeur limite.
- Variations annuelles. Les concentrations de polluants absolues sont fortement influencées par les conditions météorologiques. Dans certains cas, les mesures entreprises seraient suffisantes pour observer la conformité pendant les années moyennes, cependant pas si les conditions de dispersion sont défavorables.

Rentabilité des mesures

Actuellement, de données sur la rentabilité des mesures ne sont disponibles qu'en peu de cas. En vertu des estimations des experts, les interviewés ont désigné comme particulièrement rentables des mesures dans les domaines infrastructure, législation, avantages fiscaux, restrictions du transport et campagnes d'information. Plusieurs interviewés ont indiqué que certaines mesures sont souvent considérées plus rentables, si implémentées au niveau national ou européen.

Une analyse coût efficience a été effectuée pour un nombre limité de P&P, resp. pour des mesures séparées. Les données disponibles provenaient de Londres, de la Grande Bretagne, de Stockholm et de Madrid. L'efficacité d'une « zone à basses émissions » (LEZ, Low Emissions Zone) à Londres a été analysée en détail. Les zones à basses émissions sont des régions urbaines interdites aux véhicules automobiles. Pour Londres, on a pu estimer qu'aucune autre alternative ne pourrait apporter les mêmes avantages.

A Stockholm, les coûts et bénéfices ont été calculés pour les testes pilotes d'un modèle de congestion routière. La comparaison entre les coûts nets pour la période originale et le bénéfice net à long terme indique que le coût original pourrait être compensé par le bénéfice social (surtout bénéfices environnementaux et revenus fiscaux) au cours de quatre années. Cette période est relativement courte par rapport aux investissements publics comparables (par exemple, infrastructure, transport public etc.), qui montrent des délais d'amortissement de 15 à 25 ans.

À Madrid, l'analyse a montré que les mesures planifiées pour réduire la pollution de NO_2 et PM10 résultent à un bénéfice total dépassant les coûts de ces mesures.

Intégration de plans de transport

Au cours de la préparation de P&P, la plupart des autorités publiques ont collaboré avec les départements chargés de la planification routière. Comme la planification routière est très importante pour la planification de la qualité de l'air ambiant, l'analyse détaillée a aussi considéré les plans de transport dans les régions où tels étaient disponibles.

Il s'est produit que les objectifs environnementaux figurent dans la plupart des stratégies analysées, cependant qu'ils sont vaguement formulés. De même, une partie importante des mesures proposées (par exemple, amélioration du transport public, gestion du transport) est en général compatible avec les objectifs de la qualité de l'air. Trois des plans de transport disponibles comportent des listes d'indicateurs pour quantifier le taux de succès des mesures entreprises. A Vienne et à Berlin, on a pu identifier des indicateurs concrets mesurant la qualité de l'air (concentrations des polluants).

Recommandations

Les résultats de l'analyse approfondie ainsi que l'expérience d'autres projets similaires servent de base pour les recommandations. En outre, un atelier de travail a eu lieu avec des experts ainsi que des praticiens de la qualité de l'air et de planification. De l'analyse des P&P et de l'atelier de travail résultent les suivantes recommandations et conclusions générales :

- Une planification saine et ponctuelle est indispensable pour l'observation des valeurs limites à la date prescrite.
- Le modelage obligatoire de la qualité de l'air ainsi que les registres des émissions sont indispensables pour la détermination des secteurs les plus affectés et pour le développement et la mise en œuvre de mesures.
- Un échange d'informations sur des mesures et d'exemples de bonnes pratiques doit être initié parmi tous les Etats-membres. Un feedback de la part de la Commission Européenne par rapport aux P&P rapportés devrait être institutionnalisé.
- Les P&P devraient être harmonisés avec d'autres politiques et plans nationaux.
- Des instructions pour une planification de la qualité de l'air plus efficace doivent être rédigées.
- Il convient de renforcer les obligations de rapportage, notamment concernant les coûts, l'efficacité de certaines mesures, les indicateurs et les délais de certaines mesures.
- L'échange des informations sur P&P devrait être facilité en désignant des formulaires conviviaux et en publiant toutes les informations rapportées.

1 INTRODUCTION

The Air Quality Framework Directive (96/62/EC; AQ FWD) and its four Daughter Directives (DD) set air quality objectives, which have to be attained by a certain date.

In case the sum of a limit value and margin of tolerance is exceeded in a zone prior to the attainment date, plans or programmes have to be established and implemented to ensure that the limit or target values are achieved by the attainment date defined in the Directive.

The first plans or programmes were due after exceedances of the sum of the limit value and the margin of tolerance of the DD1 (1999/30/EC) in 2001. A number of plans or programmes have been elaborated since then by local, regional and national authorities.

Even though plans or programmes are usually developed at a local, regional or national level (if exceedances occur following significant pollution originating in another Member State, consultations with the relevant Member State may be held), they must be reported to the Commission no later than two years after the end of the year during which the exceedance was recorded. In addition, the Commission has to be informed every three years of the progress of the plan or programme.

Therefore, it seems timely to assess the experiences gained in various Member States during the preparation of these plans or programmes. In order to carry out this assessment the European Commission (EC) has concluded a contract on the 'Assessment of Plans and Programmes reported under 1996/62/EC' with the Umweltbundesamt, signed on 21st December 2005.

This in-depth assessment should be the basis for improving the effectiveness of current provisions stipulated in the Directives. Different authorities faced various difficulties when establishing the plans or programmes. These included technical obstacles (e.g., uncertain emission inventories), legal problems (e.g., concerning the responsibilities for implementing effective measures) and often problems with the deadlines defined in the Directives.

On 9th October a stakeholder workshop was held in Brussels. The aim of the workshop was to present and discuss the main findings of the in-depth analysis of P&P with the stakeholders and to discuss recommendations for their improvement. The results of the workshop were incorporated into the report of this project. The presentations given at this workshop are available via a CIRCA website[4]; the minutes of the workshop can be found in the Annex.

This final report of the project includes:

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4 http://forum.europa.eu.int/Public/irc/env/cafe_baseline/library?l=/cafe_ambient_quality/workshop_programmes&vm=detailed&sb=Title

- Background information about the current legislation, other ongoing projects, plans or programmes required within the NEC framework, for the GHG monitoring mechanism or noise reduction (chapter 2);
- Background documents of finalised projects are summarised in chapter 3;
- In chapter 4 the results of the screening and classification of all available plans and programmes (P&P) under the AQ FWD, which have been submitted to the EC according to Commission Decision 2004/224/EC, are presented;
- Based on the information about all P&P, 18 P&P have been selected for an in-depth analysis (chapter 5). This analysis, which has been supplemented by a questionnaire submitted to the authorities responsible for the P&P, focuses on:
  - Identifying (cost) effective measures, especially for transport;
  - Effectiveness of measures in order to comply with the limit values
  - Interaction with other P&P (e.g. NEC or GHG);
  - Cooperation between authorities on different levels.
- Recommendations for improvement of the planning process based on the questionnaire for the in-depth analysis and the results of the stakeholder workshop (chapter 6).
- Recommendations for improving the implementing provisions (chapter 7)

A list of abbreviations can be found in chapter 8.

The minutes of the workshop are given in the Annex.

The Appendix describes the regions or cities selected for the in-depth analysis with respect to air quality, meteorology and climate. A summary of the P&P and transport plan is given as well.

2 BACKGROUND INFORMATION

2.1 Current legislation

The Council Directive 96/62/EC on ambient air quality assessment and management, the so-called Air Quality Framework Directive (AQ FWD), provides the framework for EC legislation on air quality. The main objectives of the Directive are to

- define and establish objectives for ambient air quality in the Community to avoid, prevent or reduce harmful effects on human health and the environment as a whole,
- assess the ambient air quality in Member States on the basis of common methods and criteria,
- obtain adequate information on ambient air quality and ensure that it is made available to the public,
- maintain ambient air quality where it is good and improve it in other cases.

The Daughter Directives to the AQ FWD are concerned with the following pollutants:

- 1^{st} Daughter Directive 1999/30/EC: sulphur dioxide, NO_2 and NO_x, particulate matter and lead;
- 2^{nd} Daughter Directive 2000/69/EC: carbon monoxide and benzene;
- 3^{rd} Daughter Directive 2002/3/EC: ozone
- 4^{th} Daughter Directive 2004/107/EC: arsenic, nickel, cadmium, mercury and PAHs[5].

The Daughter Directives specify limit or target values and dates when they have to be met for these pollutants.

'Limit values' are defined as a level fixed on the basis of scientific knowledge, with the aim of avoiding, preventing or reducing harmful effects on human health and/or the environment as a whole, to be attained within a given period and not to be exceeded once attained.

The 'Margin of Tolerance' is a percentage of the limit value which decreases over time and which falls to zero on the date of the entry into force of the limit value (see Figure 1 as an example).

As it is shown in chapter 4.5.1, most exceedances within the MS for which P&P are available occurred for PM10 and NO_2. Table 1 and Table 2 describe the limit values for these two pollutants. The limit values for PM10 had to be attained by 2005; those of NO_2 will have to be attained by 2010.

[5] Environmental objectives were defined for Ni, As, Cd and benzo[a]pyrene.

Table 1: NO_2 limit values according to the 1st DD.

Averaging period	Limit value	Margin of tolerance	Date by which limit value is to be met
1 hour	200 µg/m³ NO_2, not to be exceeded more than 18 times a calendar year	50% (100 µg/m³) on the entry into force of this Directive, reducing on 1 January 2001 and every 12 months thereafter by equal annual percentages to reach 0% by 1 January 2010	1. January 2010
Calendar year	40 µg/m³	50% (20 µg/m³) on the entry into force of this Directive, reducing on 1 January 2001 and every 12 months thereafter by equal annual percentages to reach 0% by 1 January 2010	1. January 2010

Table 2: PM10 limit values according to the 1st DD.

Averaging period	Limit value	Margin of tolerance	Date by which limit value is to be met
24 hours	50 µg/m³ PM10, not to be exceeded more than 35 times a calendar year	50% (25 µg/m³) on the entry into force of this Directive, reducing on 1 January 2001 and every 12 months thereafter by equal annual percentages to reach 0% by 1 January 2005	1. January 2005
Calendar year	40 µg/m³	20% (8 µg/m³) on the entry into force of this Directive, reducing on 1 January 2001 and every 12 months thereafter by equal annual percentages to reach 0% by 1 January 2005	1. January 2005

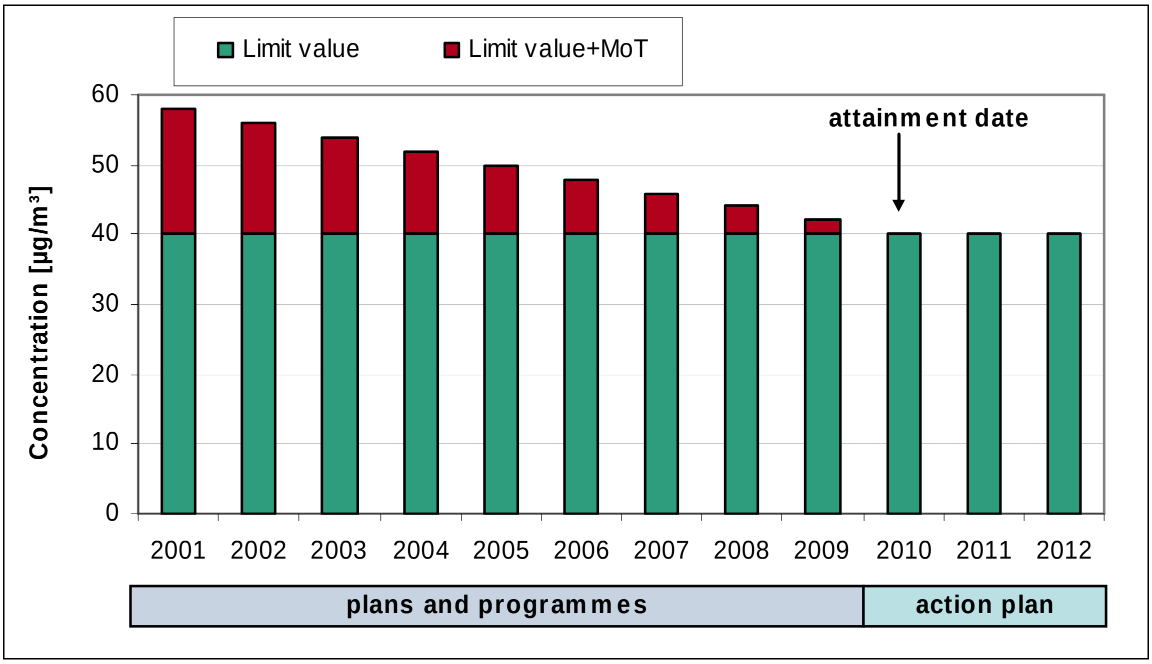

Figure 1: NO_2 limit value and margin of tolerance according to the 1st DD.

In case of an exceedance of the sum of limit value plus margin of tolerance, Member States shall take measures to ensure that a plan or programme is prepared or implemented for attaining the limit value within the specific time limit (AQ FWD, Article 8 (3)). Plans or programmes have to be sent to the European Commission at the latest two years following the year the exceedance has been observed.

2.2 Information required in plans or programmes

Annex IV of the AQ FWD identifies information to be included in the local, regional or national programmes for improvement of ambient air quality.

Comprehensive information has to be included in the plans or programmes, including

- Responsible authorities
- A description of the localization of excess pollution
- Nature and assessment of the excess pollution
- Estimate of the polluted area (km²) and of the population exposed to the excess pollution
- Origin of pollution (including quantitative information on main emission sources, relevance of local versus regional and long range pollution, etc)
- Possible measures for improvement of air quality
- Detailed description of the measures foreseen to be implemented including a timetable for implementation and estimations of the effects on air quality

These plans or programmes have to be forwarded to the Commission no later than two years after the end of the year during which the levels were observed. The first DD had to be transposed into national legislation by July 2001. For exceedances of the sum of limit value and margin of tolerance in the year 2001, plans or programmes had to be sent to the European Commission by the end of 2003. For exceedances in 2002, plans or programmes were due in 2004, for 2003 by the end of 2005.

After the attainment date (which was 2005 in the case of PM10 and will be 2010 for NO_2), the substantial obligation under the AQ FWD and its DD is to comply with the limit value and to take all measures necessary to ensure such compliance. MS may internally request local or regional authorities to prepare and implement plans, and if they do, it is not necessary under the Directive to communicate them to the Commission.

However, if limit values are exceeded after the attainment date, the EC may open an infringement procedure against the respective MS. During this procedure the question may arise what measures have been taken to ensure compliance within a specific zone. P&P covering all relevant measures and their status of implementation could automatically provide this kind of information.

The proposal for a new Air Quality Directive (COM(2005) 447) includes the requirement for an air quality plan even after the attainment date with an objective to 'keep the non-attainment period as short as possible". It also includes the attainment date extension option (Article 20), basically conditioned by the submission of an air quality plan with additional elements (see also chapter 2.4):

- justification of the request, demonstrating how compliance will be achieved by the new deadline;
- information on the state of implementation of relevant Community legislation within the zone;
- documented consideration (even if the measure has not been selected for implementation) of all measures listed in the Annex of the new Directive proposal.

Hence the P&P should be updated or prepared even if exceedances of PM10 limit values are observed after 2005.

2.3 Commission Decision 2004/224/EC

In order to facilitate the transmission of harmonised and structured information on the plans or programmes transmitted by Member States to the European Commission, Commission Decision 2004/224/EC was adopted laying down arrangements for the submission of information on plans or programmes required under Council Directive 96/62/EC. The Decision specifies that the information shall be given to the Commission in seven forms.

The following information has to be submitted:

- General information on the plan or programme (reference year, Member State, code numbers of exceedance situation, contact details).
- Description of the exceedance of the limit value (such as pollutant, concentration levels, area (km²) where levels were above LV, population exposed to excess pollution etc.).
- Analysis of the causes of any exceedance of the limit value (estimation of the regional background level and the total background level, contribution of local sources, reference to emission inventory, local climatology and topography).
- Baseline level (emission scenarios for baseline level, expected levels in the first year when LV has to be met, measures beyond existing legislation).
- Details of measures beyond those already required by existing legislation (including timetable, indicators to monitor progress, funding allocated, total costs).
- Optional: Possible measures that have not yet been taken and long term measures (including information about the administrative level, reasons for not taking the measure).
- Summary of measures (information about the administrative level, type of measure, time scale of reduction, sources affected including the spatial scale of these sources).

The Working Group on Implementation established by the EC has drafted guidelines[6] for the Commission Decision 2004/224/EC (WORKING GROUP ON IMPLEMENTATION 2003).

2.4 New Air Quality Directive

In September 2005, the Commission proposed a revision of the AQ FWD and the first three DD (COM(2005) 447). The proposal aims at a streamlining of these Directives. In addition, it contains several new elements, including environmental objectives for PM2.5. It is also proposed to keep the current limit values unchanged. However, the proposal of the Directive also takes account of difficulties experienced by several Member States in attaining current air quality limit values. Under certain circumstances, it is foreseen to postpone the attainment deadlines and to apply for exemptions from the obligation to apply certain limit values. One of the foreseen requirements for postponement is the availability of a plan or programme. This plan or programme will have to fulfil certain quality criteria.

The new Directive has to be adopted by co-decision. Adoption is not expected before mid-2007.

2.5 Other plans or programmes

In addition to the obligations under the AQ FWD, there are others for EU Member States, namely to prepare and report on plans to reduce emissions of air pollutants and to manage noise issues. These are also relevant here, since

[6] http://ec.europa.eu/environment/air/cafe/pdf/working_groups/recommend_plans_programmes.pdf

- These other policies might have significant influences on ambient air quality (e.g., measures for reducing the emissions of greenhouse gases can have positive or negative effects on the emission of "classical pollutants");
- The reporting of Member States under different rules and requirements should be consistent (e.g., use of consistent energy scenarios);
- Lessons learned during the implementation of the different provisions should be used to further improve and optimise the current legislation on this issue;
- Any duplication of reporting should be avoided.

2.5.1 National Emission Ceilings Directive

Plans or programmes have to be submitted also under other the Directive on National Emission Ceilings (NECD, 2001/81/EC). This Directive requires Member States to develop national programmes for the progressive reduction of the pollutants covered by this Directive: SO_2, NO_x, NMVOC and NH_3. In addition, the report should contain information on the likely impact of policy measures on emissions in 2010. The NECD further requires Member States to provide annually updated emission inventories and emissions projections for 2010, which will subsequently be made available to all other Member States.

Articles 9, 10 and 12 of the NECD set out the requirements for a review of the national emission ceilings, incorporating further investigations of the costs and benefits of achieving the ceilings. The Commission must report in 2004, 2008 and 2012 to the European Parliament and the Council on progress of the implementation of the ceilings and towards attaining the interim environmental objectives and the long-term objectives set by the Directive.

Articles 6, 7 and 8 of the NECD set down the reporting requirements for Member States for their national programmes and emission inventories and projections. Member States are required by the Directive to inform the Commission of their national programmes for the first time by 31st December 2002. Under Article 6(2), the Directive states that national programmes should include:

'... *information on adopted and envisaged policies and measures and quantified estimates of the effect of these policies and measures on emissions of the pollutants in 2010. Anticipated significant changes in the geographical distribution of national emissions shall be indicated*.'

The New Member States must prepare and submit national programmes under the NECD by 1st October 2006. Those Member States which submitted a programme in 2002 are required to '… update and revise…' their national programmes, as required, by this date.

The Commission has issued a contract under which an in depth analysis of the NEC national programmes has to be performed, which has been carried out by Entec UK Limited and the results are available (see **http://ec.europa.eu/environment/air/necr.htm**).

2.5.2 Large Combustion Plant Directive

Directive 2001/80/EC aims to reduce emissions of acidifying pollutants and ozone precursors and therefore its goals are directly in line with the NECD. For existing plants (those licensed before 1 July 1987), Member States may choose, by 1 January 2008, to either comply with the Emission Limit Values (ELV) set down in the LCPD or to produce and implement a national emission reduction plan.

National plans should reduce the total annual emissions of SO_2, NO_x and particulate matter to the levels that would have been achieved by applying the ELVs set out in the LCPD to existing plants in operation in the year 2000, on the basis of each plant's operational performance averaged over the last five years of operation up to and including 2000. National plans should specify the measures that will be implemented to ensure that this is achieved.

For the reporting of national emission reduction plans a guidance document has been developed (ENTEC 2002). The respective report contains spread sheets that should list all plants covered by the LCP Directive, the emissions of these plants as well as the emission targets and measures to achieve these targets. As of November 2006, only one national programme for Slovakia can be found in the CDR, which however contains only aggregated emissions but no measures or emission projections. Additionally, two reports about emission are available from Sweden.

2.5.3 Greenhouse Gases Monitoring Mechanism

Member States have to comply with a series of reporting requirements set down in Decision No 280/2004/EC of 11 February 2004 concerning a mechanism for monitoring Community greenhouse gas emissions (GHG) and for implementing the Kyoto Protocol.

Article 2 of Decision 99/296/EC - now replaced by Article 3 Paragraph 2 of Decision No 280/2004/EC - requires Member States to produce, implement and periodically update national programmes for limiting and/or reducing their anthropogenic emissions by sources and enhancing removals by sinks of all GHGs not controlled by the Montreal Protocol. Both articles include specific requirements for the reporting of all policies and measures, emissions projections and the assumptions and methodologies used. Parties to the United Nations Framework Convention on Climate Change (UNFCCC) are required to submit national communications (in depth national programmes detailing actions to reduce emissions of greenhouse gases) approximately every 3-5 years. Annex I countries (including all of EU-15) submitted their third national communications between 2001 and 2003 and the fourth national communications are due in 2006.

2.5.4 Reporting under the Convention on Long Range Transboundary Air Pollution on strategies and policies for air pollution abatement

Under the Convention on Long Range Transboundary Air Pollution (Convention on LRTAP), strategies and policies for air pollution abatement are reviewed at regular intervals. The main tool for receiving information from the parties to the Convention is a questionnaire, which contains questions specific to the different Protocols under the Convention on LRTAP. The answers to the questionnaires are usually compiled by the secretariat in Geneva and are subsequently provided to the Executive Body, the Implementation Committee and are made available through the Convention's web site.

2.5.5 Action Plans – Noise

Directive 2002/49/EC relating to the assessment and management of environmental noise requires the Member States to draw up strategic noise maps for major roads, major railways and major airports. Additionally in agglomerations also roads and railways with lower traffic volume have to be taken into account. Following the strategic noise maps action plans designed to manage noise issues and impacts, including noise reduction have to be drawn up. The first strategic noise maps have to be reported to the European Commission by July 2007

Art. 8 of Dir 2002/49/EC states that "Member States shall ensure that, no later than 18 July 2013, the competent authorities have drawn up action plans notably to address priorities which may be identified by the exceeding of any relevant limit value or by other criteria chosen by the Member States for the agglomerations and for the major roads as well as the major railways within their territories.". The information that has to be submitted is listed in Annex V of this Directive. No further reporting requirements or guidelines have been implemented so far.

2.5.6 Urban Thematic Strategy

On 13th January 2006 the European Commission launched a new Thematic Strategy on the Urban Environment[7]. The Strategy is one of seven foreseen under the 6th Environmental Action Programme. Its goal is to facilitate better implementation of EU environmental policies and legislation at the local level through exchange of experience and good practice between Europe's local authorities in order to improve the environmental performance of Europe's cities (press release IP/06/34 of 13.1.2006):

The main actions under the strategy are:

- **Guidance on integrated environmental management and on sustainable urban transport plans**. The guidance will be based on cities' experiences, expert views and research, and will help ensure full implementation of EU legislation. It will provide sources of further information to help prepare and implement action plans.
- **Training**. A number of Community programmes will provide opportunities for training and capacity-building for local authorities to develop the skills needed for managing the urban environment. Moreover, support will be offered to local authorities to work together and learn from each other. All these opportunities should be used both by the Member States and local authorities.
- **Support for EU wide exchange of best practices**. Consideration will be given to the establishment of a new European programme to exchange knowledge and experience on urban issues under the new Cohesion Policy. The Commission will closely cooperate with Member States and local authorities. This work will be based on a pilot network of focal points on urban issues (the "European Knowledge Platform") which offers advice to local authorities across Europe.
- **Commission internet portal for local authorities**. The feasibility of creating a new internet portal for local authorities on the Europe website will be explored to provide better access to the latest information.

2.6 Clean Air for Europe (CAFE)

The European Commission undertook a programme of preparatory work to underpin the thematic strategy on air pollution (COM(2005) 446). The Clean Air For Europe programme (CAFE) listed several objectives, including

- the development, collection and validation of scientific information relating to the effects of outdoor air pollution, emission inventories, air quality assessment, emission and air quality projections, cost-effectiveness studies and integrated assessment modelling, leading to the

[7] http://ec.europa.eu/environment/urban/thematic_strategy.htm

development and updating of air quality and deposition objectives and indicators and identification of the measures required to reduce emissions;

- the support of the implementation and review of the effectiveness of existing legislation, in particular the air quality daughter directives, the decision on exchange of information, and national emission ceilings as set out in recent legislation, to contribute to the review of international protocols, and to develop new proposals as and when necessary.

A number of previous activities under CAFE are relevant for this project, see chapter 3.

Further information can be found on the CAFE website[8].

[8] **http://ec.europa.eu/environment/air/cafe/index.htm**

3 BACKGROUND DOCUMENTS

Within this study a number of ongoing and finished projects have been identified to be of importance for this project. These projects have been considered for the in-depth analysis and the recommendations for improvement of the plans and programmes:

- Overview of reports on plans or programmes for reducing air pollution, submitted under Decision 2004/224/EC by Dick van den Hout, TNO (HOUT 2006)
- List of zones in EU Member States in relation to air quality thresholds by European Commission, DG Environment (DG ENV 2005b)
- Report of the Workshop on Plans and Programmes of Air Quality and National Emission Ceilings Directives (DG ENV 2005a)
- Review on abatement measures for PM10 in Europe by "17und4 Organisationsberatung GmbH" (SCHREFEL & HAJSZAN 2005)
- Review on abatement measures for PM10 and NO_2 in Germany ("Maßnahmen zur Reduzierung von Feinstaub und Stickstoffdioxid" by IVU Umwelt GmbH for the Umweltbundesamt Berlin) (IVU 2006).
- Snapshot report by the European Environmental Bureau: Particle reduction plans in Europe (EEB 2005)
- Assessment of the Effectiveness of European Air Quality Policies and Measures ("Ex post analysis") carried out by Milieu Ltd. (MILIEU 2004)
- Service Contract for "ex-post" evaluation of short-term and local measures in the CAFE context (AEA TECHNOLOGY ENVIRONMENT 2005).
- National Emission Ceilings Directive Review by Entec UK Limited (ENTEC 2005)
- Sustainable Urban Transport Plans (SUTP) and urban environment: Policies, effects, and simulations - review of European references regarding noise, air quality and CO_2 emissions by Rupprecht Consult — Forschung & Beratung GmbH (RUPPRECHT 2005)
- INTEGAIRE (**www.integaire.org**) and CITEAIR project (**http://citeair.rec.org/**)
- Report from the Working Group on Environmental Zones - Exploring the issue of environmentally-related road traffic restrictions (WORKING GROUP ON ENVIRONMENTAL ZONES 2005)
- Local Air Quality Management Guidelines by DEFRA (DEFRA 2003)
- Clean Air Act of US EPA (EPA 1990), described in detail in (NRC 2004)
- Ongoing project on development of EU policies to reduce emissions from in-use heavy duty vehicles (SADLER CONSULTANTS 2006).

In the following these projects are described in more detail.

3.1 Overview of reports on plans or programmes by TNO

The report gives an overview of reports on plans and programmes sent to the EC by December 2005 (text reports were not considered). Besides a detailed analysis of the number of exceedance situations of different air pollutants in the MS, two comparisons were made (HOUT 2006): First, the zones in exceedance of the Assessment questionnaires were compared with the zones addressed in plans and programmes and second, the stations were compared in the same way. The quality of the reports on plans and programmes was assessed as well and conclusions were drawn.

3.2 List of zones in EU Member States in relation to air quality thresholds by European Commission, DG Environment

In August 2005 DG ENV published a list of zones in EU member states in relation to air quality thresholds for the years 2001, 2002 and 2003 (DG ENV 2005b). For each limit value the compliance status was indicated either to be below the limit value, above a limit value already in force, above a limit value not yet in force, between a limit value and the sum of limit value and margin of tolerance as well as to be above the sum of limit value and margin of tolerance at one or more locations. The results are summarised in HOUT 2006 (see above).

3.3 Workshop on Plans and Programmes of Air Quality and National Emission Ceilings Directives

On 1st and 2nd of September 2004 a workshop on plans and programmes of Air Quality and NECD was held. The workshop was organised by the DG ENV in association with the European Federation of Clean Air and Environmental Protection Associations (EFCA) and the EEA (DG ENV 2005a).

The main purpose of the workshop was to exchange initial experiences on fulfilling the obligations under AQ FWD and NECD. Furthermore related activities of the EEA and EC as well as the outcome of the workshop on Air Quality Management during the IUAPPA World Clean Air Congress[9] in August in London were communicated to the Member States. The objective was to disseminate good practices and facilitate integration of the new Member States.

The report of the workshop as well as abstracts and PowerPoint files of the presentations are available via internet[10].

3.4 Review on abatement measures for PM10 in Europe

The project was started by three federal provinces in Austria to benefit from the experience in implementing measures to reduce PM10 throughout Europe (SCHREFEL & HAJSZAN 2005). Besides a review of plans and programmes and various reports dealing with abatement measures, a questionnaire was sent to local, regional and national authorities to gain further insight into cost, efficiency and social aspects of measures. The authors concluded that the most important sources of PM10 are traffic, residential heating and industry as well as transboundary transport. With respect to traffic most measures deal with diesel cars. Environmental zones were regarded as a promising tool. In the industrial sector construction work was mentioned. Public participation was seen as an essential part.

[9] http://www.kenes.com/cleanair/

[10] http://europa.eu.int/comm/environment/air/cafe/general/workshop_on_plans_programmes.htm

3.5 Review on abatement measures for PM10 and NO_2 in Germany

The German Umweltbundesamt (Federal Environmental Agency in Dessau) requested IVU Umwelt GmbH and IFEU to conduct a survey of all German P&P and action plans (IVU 2006). The main focus was on an analysis of the reasons for the exceedances and on the measures to reduce PM10 and NO_2 levels. The measures were classified and analysed regarding the sectors affected, type of measures, reduction potential etc. About 80% of all measures were related to traffic. Selected measures (LEZ, restrictions of transit HDV traffic, retrofitting with particle filters, alternative fuels, reduction of resuspension, avoidance and relocation of traffic, construction machinery) were described in detail regarding reduction potential and costs.

3.6 Survey on particle reduction plans in Europe by EEB

The European Environmental Bureau made an analysis of plans and programmes to reduce PM10 levels of about 30 European cities (EEB 2005). To support the analysis a questionnaire was sent to NGO's. The questionnaire on the one hand focused on the implementation of EU legislation, on the other hand on air quality management plans and national measures to support or contradict the local plans. The plans and programmes as well as accessibility of these plans and information about air quality issues in general are evaluated; good and bad examples are highlighted.

3.7 "Ex post analysis" by Milieu Ltd

Milieu Ltd made an assessment of the effectiveness of European air quality policies and measures under a contract by the EC (MILIEU 2004). The final report was finished in December 2004. The main results of this project are databases for studies relevant for the ex post analysis and for comparison of different air quality standards, four case studies, interviews and questionnaires with stakeholders, a study on transparency and public consultation as well as a homepage where this information can be downloaded[11].

The four case studies were comparisons between the EU and the US of approaches towards acidification, eutrophication and ground-level ozone, air quality standards and planning requirements, approaches towards controlling emissions from high-emitting vehicles and approaches towards particulate matter.

3.8 Service Contract for "ex-post" Evaluation of short-term and Local Measures in the CAFE Context by AEA Technology

In this study, which was funded by DG ENV, the focus is on measures that address short-term pollution peaks as well as on measures to tackle air quality hot-spots on a local level (AEA TECHNOLOGY ENVIRONMENT 2005). A Europe-wide survey of municipalities and regional authorities was conducted to get information on these measures. The information gathered throughout this survey has been fed into a database[12]. The database contains 91 measures,

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[11] http://www2.dmu.dk/AtmosphericEnvironment/Expost/default.asp

[12] The database as well as the final report of this study can be downloaded from: http://www.airquality.co.uk/archive/reports/reports.php?action=category&section_id=9

most of them are traffic related and permanent ones. A more detailed analysis has been undertaken for five measures for which sufficient data for an ex post evaluation of the impacts on air quality, emissions as well as a cost benefit analysis were available. The five measures are:

- Congestion charge in London and Stockholm
- Low emission zone (London)
- Controlled traffic flow by speed cameras (Rotterdam)
- Short-term incentive to switch travel modes (Strasbourg)
- Ban on a category of solid fuel (Dublin)

In addition, a programme of Cracow as well as examples of bans on old vehicles are described.

Furthermore, chapter 4.5 gives recommendations that might be of relevance for the thematic strategy "air".

3.9 National Emission Ceilings Directive Review by Entec UK Limited

The review of National Emission Ceilings Directive 2001/81/EC was performed under a contract from the EC (ENTEC 2005). The objectives were *inter alia* to undertake an intercomparison of the national programmes submitted to the Commission, an assessment of the consistency of these programmes with other programmes (e.g. plans and programmes concerning GHG and under the AQ FWD), an assessment of the administrative and political procedure and to give recommendations for improvements as well as recommendations for further legislation and the Thematic Strategy. Further tasks were an analysis of the feasibility of PM and Methane emission ceilings. The review[13] was finished in May 2005 and the reports are available via the internet.

3.10 Sustainable Urban Transport Plans (SUTP) and urban environment

The European Commission requested Rupprecht Consult to conduct a review of available Sustainable Urban Transport Plans (SUTP) policy assessments, aiming to provide a structured overview of empirical outcomes, to analyse their compatibility and complementarity, and to pinpoint current knowledge gaps (RUPPRECHT 2005). The study was conceived to focus on NO_x, PM, VOC, O_3, CO_2 and noise. An overview of the efficiency of various measures of about 50 assessments is given. The importance of policy integration is highlighted.

3.11 INTEGAIRE and CITEAIR project

INTEGAIRE (Integrated Urban Governance and Air Quality Management in Europe) is a network of air pollution experts from cities and research institutes. It was established and funded under the Fifth Framework Research Programme of the European Union, under the key action 'City of Tomorrow and Cultural Heritage'. The project started in March 2002 and focused on the topics governance, legislation, assessment as well as planning and measures. Besides a database on measures, guidebooks for cities on these topics were also produced. All documents are available via the INTEGAIRE homepage (**www.integaire.org**).

[13] **http://europa.eu.int/comm/environment/air/necr.htm**

Whereas INTEGAIRE focuses on city professionals, the CITEAIR project (Common Information to European Air) aims at providing AQ information also to the public (**http://citeair.rec.org/**). Within CITEAIR a common air quality index on the European level has been developed. This index is practically implemented on a common operational web page (**www.airqualitynow.org**). In addition to information to the public best practice examples of AQ and traffic management are reviewed. Guidebooks on environmental management and AQ reporting as well as a protocol for the transfer of best practice examples to other regions in Europe will be developed. The project started in March 2004 and will last for 46 months.

3.12 Report from the Working Group on Environmental Zones

The Joint Expert Group on Transport and Environment was asked by the EC to explore the topic of environmental zones as on the one hand this might be an interesting tool to tackle environmental problems, but on the other hand a conflict might arouse with Treaty principles if these zones are not carefully set up. Hence a working group was set up to analyse the issue.

The report that was finished in February 2005 gives an overview of existing and planned environmental zones throughout Europe; it gives also recommendations to the Commission. The latter include a common format for information sharing, the development of a Directive which facilitates the introduction of road traffic restrictions, mandatory information about the Euro standard, promotion of a harmonized road sign, and development of a common accreditation system for retrofitting vehicles.

3.13 Local Air Quality Management Guidelines by DEFRA

The Department for Environment, Food and Rural Affairs (DEFRA) of the UK published policy and technical guidance documents for local authorities[14]. These documents were designed to help local authorities with their local air quality management duties. The policy guidance document represents all aspects of policy, including air quality reviews and assessments, air quality action planning, transport planning and land use planning. The technical guidance document was designed to guide local authorities through the review and assessment process on a pollutant by pollutant basis.

3.14 Clean Air Act of US EPA

The 1990 Clean Air Act (CAA) is a federal law of the USA that controls air quality and emissions of air pollutants. Under this law, EPA sets air quality standards for various air pollutants. In case of exceedance of these standards, the states have to develop state implementation plans (SIP) which have to be approved by EPA. These SIPs have to include emission inventories, air quality modelling, information about emission reductions needed to meet the standards and control measures to achieve reductions. The 1990 CAA authorizes EPA to introduce sanctions if no adequate plan is submitted or attainment by deadline cannot be demonstrated. It is also foreseen to provide for interstate commissions in the case of transboundary air pollution.

Under the CAA a cap-and-trade system for SO_2 has been established that began in 1995. A detailed description of the US air quality management system can be found in (NRC 2004).

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[14] The documents are available at: **http://www.defra.gov.uk/environment/airquality/local/guidance/index.htm**.

3.15 Development of EU policies to reduce emissions from in-use heavy duty vehicles

This ongoing project looks at technical measures (i.e. mostly retrofitting) in the context of what can be supported by the EU, as the purpose of the project is to define concrete policy proposals at EU level, which could help to support the most promising technological options. In particular, the feasibility of a common system at EU level for vehicle certification that takes on board improvements of existing vehicles is investigated in the context of Low Emission Zones, charging systems, economic incentives, public procurement policies, etc. (SADLER CONSULTANTS 2006).

The project has three main parts:

- Assessment of technical measures, their costs, benefits. Provide evidence for the cost effectiveness of their use.
- Identification of existing barriers to greater use of these technical measures by those having experience with them, in order to encourage the uptake of these measures, particularly of those over which the EU has influence.
- Recommendation of concrete policy measures to be implemented in the EU to encourage greater use of these technical measures.

4 SCREENING AND CLASSIFICATION OF PLANS AND PROGRAMMES

In order to give an overview of reported plans and programmes and to select plans and programmes for the in-depth analysis, all available information on plans and programmes according to Commission Decision 2004/224/EC were screened and classified according to various criteria. This assessment consisted of the following steps:

- Overview of available reports on plans and programmes;
- Establishing a database of all reported plans and programmes;
- Translation of key information into English;
- Classification of the plans and programmes, exceedance situations and measures according to various criteria;
- Screening of plans and programmes for features which are of special interest for a detailed analysis.

4.1 Overview of available plans and programmes

A total of 120 reports on plans and programmes (P&P) were available in the suggested reporting format (Excel file with seven tables according to Commission Decision 2004/224/EC). Four reports were available in different formats (Word/PDF documents), but followed the structure of the seven tables as well. A total of 17 reports were available in different, unstructured formats, i.e. as reports on exceedance situations without detailed information on related measures.

Table 3 lists all reports on P&P included in the analysis made available to the authors either by the Commission or by the authorities themselves.

Table 3: Summary of the reports on plans and programmes available.

Member State	Reference year			
	2001	**2002**	**2003**	**2004**
Austria		1 form	7 forms	2 forms
Belgium	1 form, 2 structured reports	1 form	1 form	
Denmark		1 form	1 form	
France	1 form for years 2001 and 2002		1 form	
Germany		10 forms	26 forms	
Italy	20 forms	10 forms		
Netherlands		1 form	1 form	
Norway[15]			1 form	
Portugal	2 forms	2 forms		
Slovakia	16 unstructured reports, each for years 2001 to 2003			
Spain	9 forms	8 forms	10 forms	
Sweden	1 unstructured report		1 form	1 form
United Kingdom	1 structured report	1 structured report	1 form	

Compared to the draft overview on plans and programmes (HOUT 2006), additional reports were made available from various Member States: Forms for the years 2002 to 2004 were available from Austria, Belgium, Denmark, Spain and France, forms for the years 2001 and 2002 were available from Italy and Portugal, one form for the year 2002 was available from the Netherlands, and reports for the years 2001 to 2003 were available from the Slovak Republic. In addition, a form from the non-Member State Norway was included in the analysis.

4.2 Comparison of required and available P&P

The compliance with the requirements to send P&P to the EC has been analysed in detail for each pollutant, zone and station for the years 2001, 2002 and 2003 (HOUT 2006). Table 4 shows the results of this analysis; additional P&P that were received within this project were also considered.

[15] Non-member state which also submitted a report on plans and programmes.

Table 4: Availability of P&P for NO_2 and PM10 from EU-15 MS (n.e.: no exceedance; "++" all necessary P&P available; "+" some P&P available; "-": no P&P submitted; after HOUT 2006).

Member State	NO_2 hour	NO_2 year	PM10 day	PM10 year
Austria	n.e.	+	+	+
Belgium	n.e.	+	+	+
Denmark	n.e.	++	n.e.	n.e.
Finland	n.e.	n.e.	n.e.	n.e.
France	n.e.	+	+	+
Germany	n.e.	+	+	+
Greece	n.e.	–	–	–
Ireland	[16]	n.e.	n.e.	n.e.
Italy	+	+	+	+
Luxemburg	n.e.	–	n.e.	n.e.
Netherlands	n.e.	++	++	++
Portugal	n.e.	+	+	+
Spain	n.e.	+	+	+
Sweden	n.e.	n.e.	++	n.e.
United Kingdom	++	++	++	++

Ireland did not send a P&P for the only exceedance situation observed as the monitoring data was anomalous. This was explained in a letter to the EC. From Greece and Luxembourg, no P&P were available; from the other MS at least some P&P were available.

4.3 Database

Those reports which were available in the Excel format and those with tabular structure were included in a database. The remaining reports, which were available in different formats, were screened for features of special interest only.

The database was implemented in Microsoft Access. The seven forms of each report on plans and programmes were checked for completeness, converted into a standardised format and then imported into the database.

The database consists of seven forms, so-called tables, as well. For example, in table 1, all information from Excel form number 1 is stored. Each line of the table contains all information related to one plan and programme; each column of table 1 contains all data entries of the same type, e.g. the reference years, member states, or references to plans and programmes. Similarly, each line in table 2 contains all information related to one exceedance situation; each column in table 2 contains data entries like pollutant, zone code, or region.

The Access application facilitated statistical analyses of the information stored in the tables, e.g. an analysis of the numbers of exceedance situations related to a certain pollutant. It also allowed combining information which was originally spread across several forms, e.g. combining causes of exceedance situations (Table 3) with measures (Table 7).

[16] In a letter to the EC it was stated that the validity of the data at one monitoring station where the exceedances were observed (Winetavern Street) is anomalous. Hence no P&P had to be prepared.

The combination of several tables was done as follows: Each data entry in each table was identified by a key (a consecutive number). As shown in Figure 2, the key of related tables was entered in other tables as well. For example, for each exceedance situation entered in Table 2, the corresponding key of Table 1 (i.e, the corresponding plan or programme) was entered. For each required measure in Table 7, the corresponding key of Table 5 and the corresponding key of Table 1 were entered. If one measure corresponded to several exceedance situations, the key of this measure was entered for each of the exceedance situations in Table 5. In this way, it was possible to create so-called queries in the Access database, i.e. analyses of several tables linked together.

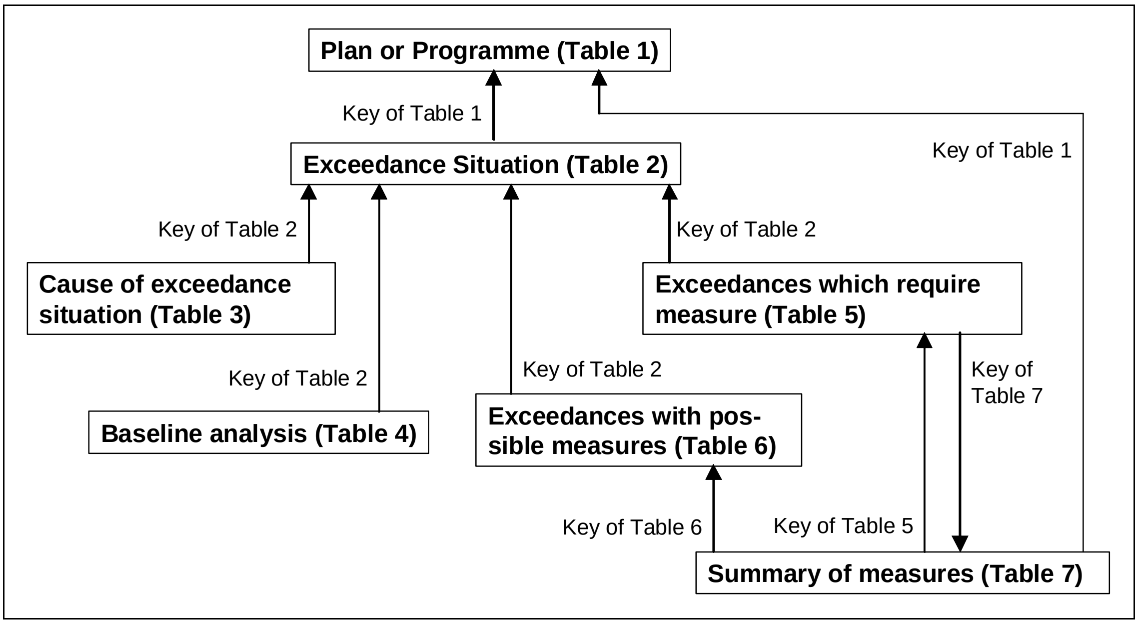

Figure 2: Structure of the Access database.

Results taken from the database are shown in chapter 4.5. The database is available for additional analyses using the standard Access functions or other software applications. The database may also be appended with new plans and programmes. However, the format of all Excel forms has to be checked and standardised before importing the data into the database.

4.4 Translation

The reports on plans and programmes were available in the following languages: English, German, French, Italian, Spanish, Portuguese, Dutch, Danish and Slovak. For the screening of P&P, only part of the Dutch information was translated and of the information from Denmark, only the form supplied in English was used. The Slovak reports, which were not included in the database, were not translated but screened for their content only.

From the reports in German, French, Italian, Spanish, Portuguese and Dutch, the following information was translated into English: indicators for monitoring the progress (Table 5), reasons for not taking measures (Table 6), and title of the measure (Table 7).

Other key information in the tables, e.g. pollutant, concentration level or classification of the table, was available in numerical or standardised form and was not translated.

4.5 Classification

Using the database, the reports on plans and programmes were classified according to the following criteria:

- Member States;
- Pollutants and sources;
- Characteristics of the zones (Climatological situation, geographical region);
- Types of measures.

In the following sections, the results of this classification are reported and critically discussed. It is important to note that the classification is based on the reports available by November 2006 and therefore may not be representative of all plans and programmes. Nevertheless, this classification gives a comprehensive overview of plans and measures available at present.

4.5.1 Pollutants and sources

Table 5 to Table 8 show the number of exceedance situations reported by the various Member States. It is important to note that a reported exceedance situation does not always concern one single local situation but concerns a combination of very similar situations within one zone or agglomeration.

PM10 accounts for about half of all reported exceedance situations, followed by NO_2. Due to additional reports received by November 2006, the results differ from the overview of plans and programmes by HOUT (2006). Germany reported one exceedance for benzene. The exceedance of the NO_x limit value reported by France was not included in this analysis, because it does not require a P&P.

Concerning the number of exceedance situations for France, it has to be noted that a correction factor of 1 was used for converting continuous monitoring data from TEOM instruments so as to be equivalent to the reference measurement method. Also for France, exceedances for 2001 and 2002 were reported together.

Table 5: Member states and reported exceedance situations, 2001.

Member State	PM10	NO_2	SO_2	Benzene	Total
Austria					**0**
Belgium	4	1	3		**8**
Germany					**0**
Denmark					**0**
Spain	10	3	2		**15**
France	1	15	15		**31**
Italy	28	16	2		**46**
Norway					**0**
Netherlands					**0**
Portugal	3				**3**
Sweden					**0**
United Kingdom	2	5	1		**8**
Total	**48**	**40**	**23**	**0**	**111**

Table 6: Member states and reported exceedance situations, 2002.

Member State	PM10	NO_2	SO_2	Benzene	Total
Austria		1			**1**
Belgium	3		3		**6**
Germany	7	20			**27**
Denmark		1			**1**
Spain	20	2	19		**41**
France	1	15	15		**31**
Italy	16	4	1		**21**
Norway					**0**
Netherlands	12	12			**24**
Portugal	3	1			**4**
Sweden					**0**
United Kingdom	2	5			**7**
Total	**64**	**61**	**38**	**0**	**163**

Table 7: Member states and reported exceedance situations, 2003.

Member State	PM10	NO_2	SO_2	Benzene	Total
Austria	17	7			**24**
Belgium	10				**10**
Germany	34	25		1	**60**
Denmark		1			**1**
Spain	14		2		**16**
France	6	12	6		**24**
Italy					**0**
Norway	2				**2**
Netherlands					**0**
Sweden	1				**1**
United Kingdom	5	6	2		**13**
Total	**91**	**56**	**11**	**1**	**139**

Table 8: Member states and reported exceedance situations, 2004.

Member State	PM10	NO_2	SO_2	Benzene	Total
Austria	4	1			**5**
Belgium					**0**
Germany	1				**1**
Denmark					**0**
Spain					**0**
France					**0**
Italy					**0**
Norway					**0**
Netherlands					**0**
Sweden	5				**5**
United Kingdom					**0**
Total	**10**	**1**	**0**	**0**	**11**

Member States were required to report the main pollutant sources responsible for each exceedance situation, and to rank them according to their contribution. As Figure 3 shows, traffic was reported as the major source of pollution for 254 exceedance situations (63 % of all exceedance situations), followed by industry (30 %). Commercial and residential sources were ranked as number two in a large number of cases. One has to note that for most exceedance situations, only one or two sources were reported, and for 4 % of all exceedance situations, no sources were reported at all.

Where “Other” was reported as a source of pollution, the following sources were specified in the comments sections of the reports: Weathering (17 % of other sources mentioned), biogenic sources, (14 %), construction sites (22 %), ship traffic (6 %), air traffic (5 %), small combustion (14 %), formation of secondary particles (16 %), transboundary pollution (6 %).

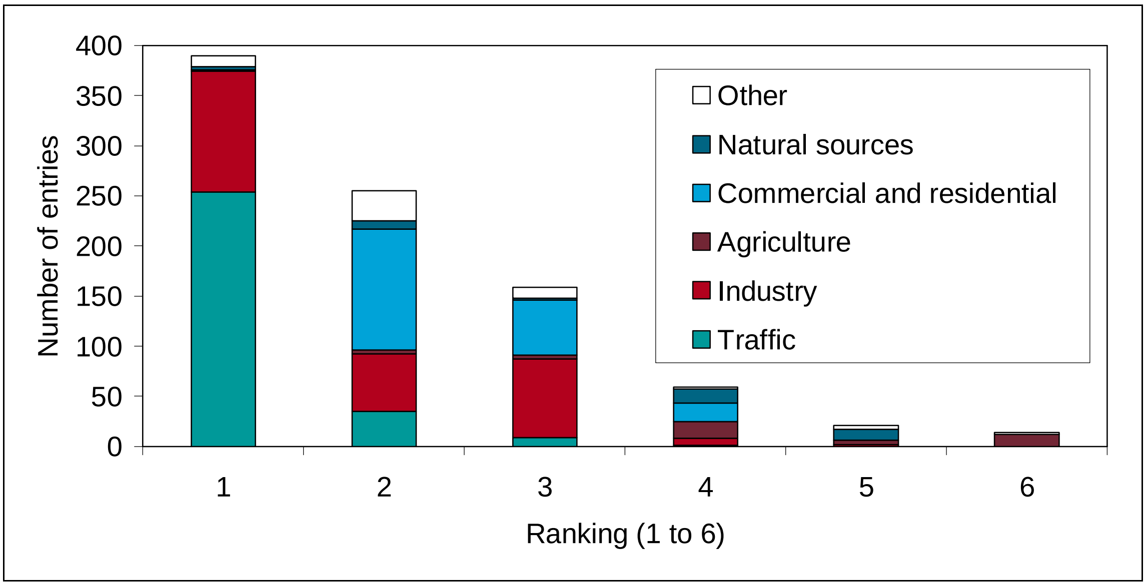

Figure 3: Ranking of the sources of pollutions: Number of entries where the six main sources of pollution were ranked first, second, etc. For 17 exceedance situations, no ranking was reported.

As Figure 4 shows, there is a close relation between main sources and pollutants. Traffic was reported as number-one source of all except one NO_2 exceedance situations and of most PM10 exceedance situations, whereas Industry was reported as number-one source of all SO_2, a considerable number of PM10 and one benzene exceedance situation. All number-one sources which were reported as “Other” were related to PM10 exceedance situations.

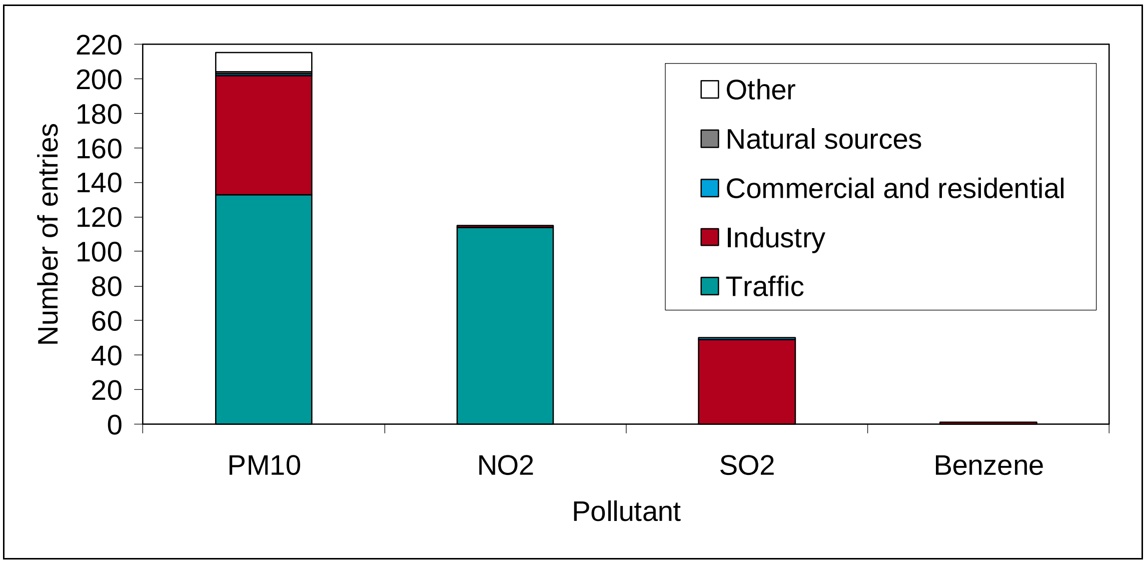

Figure 4: Main sources listed for different pollutants. For 17 exceedance situations, no main source was reported.

4.5.2 Characteristics of the zones

In order to obtain an overview of the climatological and geographical situations of the exceedance areas, they were grouped into eight climatic and seven geographical classes (for the climatic regions in Europe see Figure 20). This coarse classification was performed using basic knowledge of geographical and climatic zones and is appropriate for the purpose of an overview only.

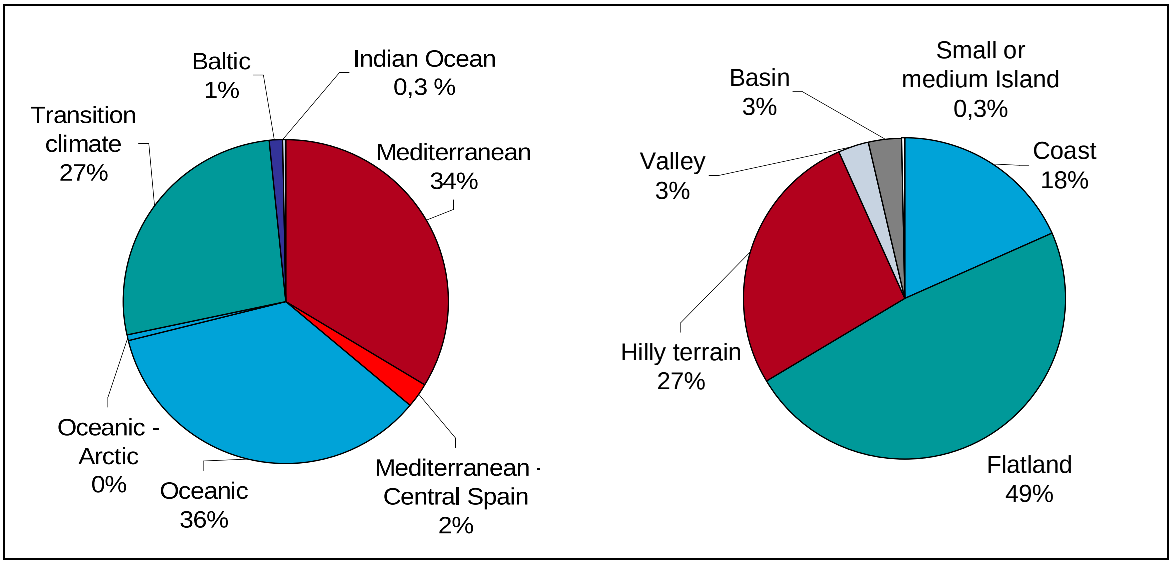

Figure 5: Climatic situations (left) and geographical regions (right) of the exceedance areas.

Figure 5 shows that the reported exceedance situations cover different climatic situations (mediterranean, oceanic, transitional climate) in comparable numbers. Geographical regions are dominated by flatland, followed by hilly terrain and coast. As this is a coarse classification only, it should not be over-interpreted. However, the figure shows that all important climatic and geographical zones are covered by the plans and programmes available. The “small or medium island” in the Indian Ocean is Réunion, reported by France.

For each exceedance situation, Member States had to report the area and the length of road affected by the exceedance. Figure 6 shows the reported areas and lengths of road. A large proportion of the areas is within a range of 100 to 1000 km², whereas the largest group of reported lengths of road is below 1 km. It is important to note that in many cases, the exceedance situations were estimated to affect large parts of a city and therefore cover road networks longer than 1000 km. In some of these cases, however, the whole city area (and therefore the whole road network) was reported as being exceeded, even though from the monitoring results it can be seen that only traffic related sites but not urban background sites show exceedances. Hence the actual exceedance area might be much smaller in some cases. This holds true also for the number of people exposed (Figure 7). Therefore, caution is necessary when comparing various areas or lengths of roads.

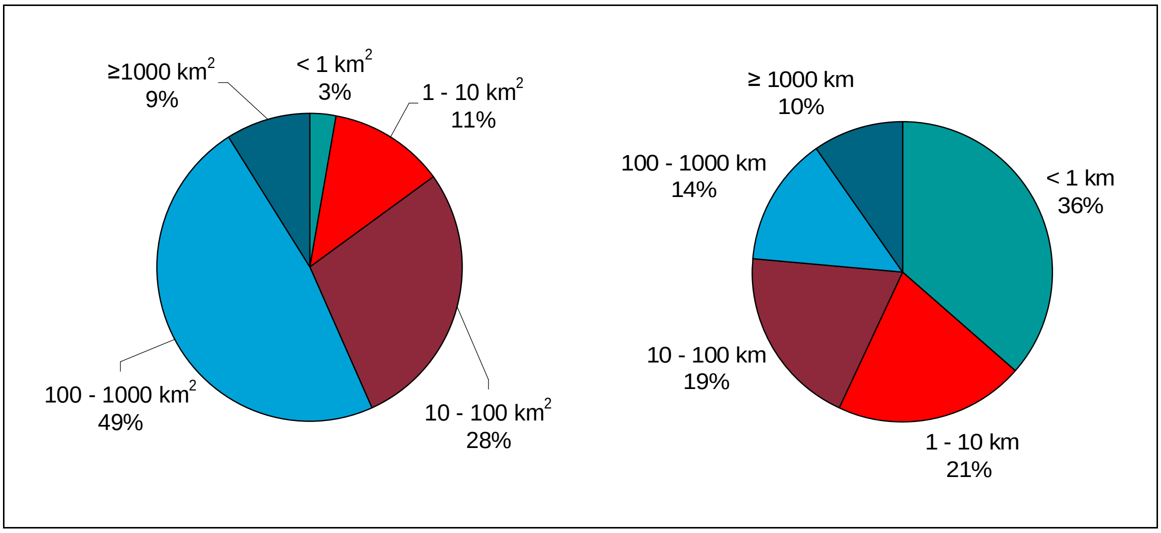

Figure 6: Left: Estimate of the surface area where the level was above the limit value in the reference year. Right: Estimate of the length of road where the level was above the limit value in the reference year. For 30 % of exceedance situations, no surface area and no length of road was reported.

Similar to the spatial dimension, the exposed population varies greatly. Each of the five classes of population suggested in the report has a share of at least 14 %.

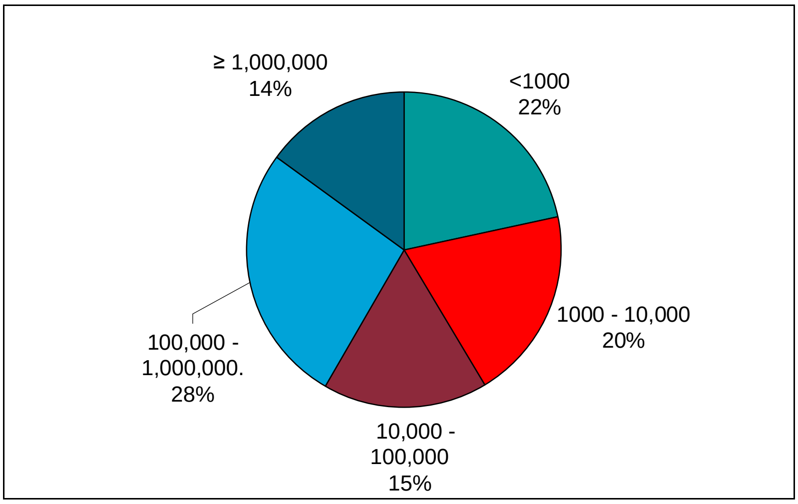

Figure 7: Estimate of the total population exposed to a level above the limit value in the reference year. For 34 % of the exceedance situations, no estimate of the population exposed was given.

According to the Guidance on the Annexes to Decision 97/101/EC on Exchange of Information as revised by Decision 2001/752/EC, all monitoring stations are classified into nine types of stations. Figure 8 shows the station classifications reported for all exceedance situations. A large part of all exceedances were recorded at urban traffic stations; however, for one quarter of the exceedances reported, no valid classification was specified (e.g., in many cases, stations were classified as “traffic” only).

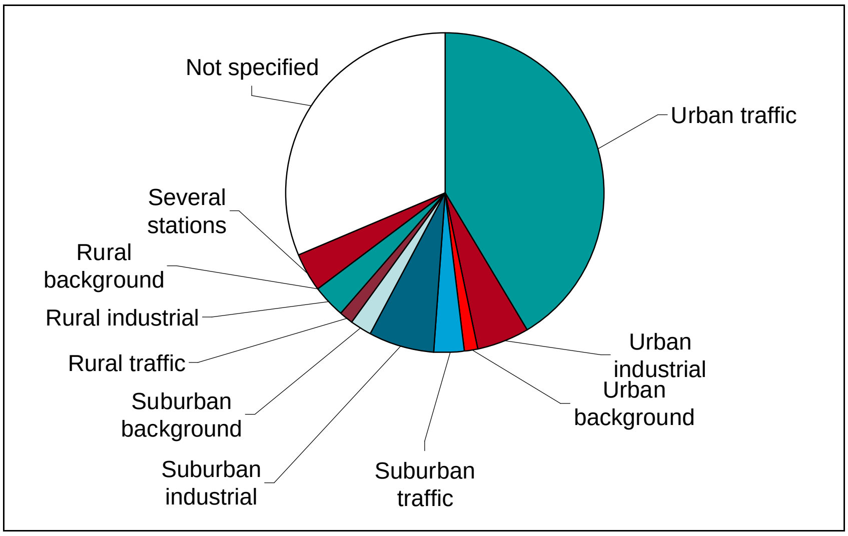

Figure 8: Classification of the stations where exceedance situations were observed.

Differences in reporting between the member states, which may be caused by different country sizes or different administrative structure, may be of interest too. Among the Member States that reported plans and programmes, countries with a federal administrative structure like Germany submitted a large number of individual tables. On the other hand, countries like France and the United Kingdom combined all information in one document. Some countries like Italy reported many national measures, whereas other countries reported mostly local and regional measures. Still, no specific differences between small and large countries were found in the plans and programmes they reported.

4.5.3 Measures

A total of 1595 measures were reported. In the reports, they were classified into four types: A (economic/fiscal), B (technical), C (education/information), D (other). Figure 9 shows that the largest share was technical, and that in many cases a combination of types was reported.

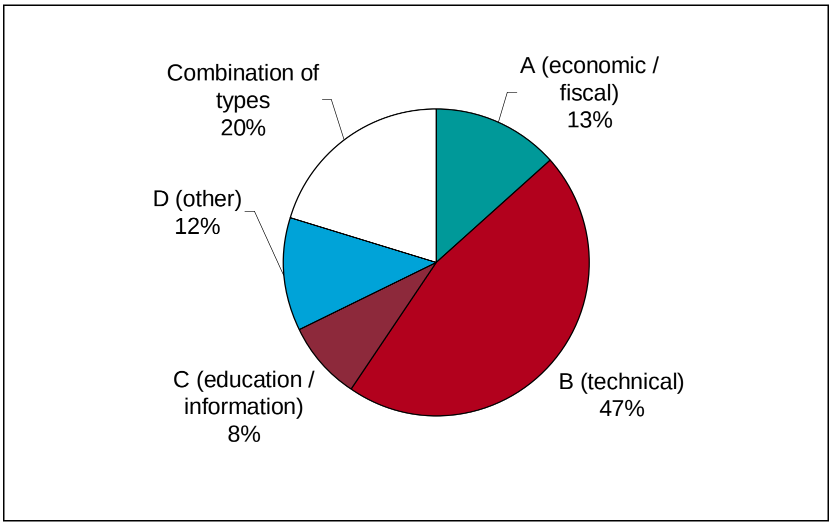

Figure 9: Reported types of measures. For 3 % of all measures, no type was reported.

From screening the reported measures, it became evident that it would be helpful to further divide the measures into different categories. Within the INTEGAIRE project, for example, a classification of measures exists which includes various categories of traffic and land use measures. For the purpose of the present study, a list of categories was selected which is similar to the INTEGAIRE categories, but was selected in such a way as to cover the scope of all measures reported.

Five categories and several sub-categories were formed, and each measure was assigned to one of these categories. The assignment of a measure to a specific category may be arbitrary, and often several categories may apply. Still, the classification scheme proved to be useful for providing an overview of the large number of measures reported.

For example, measures to improve traffic flow and measures concerning parking regulations were grouped in the category "traffic" and in the sub-category "traffic management". As another example, measures which deal with air quality monitoring only were not classified as measures according to the Air Quality Framework Directive, but as "other activities". Figure 10 gives and overview of the categories and sub-categories. Table 9 lists all measures found for each category and sub-category.

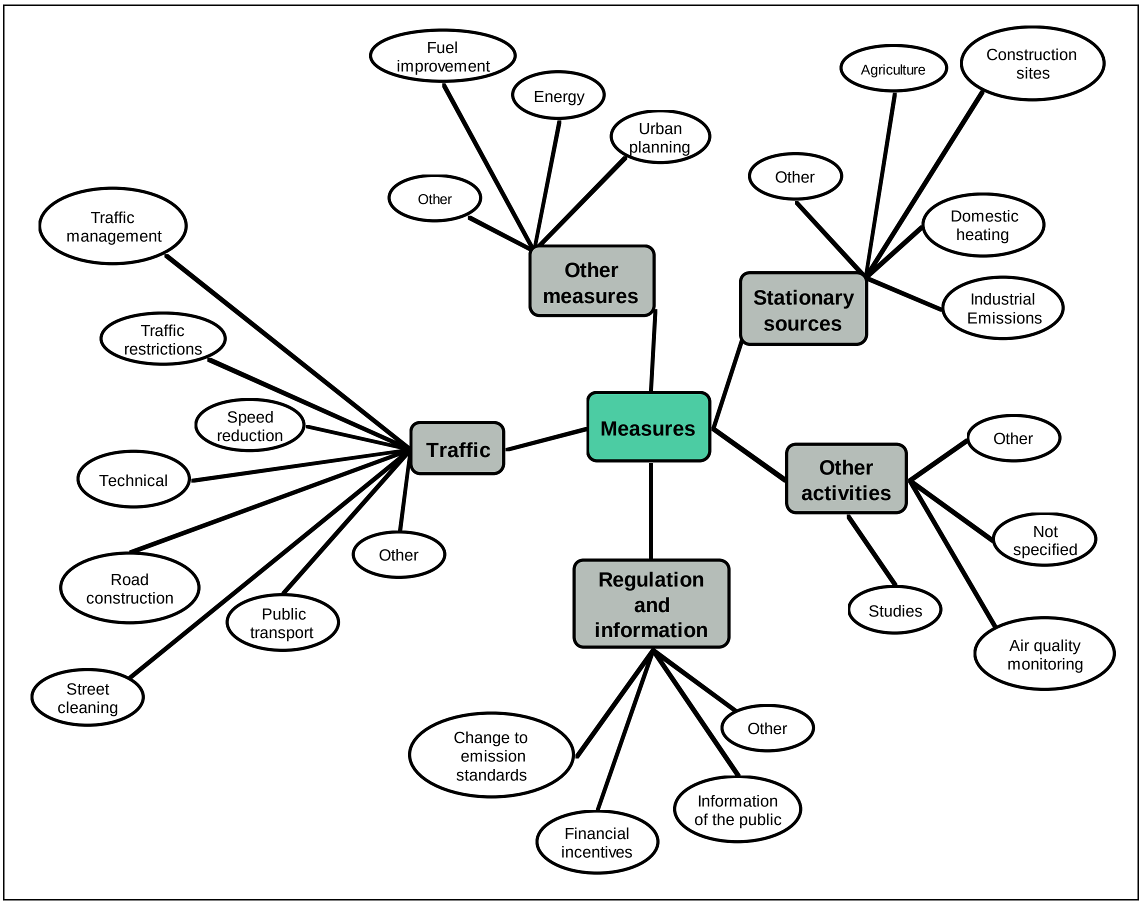

Figure 10: Categories and sub-categories of measures.

Table 9: List of categories, sub-categories and measures.

Category: Traffic	
Sub-category	**Measures**
Technical	Emission reduction of cars, buses, lorries, motorcycles, railways, ships, air-planes
Traffic manage-ment	Traffic flow management, parking charges, congestion charges, improved cargo logistics, airport traffic management
Public transport	Improvement and promotion of public transport, promotion of bicycle and pe-destrian traffic
Traffic restrictions	Measures which restrict traffic in certain areas
Road construction	Construction of by-pass roads, constructive measures which improve traffic flow
Speed reduction	Area or road specific speed limits
Street cleaning	Improved street cleaning, alternative winter sanding
Other	alternative traffic concept, bicycle sharing, car sharing, car pooling, efficient driving training, labelling of low emission vehicles, low emission road surface, promotion of methane fuel stations, mobility planning, promotion of railway cargo transport, restriction on keeping the engine running, restrictions on stud-ded tyres, truck toll, tunnel exhaust cleaning
Category: Stationary sources	
Sub-category	**Measures**
Agriculture	Measures in the area of manure handling and feeding
Construction	Measures to reduce emissions on construction sites
Heating	Improvement of heaters, building insulation, district heat
Industrial	Measures to reduce industrial and power plant emissions
Other	Restriction of open fires, removal of sand surfaces
Category: Regulation and information	
Sub-category	**Measures**
Financial incentives	Fiscal stimulation, emission certificates, financial support of low-emission tech-nology
Information of the public	Information and awareness of employees, pupils and the general public
Change to emission standards	Improvement of emission standards on the European level
Other	---
Category: Other measures	
Sub-category	**Measures**
Energy	Support of alternative energy production, measures to reduce energy con-sumption
Fuel improvement	Propagation of low-sulphur and low-VOC fuels
Urban planning	Integration of mobility and air quality aspects in urban planning.
Other	Combination of information, incentives and traffic restrictions; procedure of regularly taking and evaluating new measures. Reduction of transboundary pollution; planting of trees; construction of protective walls.

Category: Other activities	
Sub-category	**Measures**
Air quality monitoring	Monitoring of pollutant concentrations
Studies	Emission inventory, emission monitoring, emission study, energy consumption research, exposure study, research programmes, study on regional transport
Not specified	Measures with unspecified emission reduction, measures which are in the stage of planning
Other	Definition of plans to reduce emissions, resettlement of population.

Figure 11 shows the frequency of the different sub-categories of measures. A total of 207 measures were classified as "Traffic – Traffic management", followed by "Stationary sources – Industrial". A considerable number of entries were not classified as measures according to the Air Quality Framework Directive, but as "Other activities – Studies". The classification of each measure may be arbitrary in certain cases, but it still gives an overview of the scope of measures reported.

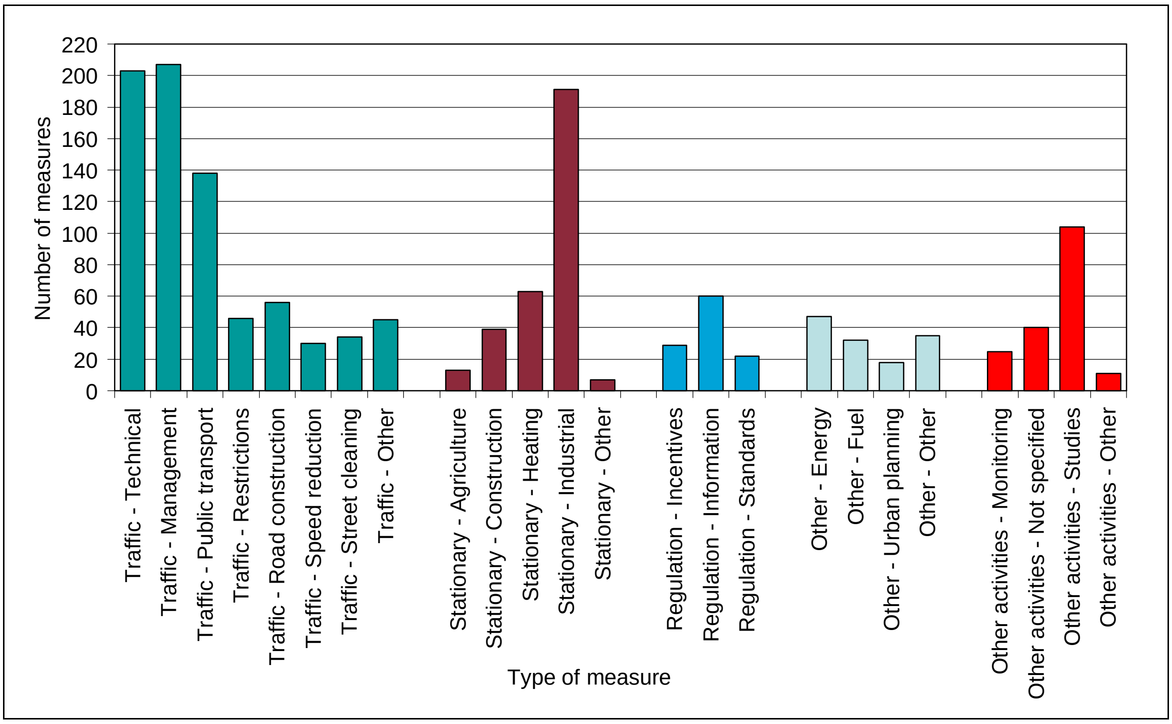

Figure 11: Categories of measures reported by all Member States.

The overall sum of measures reported in the five categories is 759 for traffic-related measures, 313 for stationary sources, 111 for regulation and information, 132 for other stations, and 180 for other activities.

It is interesting to compare the categories of measures reported by different Member States. A comparison of the four Member States which reported the largest number of measures (Figure 12) shows that France reported a large number of industrial measures, whereas Germany and Italy predominantly reported traffic measures and Spain reported a large number of studies.

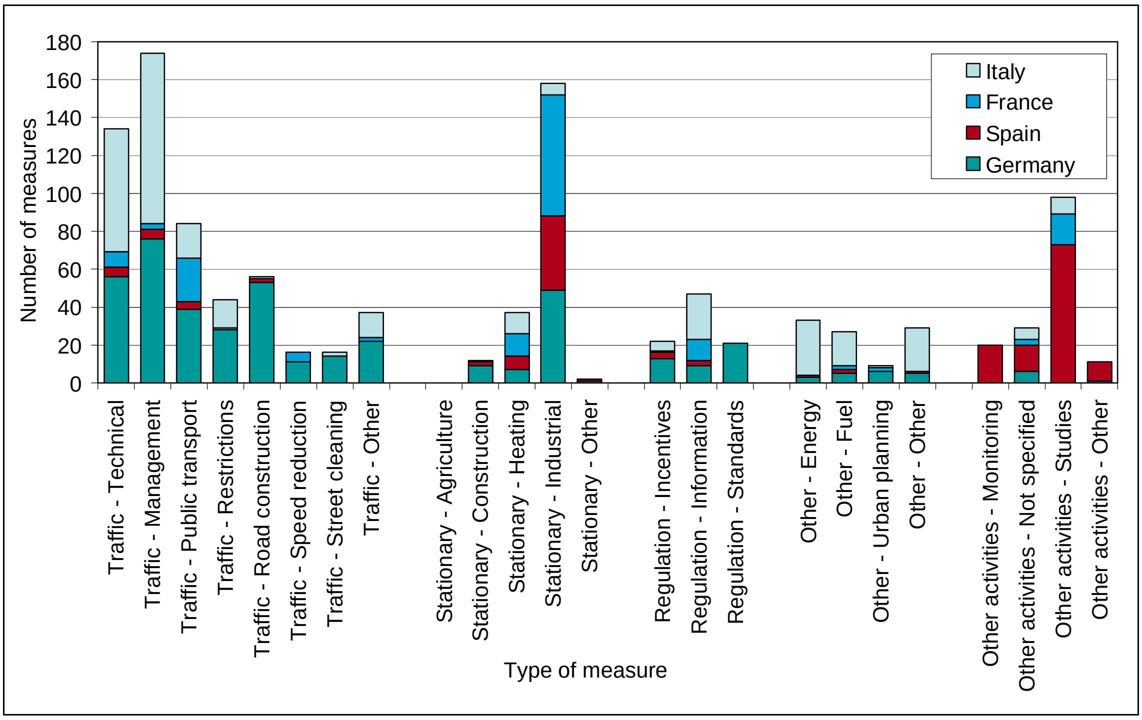

Figure 12: Categories of measures reported by Germany, France, Spain, and Italy.

Figure 13 focuses on the measures which were defined specifically for one exceedance situation. Measures reported for several exceedance situations are not included. The figure shows that the number of measures defined specifically for NO_2 and SO_2 exceedance situations is relatively small. However, one has to note that there are a large number of measures which focus on both NO_2 and PM10 exceedances and are therefore not included in the figure.

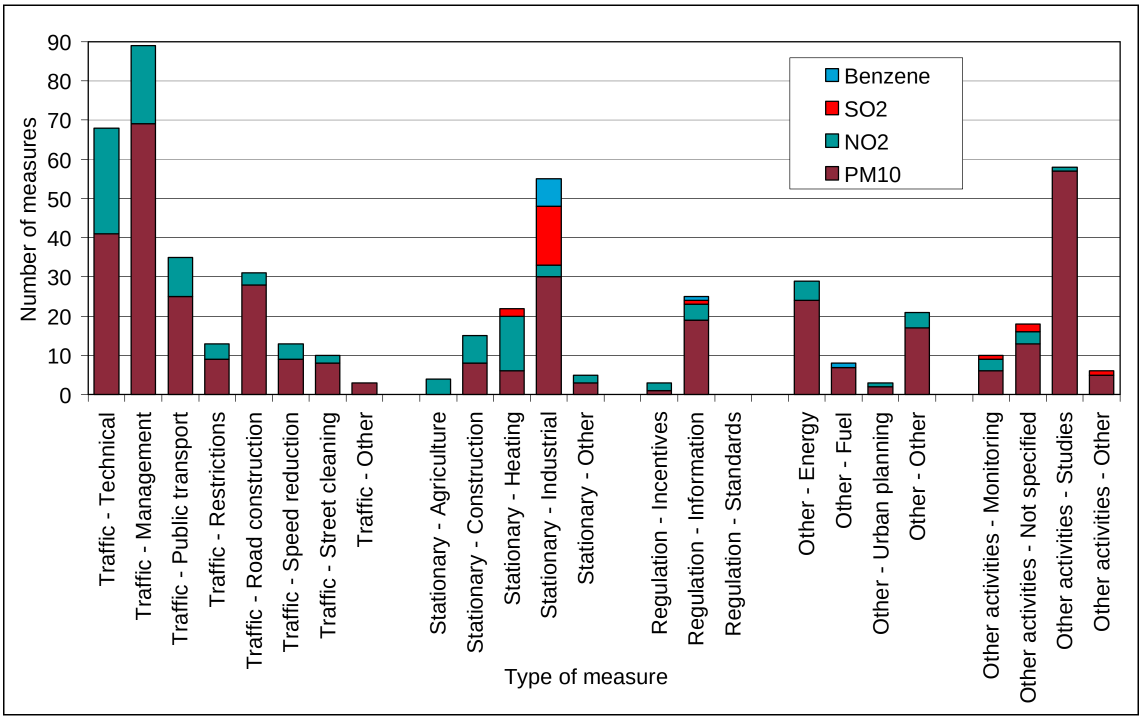

Figure 13: Measures which were taken specifically for a single exceedance situation, differentiated by pollutant.

As Figure 14 shows, funding was reported to be zero in many cases. In many situations, the projected costs were higher than the funding available at the time of reporting. However, many Member States did not report funding and costs, and funding which was reported specifically for different periods was not included in the analysis. Therefore, Figure 14 cannot be regarded as representative of the funding and costs of all measures. Funding and costs are an example of information that was provided in a minority of reports only.

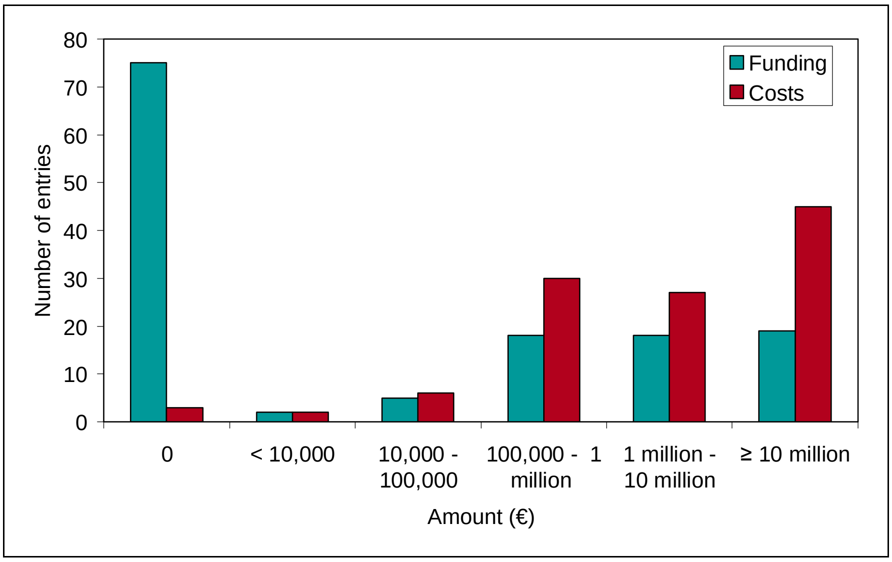

Figure 14: Funding available and costs of measures. Funding was reported in 25 % of cases, and costs were reported in 20 % of cases only.

Almost half of the measures reported were assigned to the local level (A), about one fifth to the regional level (B) and 8 % to the national level (C), see Figure 15 (left). For 1 % of the measures the administrative level was not specified. For a large number of measures, the administrative level was not restricted to one specific level. As seen in Figure 15 (right), 45 % of the measures were reported as “regulatory”.

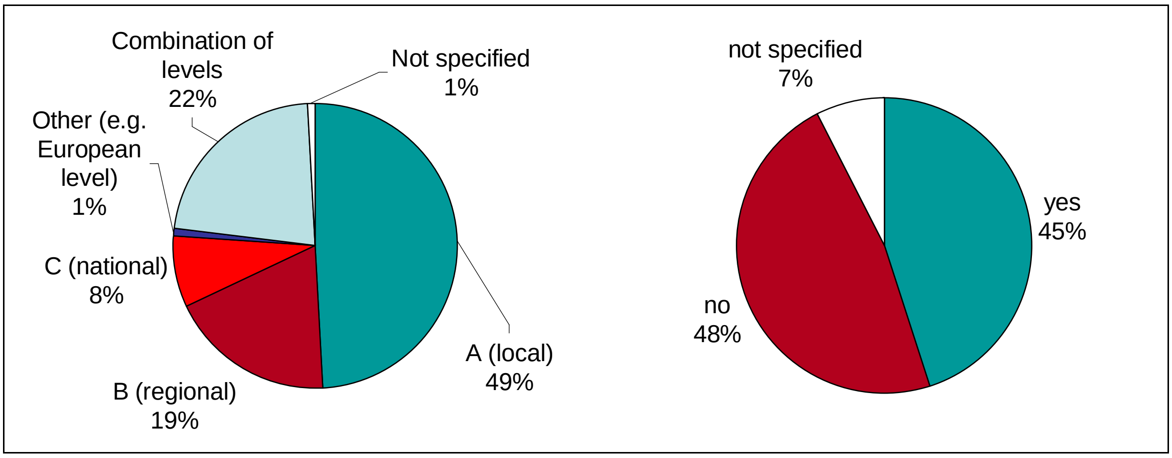

Figure 15: Administrative level at which the measure could be taken (left); regulatory (right).

For compliance with limit values, the time as well as spatial scale of measures is crucial. A large part of measures was reported as “long term”, and concerning spatial scale, “urban” was mentioned most often (Figure 16).

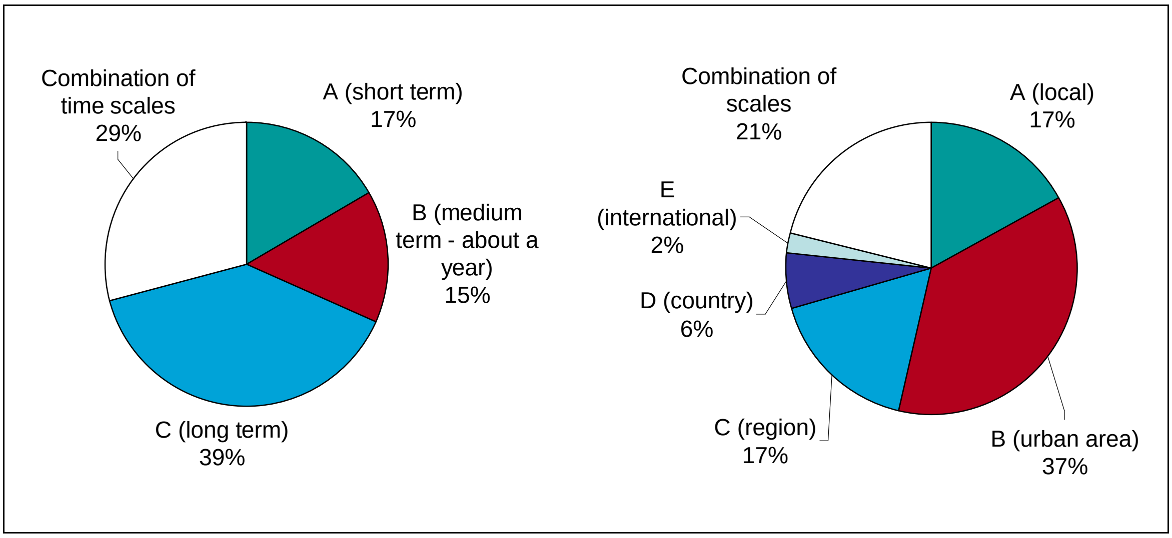

Figure 16: Time scale (left) and spatial scale (right) of measures.

The indicators chosen for monitoring the effects of the applied measures are shown in Figure 17. Air quality monitoring and traffic-related indicators such as the number of cars per day were the most popular indicators.

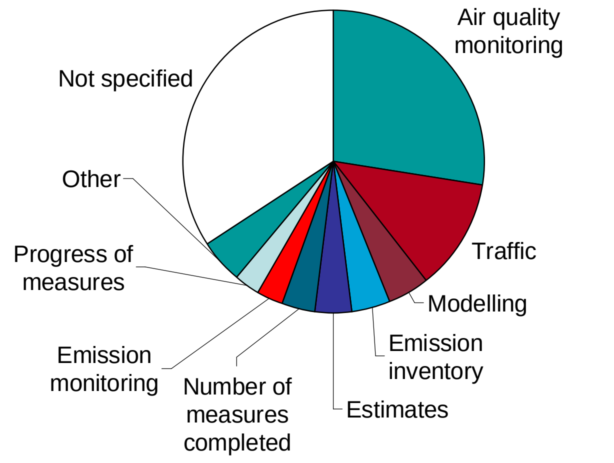

Figure 17: Indicators for monitoring progress of measures.

In the reports on plans and programmes, there is the option of listing additional measures which were not taken. For these measures, the reasons for not taking them were reported as well. These reasons were similar in many cases and therefore classified into six categories for the present analysis (Figure 18). Lack of legal competence, costs and the long period until the measure would become effective ("time scale") were mentioned most often.

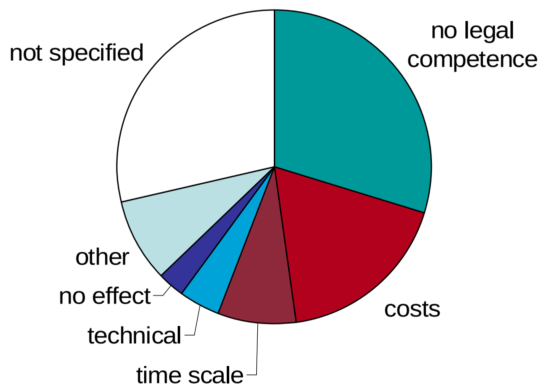

Figure 18: Reasons for not taking additional measures.

In general, many reports on plans and programmes were not filled in completely, as also stated by HOUT (2006). Table 10 shows that e.g the classification of stations was reported correctly in two thirds of the reports only. Such points can be corrected easily by following the instructions available. Other missing information, like the baseline analysis, which was incomplete in one fourth of the reports, requires thorough consideration by the reporting agency. In any case, it has to be noted that most information is mandatory as stated in the requirements of Annex IV of Directive 1996/62/EC.

Table 10: Percentage of information submitted completely in the forms on plans and programmes available.

Information	**Percentage of information given completely**
Sufficient contact information	98 %
Complete information on exceedances (concentration, number of exceedances etc.)	99 %
Correct classification of station	68 %
Complete information on baseline analysis	74 %
Complete information on measures	97 %

5 IN-DEPTH ANALYSIS OF SELECTED PLANS AND PROGRAMMES

The key objective of task 1 of this project was to undertake an in-depth analysis of selected plans and programmes submitted to the EC under the AQ FWD and the related DD. In collaboration with the EC, as a first step 28 cities and regions, for which plans and programmes (P&P) were available, were chosen. Finally, 18 out of these 28 P&P were considered for the in-depth analysis.

This chapter describes the main results of the analysis:

In chapter 5.1 an overview of the selected P&P is given (in the Appendix the cities and regions are described in more detail);

For each of the selected P&P, questions concerning planning, implementation and evaluation were addressed. The results are summarised in chapter 5.2.

As traffic plays a crucial role for AQ, transport plans and their interrelation with AQ planning are summarised in chapter 5.3. Furthermore, P&P under the NEC Directive and the GHG monitoring mechanism are taken into account.

During the planning process for several P&P, air quality models were applied. Chapter 5.4 describes the modelling approaches used for the selected P&P and their applicability to other cases.

After discussing planning and implementation, the last two sections of chapter 5 focus on measures.

The impact on air quality, the costs of implementing measures and the cost effectiveness of measures are described in chapter 5.5 – providing this information was available.

Chapter 5.6 describes the most effective, relevant and interesting measures that were found in the selected P&P.

Finally, some recommendations for improvement of the planning process are given in chapter 6, some for improvement of the implementing provisions in chapter 7.

5.1 Selection of plans and programmes

Within this project, an in-depth analysis of plans and programmes was undertaken. As it is not possible or useful to analyse all plans and programmes in detail (as seen in chapter 4.1, about 140 reports on P&P are available), only selected plans and programmes are accounted for. Based on the classification presented in chapter 4, a total of 28 plans and programmes were selected and approved by the EC (Table 11).

Table 11: Plans and programmes selected for the in-depth analysis under Task 1.

MS	City	Year	Pollutant(s)	Station[17]	Main source	Geogr. region
Austria	Graz	2003	PM10, NO_2	UT	Traffic	Basin
Austria	Linz	2003	PM10	UT, UI,SI	Industry	Hilly terrain
Austria	Salzburg and Hallein	2003	PM10, NO_2	UT, RT	Traffic	Valley
Austria	Vienna	2003	PM10, NO_2	UT	Traffic	Hilly terrain
Belgium	Antwerpen	2003	PM10, SO_2	UI, SI	Industry	Flatland
Belgium	Brussels	2001	PM10, NO_2	UT, UI	Traffic	Flatland
Denmark	Copenhagen	2003	NO_2	UT	Traffic	Flatland
France	Paris	2003	PM10, NO_2	T	Traffic	Flatland
France	Marseille area	2003	NO_2, SO_2	T, I	Traffic, Industry	Coast
Germany	Munich	2003	PM10, NO_2	UT	Traffic	Flatland
Germany	Duisburg	2003	PM10	UI	Industry	Flatland
Germany	Berlin	2003	PM10, NO_2	UT	Traffic	Flatland
Germany	Rhein-Main area	2002	PM10, NO_2	UT	Traffic	Flatland
Germany	Hannover	2003	PM10, NO_2	UT, UB	Traffic	Flatland
Germany	Stuttgart	2002-04	NO_2 (PM10)	UT	Traffic	Hilly terrain
Italy	Bozen	2003	PM10	UT	Traffic	Valley
Italy	Genova	2002	PM10, NO_2	UT	Traffic	Coast
Italy	Roma	2002	PM10, NO_2	UT	Traffic	Flatland
Italy	Milan	2001	PM10, NO_2	UT	Traffic	Flatland
Netherlands	Amsterdam and other cities	2002	PM10, NO_2	UT	Traffic	Flatland
Slovakia	Bratislava	2003	PM10, NO_2	n.a.	n.a.	Flatland
Slovakia	Košice	2003	PM10, NO_2	n.a.	n.a.	Hilly terrain
Spain	Madrid	2002	NO_2	UT	Traffic	Flatland
Spain	Burgos	2003	PM10	UT	Traffic	Flatland
Spain	Barcelona	2003	PM10, NO_2	SI	Industry	Hilly terrain
Sweden	Stockholm	2004	PM10	ST	Traffic	Flatland
UK	London	2003	PM10, NO_2	UT	Traffic	Flatland
UK	Nottingham	2002	NO_2	UT	Traffic	Flatland

As described in chapter 4.2, no P&P were available for some countries that might be of interest due to their rather high levels of air pollution (like e.g. Greece or new Member States. Of the latter, only Slovakia submitted P&P on a voluntary basis).

Finally, 18 out of the 28 cities and regions listed in Table 11 were considered for the in-depth analysis. These are shown in Table 12 and Figure 19. The table shows the names of the administrative regions and the main cities. For the purpose of simplicity, the regions are referred to by the city names in the present report. Where available, English city names are used.

[17] U: urban, T: traffic, I: industrial, B: background, S: suburban, R: rural.

Figure 20 shows the climate zones in Europe. Save the continental climate, all other climate zones are covered by the selected cities and regions.

Table 12: Cities considered in the in-depth analysis. For the Netherlands, the national plan (and therefore none of the major cities) was analysed.

Member State	**Name of the administrative unit**	**Main city**	**Name used in this report**
Austria	Bundesland Steiermark (Province of Styria)	Graz	Graz
Austria	Stadt Wien (City of Vienna)	Wien (Vienna)	Vienna
Belgium	Région de Bruxelles-Capitale Brussels Hoofdstedelijk Gewest (Region of Brussels-Capital)	Bruxelles Brussel (Brussels)	Brussels
Denmark	Københavns commune (City of Copenhagen)	København (Copenhagen)	Copenhagen
France	Région d'Ile-de-France (Region of Ile-de-France)	Paris	Paris
France	Département de Bouches-du-Rhône (Province of Bouches-du-Rhône)	Marseille	Marseille
Germany	Stadt München[18] (City of Munich)	München (Munich)	Munich
Germany	Stadt Berlin[19] (City of Berlin)	Berlin	Berlin
Germany	Stadt Stuttgart (City of Stuttgart)	Stuttgart	Stuttgart
Italy	Provinz Bozen – Südtirol Provincia autonoma di Bolzano - Alto Adige (Province of Bozen - South Tyrol)	Bozen Bolzano	Bozen
Italy	Regione Lombardia (Region of Lombardy)	Milano (Milan)	Milan
Netherlands	Koninkrijk der Nederlanden (Kingdom of the Netherlands)	---	The Netherlands
Slovakia	Bratislava (City of Bratislava)	Bratislava	Bratislava
Slovakia	Košice (City of Košice)	Košice	Košice
Spain	Ciudad de Madrid (City of Madrid)	Madrid	Madrid
Spain	Comunitat Autònoma de Catalunya Comunidad Autónoma de Cataluña (Autonomous community of Catalonia)	Barcelona	Barcelona
Sweden	Stockholms Län (County of Stockholm)	Stockholm	Stockholm
UK	City of London	London	London

[18] The air quality plan of the city of Munich was ranked seventh out of the 25 P&P analysed (BUND 2006).

[19] Berlin was ranked second in the BUND assessment (BUND 2006).

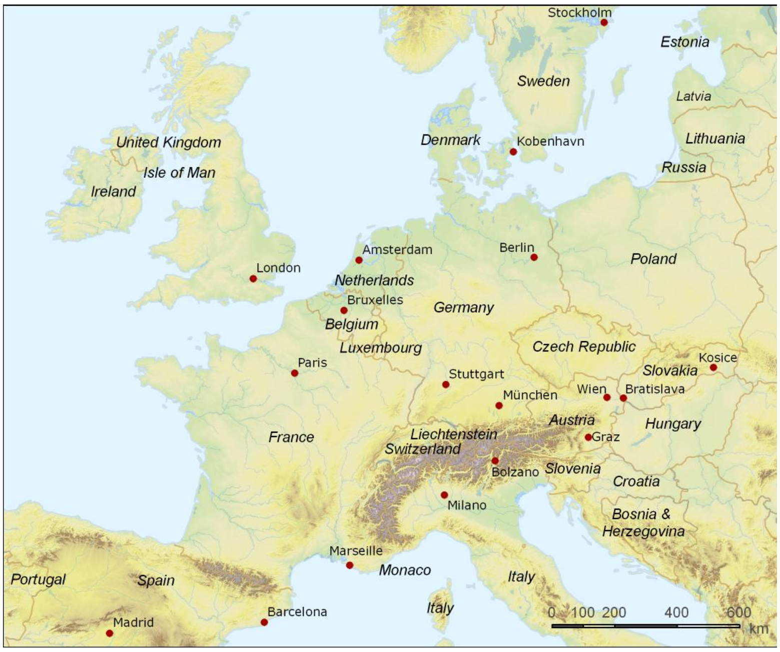

Figure 19: Cities chosen for the in-depth analysis.

Figure 20: Climate zones in Europe and cities chosen for the analysis (generic climate classification after NEEF, see e.g. http://www.m-forkel.de/klima/flohn.html).

As the P&P did not contain all the necessary information for an in-depth analysis, a questionnaire was prepared for each of these cities. These lists were discussed with the responsible authorities via telephone or answered in writing. Table 13 shows those P&P where interviews were conducted and for which P&P written responses were obtained. In three cases (Paris, Milan, London), no responses to the questionnaire were obtained from authorities by the time of finalising this report, but the P&P were still included in the analysis, because extensive documentation was available.

In three cases (Graz, Vienna, Bozen – South Tyrol), no reports on P&P had been submitted to the Commission by the time of the present study, but such reports were made available to the authors. In addition extensive P&P were available for these cities and therefore included in the analysis. For Bratislava and Košice, no standardized report, but the P&P themselves had been submitted to the Commission. For Copenhagen, Stockholm and Barcelona, the P&P were not available as separate documents. In these cases, the information was obtained from the official reports and interviews/questionnaires.

Table 13: Overview of plans and programmes used for in-depth analysis: Plans which were available as official reports (standardised forms) and as separate documents. It is also indicated for which plans interviews were conducted with authors or persons responsible for implementation, and where written responses were obtained. (X): No official form, but the plans and programmes themselves were submitted.

Member State	City / region	Official report available	Plan available as separate document	Interview	Written response
Austria	Graz	X	X	X	
Austria	Vienna	X	X		X
Belgium	Brussels	X	X	X	
Denmark	Copenhagen	X		X	
France	Paris	X	X		
France	Marseille	X	X		X
Germany	Munich	X	X		X
Germany	Berlin	X	X	X	
Germany	Stuttgart	X	X	X	
Italy	Bozen - South Tyrol		X	X	
Italy	Milan	X	X		
Netherlands	National plan	X	X	X	
Sweden	Stockholm	X			X
Slovakia	Bratislava	(X)	X	X	
Slovakia	Košice	(X)	X	X	
Spain	Madrid	X	X		X
Spain	Barcelona	X			X
UK	London	X	X		

Table 14 gives an overview of PM10 and NO_2 levels within these cities. As not all the necessary information was available from the P&P (e.g. if only NO_2 levels are exceeded no PM10 levels are given in the P&P) also results from AirBase[20] and an internet search are presented. If results from various stations are available a range of concentrations (or number of exceedances) is given. The highest PM10 levels are found at a monitoring site close to Košice and in Milan, the highest NO_2 levels in Stuttgart, Paris and London.

Table 14: PM10 and NO_2 levels of the cities chosen for the in-depth analysis.

MS	**City**	**Year**	**PM10 levels**		**NO_2 levels**	**source**
			annual mean (µg/m³)	**No. of days above 50 µg/m³**	**annual mean (µg/m³)**	
Austria	Graz	2005	33-47	56-127	28-53	annual report[21]
Austria	Vienna	2005	24-40	25-78	13-73	annual report
Belgium	Brussels	1981-2005	23-57	5-164	26-93	report[22]
Denmark	Copenhagen	2003	24-33	21-40	59	P&P, Airbase
France[23]	Paris	2003	46	75	up to 103	P&P, Airbase
France[23]	Marseille	2001-2005	25-36[23]	7-44[23]	26-83	report[24]
Germany	Munich	2003	46	69-123	68-75	P&P
Germany	Berlin	2003	47	80-117	56-61	P&P
Germany	Stuttgart	2002-04	34-51	42-160	80-109	P&P
Italy	Bozen	2003	31-45	75-85	48	P&P
Italy	Milan	2003	42-65	94-173	53-76	Airbase
Netherlands	Amsterdam and other cities	2002	45-62	35-199	56-68	P&P
Slovakia	Bratislava	2003	32-49	45-134	40-54	P&P
Slovakia	Košice	2003	41-82	98-247	17-24	P&P, Airbase
Spain	Madrid	2002, 2004	28-40	38-73	58-73	P&P, Airbase
Spain	Barcelona	2002	46-58	74-88	37-69	P&P, Airbase
Sweden	Stockholm	2004	41	80	17-51	P&P, Airbase
UK	London	2003	38-58	65-210	55-109	P&P

The following chapters describe the results of analyses of the P&P, the transport plans as well as other plans and the results of the interviews with the authorities.

However, it has to be noted that the selected cities cannot be regarded as wholly representative of all P&P submitted by MS, as the main focus lies on larger cities and on traffic related measures.

A description of the city and region, as well as of the meteorology, climate, air quality and a summary of the P&P of each city can be found in the Appendix.

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[20] http://air-climate.eionet.europa.eu/databases/airbase/airview/index_html

[21] UMWELTBUNDESAMT 2006a

[22] IBGE2006 (http://www.ibgebim.be/francais/contenu/content.asp?ref=1888)

[23] Correction factor of "1" for PM10 is used for all monitoring sites in France.

[24] http://www.airmaraix.com/site_pro/

5.2 Planning, implementation and evaluation

Of the questions to be answered by the in-depth analysis, several are related to planning, implementation and evaluation of plans and programmes.

The questions to be answered are:

- Which parts of the planning process have been effective and which need improvement?
- Are there indicators to assess the progress?
- Are there feedback mechanisms and mechanisms to disseminate good practice examples within a MS and between MS?

Information on these topics was obtained from telephone interviews with the responsible authorities and from written responses to questionnaires. The aim was not to obtain a detailed description of how the planning process proceeds within each authority but to identify factors that support or hamper the process.

5.2.1 Effectiveness of the planning process

In most cases, planning was coordinated by the regional environmental or air quality authority. In Denmark, the Netherlands and Slovakia, planning was coordinated by national institutions.

Most respondents pointed out the importance of including various stakeholders early on in the planning process. Besides experts from other administrative units like urban and transport planning, research institutes, environmental organisations, industry representatives, and experts from neighbouring regions were included.

During the planning process, it was found that detailed information on emission sources is crucial. The importance of using common models and facilitating the exchange of experience was pointed out as well.

It was also pointed out that planning was made difficult because the responsibilities of the regional authorities to introduce effective measures are limited. For example, industrial emission standards are mostly a national responsibility.

Improvements of the planning process on European but also on local and national scale were discussed in detail at the stakeholder workshop held on the 9th October in Brussels. The results of this workshop were included in this study, especially in chapters 6 and 7. In the questionnaire and the interviews the respondents were asked for input to identify in advance key aspects in the planning process that should be improved. The major problems raised included:

- Lack of data and studies to quantify the effectiveness of measures
- Slow progress of planning due to the fact that various administrations are responsible, and conflicts of interest.
- Lack of political support for specific measures

To improve the planning process, respondents pointed out the following ideas:

- EU-wide information on successful measures and best practice examples should be provided.
- This information should be given via a website together with guidelines, information about P&P according to Commission Decision 2004/224/EC and the respective P&P of the MS.
- As during the last few years experience has been gained on the strengths and weaknesses of P&P, improvements for the reporting requirements are suggested.
- The legal framework within a MS usually assigns different competencies for different measures, which often might impede the implementation of measures. However, this problem has to be solved by each MS individually.
- Funding has to be assured for both planning and implementing measures.

5.2.2 Evaluation of effectiveness

Although many measures are still in the process of implementation, several evaluation programmes have been laid out within the P&P. Evaluation programmes are available for the Stockholm Congestion Charge (STOCKHOLMSFÖRSÖKET 2000, 2006a, 2006b), Graz (STMK LANDESREGIERUNG 2006), London (Mayor's Air Quality Strategy as well as for the congestion charge, GREATER LONDON AUTHORITY 2006a, 2006b; TFL 2006), and the German P&P (IVU 2006). For example, the evaluation report for Graz lists the current state and completeness of the measures and updates on reduction potential and costs of each measure.

For evaluation, indicators are foreseen. The indicator which is mentioned most often are measured concentrations[25], see also chapter 4.5.3 and Figure 17. Traffic count was mentioned in two cases. Two other indicators, which are planned for evaluation of the Brussels P&P are the ecological footprint and a pollution index, which is an aggregated number based on several measured air pollutant concentrations. Measured concentrations can be a suitable indicator for the effect of short-term measures like traffic restrictions during episodes (see also section 5.6.3). In the province of Bozen-Südtirol in the winter of 2005/2006, restrictions came into force after several days of high PM10 concentrations which reduced traffic by around 40 %. During such episodes, PM concentrations were reduced by up to 34 % following the traffic restrictions. However, the effect of less extensive measures may be hard to quantify using measured concentrations only.

In Berlin the number of people exposed to elevated pollution levels is used as an indicator. It is calculated on the basis of the results of the street canyon modelling and a database of the inhabitants along the main road network.

In Stuttgart a traffic census was done in May 2006, especially to check changes of the number of lorries. The implementation of the measures is also checked on a regular basis.

Furthermore a report covering all of Germany has been published recently (IVU 2006); see also chapter 3.5.

Also in chapter 6 of the London Air Quality Strategy, monitoring of the progress of the Strategy is described. This includes an annual update of the emission inventory, but also ages of road vehicles, proportion of clean vehicles, level of infrastructure for refuelling of alternative technologies, numbers of combined heat and power schemes etc.

[25] even though the guidelines do recommend to use other indicators (WORKING GROUP ON IMPLEMENTATION 2003).

In other reported P&P (besides the ones selected for the in-depth analysis), most indicators were also related to measured concentrations. Other indicators mentioned are traffic-related, related to emission inventories, model results, estimates, and indicators related to the progress of measures.

For other examples, see also the ex-post evaluation of short-term and local measures in the CAFE context (AEA TECHNOLOGY ENVIRONMENT 2005).

A short progress report for London Air Quality Strategy was published in August 2005 (GREATER LONDON AUTHORITY 2006a, 2006b). Annual mean concentrations of PM10, NO_x and NO_2 seem to have declined between 1996 and 2004. The smallest changes have been observed for NO_2, which could be due to an increase in primary NO_2 emissions of diesel vehicles with after-treatment systems. Most of the measures that lie within responsibility of the Greater London Authority and are foreseen in the London Air Quality Strategy have already been undertaken or are underway. On London's transport strategy, an annual report is published.

The evaluation of plans and programmes for Graz (STMK LANDESREGIERUNG 2006) focused on the current implementation status of measures. Pending activities, PM10, PM2.5 and NO_x reduction potential, costs of investment and annual costs were updated for each measure. Table 15 gives an overview of the implementation status. One measure was cancelled because a detailed study showed that it was not effective.

Table 15: Implementation status of P&P for Graz, April 2006.

Topic	Total number of measures	Number of measures completed	Number of measures currently implemented	Number of measures not yet implemented	Number of measures cancelled
Traffic	25	2	17	6	
Industry and commerce	6		5	1	
Fugitive emissions	6	1	4		1
Agriculture	5	1	4		
Domestic heating	20	1	9	10	

Several respondents pointed out that in many cases, measures are seen as more effective if they are implemented at a national or even EU wide level. This applies for example to emission standards for vehicles or other standards set on a national or European level. It was suggested that the impact of local measures should not be overestimated and – on the other hand – timely and stringent abatement policies on the European level are essential.

5.3 Integration of transport plans and other P&P

5.3.1 Transport plans

Plans or programmes to reduce road transport emissions may (or should) combine technical measures (i.e. reducing specific vehicle emissions) and measures regarding transport plans, spatial planning, and urban development plans, aiming at a shift to environment-friendly transport modes. However, there may be difficulties in the assessment of the effects of such 'soft measures' on emissions and air quality. On the other hand, transport plans also have a number of effects on other environmental, economic and social issues.

Hence it was assessed

- if urban (spatial) planning and transport plans have been integrated in plans or programmes, including long-term development of urban spatial planning.
- if their impact to improve urban air quality has been assessed
- if other benefits - greenhouse gas emissions, economic aspects (e.g. health costs) of road traffic, traffic safety, etc. - have been taken into account.

Although the effect of traffic-related measures is strongly influenced by transport planning, transport plans were directly integrated into a few plans and programmes only. In many cases, measures were developed without adapting existing transport plans.

In the case of Vienna, however, the transport plan was adopted based on air quality issues. The responsible authorities stated that in Vienna, transport planning has a positive impact on air quality.

Similarly, in Berlin, air quality planning was part of the transport plan from the beginning, and the impact of the current plan on air quality is mostly seen in a positive light. Conflicts are expected in view of the construction of a bypass road, which on the one hand lowers the traffic flow in some areas, but may induce additional traffic and lead to air quality problems in other areas.

In Munich, measures listed in the transport plan form an important part of the plans and programmes. There is coordination between these two areas, and air quality issues are included in transport planning.

In several cities, transport planning was not integrated into plans and programmes because of differing responsibilities. Also, in several cities it was stated that air quality issues would play an important role in new versions of transport plans which are currently under development.

Similar to transport planning, urban development is closely linked to air quality. In some cities (Vienna, Berlin) there is cooperation between air quality and urban planning units on plans and programmes. In both Brussels and London, air quality planning and urban development planning are part of one overall strategy.

A close relationship between air quality and urban planning exists in the Netherlands. In the Dutch implementation of the air quality directives, there are tight restrictions on infrastructure projects in cases where limit values are exceeded, which were enforced by several court orders recently (MNP 2005; BACKES, VAN NIEUWERBURGH & KOELEMEIJER 2005).

It was pointed out by some respondents that air quality and urban planning objectives are sometimes contradictory, e.g. areas with high pollutant levels are still marked as industrial development areas in urban development plans.

The second and third points listed at the beginning of this section specifically concern transport plans, rather than air quality plans and programmes. Therefore, they were addressed by the respective agencies as part of their transport plan analyses.

Transport plans were available from the following cities and regions:

- Graz: City transport plan (LANDESHAUPTSTADT GRAZ 1992)
- Vienna: City transport plan (MA 18 2003)
- Berlin: Transport plan as part of the urban development plan (SENATSVERWALTUNG FÜR STADTENTWICKLUNG 2003)
- Munich: Transport plan as part of the urban development plan (LANDESHAUPTSTADT MÜNCHEN 2004)
- Paris: Transport plan of the region of Ile-de-France (PRÉFECTURE DE PARIS 2000)
- Bozen: Transport plan of the province of Bozen - Südtirol (AUTONOME PROVINZ BOZEN-SÜDTIROL 2001)
- Stockholm: Transport plan as part of the urban development plan for the Stockholm area (STOCKHOLM 2003)
- London: City transport strategy (MAYOR OF LONDON 2001)

In the following, an overview of the transport plans is given, which focuses on those points which are interesting from an air quality planning perspective. More information on each transport plan (responsible authorities, list of main measures, internet links etc.) can be found in the Appendix.

Status of transport plans: Several of the transport plans available were part of a larger urban development plan. This is an indication that in practice, urban and transport planning are often linked. On the other hand, transport plans for regions such as Bozen – South Tyrol have fewer links to urban planning. Most transport plans have the status of a position paper or strategy; the transport plan for Stockholm has the status of a law.

Motivation: The motivation/main reason for the development of the transport plans available is either a government decision, or the transport plan is the successor of a previous transport plan which is updated regularly. The transport plan for Paris, although it does not have the status of a law, follows a legal requirement: In France, transport plans are required by law in all agglomerations with more than 100,000 inhabitants.

Time horizon: This point is important in the context of the present study because the time horizons of transport plans in some cases strongly diverge from the time horizons of air quality planning: All available transport plans except one have a time horizon of at least ten years; the transport plan for Stockholm includes a scenario with a time horizon of 2030. The transport plan for Paris follows a shorter-term approach. It covers a five-year period with evaluation after 2.5 and 5 years.

Planning area: As can be seen from the list shown above, most transport plans cover cities, whereas three of the transport plans available cover regions. For the present study it is important to note that the transport plans discussed here cover the same areas as the corresponding air quality plans. Graz is an exception: The available transport plan focuses on the city of Graz, whereas the air quality plan covers the province of Styria. However, a transport plan for the province is being developed at present, and transport planners of both the city and the province played an important role in developing the air quality plan. Therefore, one can assume that the planning areas of the available transport plans generally match those of the air quality plans.

It is also important to note that all city transport plans include connections to the surrounding regions (planning of traffic to and from these regions).

Main strategy: This point is important in the context of the present study: In several transport plans, air quality issues are part of the main strategy. For example, the strategy of the Berlin transport plan covers four dimensions, one of which is the ecological dimension. The strategy of the Graz transport plan is based on principles like balanced modal split, socially and environmentally sensitive traffic. However, the link to environmental issues is rather vague in the strategies of some transport plans, and one transport plan includes no environmental issues in its strategy.

Main objectives: Similar to the general strategy, the specific objectives of the available transport plans are often related to air quality. In several transport plans, concrete objectives are laid down concerning the share of motorised individual traffic versus public/pedestrian/bike traffic. The transport plans for Berlin and Bozen – South Tyrol contain concrete objectives to reduce air pollution caused by traffic. A summary of additional objectives, which are not related to air pollution, can be found in the Appendix.

Main measures: Concerning the types of measures, there are no large differences between the transport plans. In the following, the main types are listed (a description of the measures of each transport plan can be found in the Appendix).

- Improvement of public transport;
- Speed restrictions;
- Parking management;
- Reduction of lorry traffic through rail or improved logistics;
- Public information;
- Construction of new roads, improvement of roads.

It is interesting to note that of the main measures listed in the transport plans, all except the last one are in general compatible with air quality objectives as new roads often lead to an increase in traffic. Road construction measures play an important role in one of the available transport plans, whereas in the other plans, the focus is on air-quality compatible measures.

Impact analysis: An impact analysis of the measures was provided for two transport plans (Berlin, Munich). In these plans, the impact of several scenarios on traffic volume, noise and air quality (in one plan only) were calculated using traffic models. In the other transport plans, estimates only, or no impact analyses at all were provided.

An impact analysis of transport plans is of high relevance for air quality planning. Without impact analysis, it is hard to see if there are conflicts between transport plans and air quality plans. This is especially critical because of the long-term time horizon of transport planning. On the other hand, wider conflicts between transport planning and air quality planning are usually relatively easy to assess.

Indicators of success: Three of the transport plans available contain a list of indicators to quantify the success of measures. The London Transport Strategy contains a comprehensive list of indicators (Table 16). For each of the indicators, targets were defined, against which progress can be measured. An annual progress report is foreseen in London as well.

*Table 16: Indicators for monitoring progress in delivering the London Transport Strategy (*M*AYOR OF* L*ONDON 2004).*

figure 5.3 Proposed headline indicators framework for monitoring progress in delivering the Transport Strategy

	Headline Strategy Indicators						
STRATEGY PRIORITIES (see paragraph 4A.6)	Mode shares (passenger and freight) and usage surveys	Reliability / average and long waits surveys	Journey times across modes surveys	Satisfaction surveys (for users, non-users and businesses)	Safety and security – accidents by mode, and levels of crime	Volumes of TfL and National Rail services provided	Milestones for project delivery*
(a) Reduce traffic congestion			✓	✓			✓
(b) Underground service quality		✓		✓		✓	
(c) Bus service quality		✓		✓		✓	
(d) National Rail capacity and integration		✓		✓		✓	✓
(e) Expanding transport system through major projects						✓	✓
(f) Improving journey time for car users which will particularly benefit outer London	✓						
(g) Local transport initiatives (particularly boroughs)	✓						✓
(h) Improving distribution of goods and services	✓		✓	✓			
(i) Accessibility	✓			✓			
(j) Integration				✓			✓
Safety and Security across all means of transport					✓		
Customer satisfaction				✓			

✓ = primary indicator for tracking progress on Strategy priority.

* Milestones will generally be determined through development of the TfL Business Plan, London Rail Plan and borough Local Implementation Plans.

Customer satisfaction and safety and security are implicit across the Strategy priorities but are highlighted separately here as particularly important for monitoring.

Similarly, the transport plans for Vienna and Berlin contain indicators and target values to be met at certain dates: In Vienna, target values for mode shares (motorised individual traffic – bicycle – public transport), traffic volume (vehicle-kilometres), safety (number of injuries and fatalities), air pollution (NO_2 air quality standard, CO_2 emissions), and noise complaints were defined for 2020. In Berlin, similar indicators and target values were defined for energy consumption, traffic volume, mode share and air pollution, with a time horizon between 2015 and 2025.

Monitoring: Besides the indicators and targets described above, a well-defined schedule is critical for success monitoring. In three transport plans, a monitoring plan is laid out, with intervals of 2.5 to 5 years. However, in most of the available transport plans, monitoring is not addressed or not described in detail.

5.3.2 Plans under the NEC Dir. and under the GHG monitoring mechanism

The **NEC Directive** (NECD, 2001/81/EC) requires Member States to develop national programmes for the progressive reduction of the pollutants covered by this Directive: SO_2, NO_x, NMVOC and NH_3 (see also chapter 2.5.1).

The reporting requirements for their national programmes, emission inventories and projections are set down in articles 6, 7 and 8 in a very general way. No specific format is required; the reports have to provide only "…*information on adopted and envisaged policies and measures and quantified estimates of the effect of these policies and measures on emissions of the pollutants in 2010*".

These reports had to be sent to the EC not later than 31.12.2002. Updates of these reports have to be established by 1 October 2006 and have to be forwarded to the EC by the end of 2006. New Member States must submit national programmes by 1st of October 2006.

For **GHG,** Member States have a series of reporting requirements set down in Decision No 280/2004/EC concerning a mechanism for monitoring Community greenhouse gas emissions (GHG) and for implementing the Kyoto Protocol. Article 3 Paragraph 2 requires MS to produce, implement and periodically update national programmes for limiting and/or reducing their anthropogenic emissions by sources and enhancing removals by sinks of all GHG not controlled by the Montreal Protocol. Both include specific requirements for the reporting of all policies and measures, emissions projections and the assumptions and methodologies used. Information to be delivered comprises description of measures, status of implementation of these measures, indicators to monitor and evaluate the progress, quantification of the effects of the policies and measures. Parties to the United Nations Framework Convention on Climate Change (UNFCCC) are required to submit national communications (in depth national programmes detailing actions to reduce emissions of greenhouse gases) approximately every 3-5 years. Annex I countries (including all of EU-15) submitted their third national communications between 2001 and 2003 and the fourth national communications are due in 2006.

As for both GHGs and NECs no direct link to P&P under the AQ FWD is required, it depends on the MS and on their organisational setup whether and how P&P are considered in the NEC plans or the GHG monitoring mechanism (GHG MM). Most plans for NECs and GHGs do not take into account measures implemented under the AQ FWD regime. There are most probably two reasons for this: On the one hand only very few countries suffer from nationwide AQ problems (this might be the case for either rather small countries or countries with a uniform topography), on the other hand for AQ related problems, in many MS local authorities are responsible whereas for NECs and GHGs the national government usually draws up plans.

However, at least for the Netherlands the NEC programme also describes the obligations to meet AQ LV especially for PM10 and NO_2 as well as measures to reduce emissions of these two pollutants (VROM 2003). Also the NEC programme for Belgium cites the Brussels AQ and climate plan.

For the review of the NECD a check for consistency between AQ P&P and plans for the NECD has been performed (ENTEC 2005). However, at the time the review was done, only P&P from Belgium (all three regions), Denmark, Spain, Sweden and UK were available. For Brussels and the Flanders region the AQ P&P are entirely consistent with the NEC plans, also for Sweden most measures and policies under the AQ P&P are part of the NEC plan. In the UK's plan the European policies have also been reported under the NEC plan. The Spain AQ plan for SO_2 includes measures for a power plant that are not part of the NEC plan.

The **P&P** under the **AQ FWD** on the other hand do consider in some cities and regions either the programmes under the NECD, the GHG MM or both. These are Vienna, Brussels, Munich, Madrid, Bozen, Milan, the Netherlands and London. In addition the NECD is often mentioned as a reason for a future decrease in background concentrations. In Brussels an integrated approach that covers air pollution, NECs and GHGs has been applied. However, a quantification of the impacts of climate policy or NEC measures is not given in the P&P. Mostly synergies between the measures are mentioned in a general way.

As a major **conflict** between plans to reduce **GHGs** and **AQ P&P,** the promotion of biomass burning was identified. E.g. Berlin tries to tackle this problem by requiring wood stoves to comply with certain emission limit values, and in Stuttgart wood burning will be banned completely. Furthermore, in Stuttgart the burning of garden waste will be banned. Additional minor conflicts were identified in Brussels: Improvements in insulations might lead to increased indoor air pollution; tunnel ventilation increases energy consumption.

In Bozen – South Tyrol, there are initiatives to promote biomass burning to reduce the emissions of GHG. However, because domestic heating is a major source of winter PM pollution, restrictions will be in effect from the winter 2006/07 onwards, see also chapter 5.6.7. This was also seen as a conflict which will be difficult to communicate.

5.4 Modelling for assessing air quality in P&P

In several P&P, air quality modelling played an important role. On the one hand, models were used to predict the effects of various measures and therefore to help select the right measures and gain support for them (e.g. Stuttgart). On the other hand, complete scenarios (combinations of measures) were compared and evaluated using air quality modelling (e.g. Copenhagen, Brussels).

5.4.1 Modelling approaches

The models range from sophisticated atmospheric transport models to simpler, standardized approaches. In several cases, models were combined (e.g. urban scale plus street canyon scale). Therefore, the model resolution ranges from metres to tens of kilometres, depending on the application.

- For Berlin, several types of models were used, with different spatial scales (aerosol and chemical transport model REM/CALGRID, Gaussian model IMMISnet, CPB street canyon model).
- In the case of Stuttgart, the Gaussian model PROKAS with modifications for street traffic and for building effects was used.
- In Munich the model IMMIS^{luft} was used for screening the concentrations of PM10 and NO_2 close to roads.
- For Copenhagen, the OSPM street pollution model and UBM urban background model were applied.
- The BRUXELLES Air model consists of traffic emission calculations, an “econometric type of model”, and a third module to assess the damage in physical and financial terms by means of appropriate exposure, response and damage functions.
- For Marseille, the model STREET (developed by TÜV Ecoplan Umwelt GmbH) was used. In addition, the EMME/2 traffic planning model system was applied, which does not take dispersion into account.
- For the Paris air quality plan, the NO_2 prediction was based on maps deduced from air quality data and a linear evolution according to emission scenarios for 2010. For ozone, the atmospheric chemistry and transport model CHIMÈRE was used.
- In the Netherlands, large scale background concentrations are calculated with the Dutch OPS model, which combines deterministic modelling (including impact from other countries) with calibration on the measurement data from the national monitoring network. This results in national concentration maps with background concentrations on a 1x1 km grid

scale. These maps are made available to the local authorities together with a simplified street model to calculate the local concentration contributions from traffic (CAR model). In this model also a scenario is incorporated to analyse future developments. Every year a new set of background concentration maps, emission factors and a future scenario is distributed.

- For Stockholm, the geographical information system tool AIRVIRO was used, which includes various dispersion models, e.g. Gaussian models as well as a street canyon model and the US EPA AERMOD model.
- The London air quality strategy makes use of the Gaussian dispersion model ADMS with varying resolution.

The model calculations were carried out by research institutes in most cases (Berlin, Copenhagen, Brussels, Marseille and London). For Stockholm modelling was performed by air quality experts at the Environment and Health Administration of the City of Stockholm. For Stuttgart, modelling was done by a private consultant.

All models used in the P&P studied here focus on traffic as main emission source. However, for background concentrations, additional emission data was used (EMEP data for the model calculations for Berlin).

In all studies, PM10 and NO_2 concentrations were modelled. Additional pollutants were ozone (Brussels, London), hydrocarbons (Marseille, Madrid) and soot (Stuttgart, Munich).

For modelling of traffic-induced pollution in cities, the effects of building and orography are of special importance. In the calculations for Berlin, Stuttgart, Copenhagen and Stockholm, and partly in the case of Brussels, these effects were considered accordingly.

In all applications, uncertainties were addressed in detail, although in some cases they were not included in the documentation available.

Finally, validation of the models constitutes an important point. All models had been applied and validated before in similar contexts.

5.4.2 Integrated assessment modelling

Within an Integrated Assessment Modelling (IAM) exercise emission, emission reduction strategies and their costs are linked to ambient air quality modelling. By doing this the effectiveness of various abatement strategies can be quantified and ranked according to their costs and air quality improvements. On a European scale a widely used IAM tool is the RAINS model (Regional Air Pollution Information and Simulation[26]) that was developed at IIASA[27] in Laxenburg, Austria. Model runs supported the implementation of national emission ceilings fixed in the NECD and the Gothenburg protocol and developed under the Convention on Long Range Transboundary Air Pollution (Convention on LRTAP, http://www.unece.org/env/lrtap/). The results derived from the RAINS model will also be the basis of the revision of the NECD. Recently, a RAINS model on a national scale has been established in Italy and it is currently at the stage of implementation in the Netherlands.

On a regional and local scale IAM exercises are scarce. Within the cities examined for the in-depth analysis IAM was applied in London and partly also in the Netherlands only. In Brussels it will be part of an updated P&P. The results of the IAM for London are described in chapter

[26] http://www.iiasa.ac.at/web-apps/apd/RainsWeb/

[27] International Institute for Applied Systems Analysis, http://www.iiasa.ac.at/

5.5.2. In the Netherlands the various steps of IAM were performed, but no complete Integrated Assessment as such was done so far.

It is worth mentioning that on a national scale the RAINS model has recently been adapted for Italy, and it is currently implemented in the Netherlands. There are also plans to build up a national RAINS version in Sweden.

5.4.3 Applicability and limitations

For the present study, the most interesting questions related to modelling approaches deal with their applicability to other cases and limitations of the approaches used.

As far as applicability is concerned, one can distinguish between complex, specialised approaches (e.g. for Berlin), which cannot be applied to other questions without larger changes – and simpler, standardised tools (e.g. street canyon modelling in Stuttgart, Munich, Copenhagen) which have been applied in a similar way to other cities.

In general, the models showed the following main strengths:

- Various scales, background concentrations, orography and land use are explicitly considered (Berlin).
- Limited costs due to rather simple approaches (Stuttgart, Copenhagen, Brussels).

The main drawbacks and limitations were:

- Costs, complexity, high requirements in respect to model input (Berlin);
- Approach based on archive model runs, therefore extraordinary street and building formations might not be well represented in the model (minor drawback, Stuttgart);
- Restricted to traffic emissions (Copenhagen);
- Statistical relation cannot be transferred to other regions (Brussels).

To summarize, the main approaches discussed here have the following advantages and disadvantages when used in the area of air quality planning:

The model used for Berlin with its various scales offers the possibility to model not only the present state in Europe/Germany/Berlin but to simulate future scenarios according to emission changes on these different scales. Nevertheless it has to be considered that the model uncertainties still are relatively high and that the quality of the model results is highly dependent on the representativeness of the input data (especially emissions).

The approach used for Stuttgart is appropriate to model large parts of a city or a whole street network within appropriate computing time. However, complex wind fields with spatial variations, e.g. due to sea breeze or orographic modifications within the urban area are not considered in the model approach.

For Copenhagen, the model approach was used to study various traffic policy measures that are currently under discussion.

The study for Brussels aims at developing an aid to decision-making that takes into account the environmental costs/benefits associated with air quality initiatives.

5.5 Impacts and costs of measures

The main focus of the analysis is to assess the effectiveness of P&P regarding their impact on air quality and costs of the implemented or planned measures. Hence the most important questions discussed in this chapter include:

Effectiveness:

- Are the measures foreseen or already implemented sufficient to reduce the concentration of the air pollutants below the limit values by the attainment date?
- Which measures have proved to be most effective (in terms of air quality improvement and costs)? If the impact has not been quantified, why not?

Cost-effectiveness

- Are the any measures cost effective (in relation to other possible measures)?

Selection of measures

- Are there measures that might be cost effective but were not implemented for other reasons?
- What are the main obstacles and problems observed in implementing measures?

There are differences in the status of implementation of the measures listed in P&P. Therefore, also the following question was assessed:

- What is the legal status of the measures? Are they legally binding or only a kind of declaration of intent?

Answers to these questions were either derived from the P&P or additional information was obtained from the person in charge of preparing the P&P.

In addition to the main questions listed above, the following questions were addressed to support the analysis:

- Have the measures been undertaken due to exceedance of LV or would they have been undertaken in any event?

5.5.1 Sufficiency of measures to comply with the limit values

The impacts of measures were analysed with different degrees of sophistication within the selected P&P. Some cities provided a detailed analysis of specific measures (e.g. LEZ in London and Berlin, congestion charge in Stockholm, traffic measures in Stuttgart). In Brussels, the Netherlands, Berlin and also in London the impact of the measures was calculated. Scenarios with measures are compared to business as usual scenarios. Other cities estimated the emission reduction potential of the measures only (without estimating the impact on ambient air quality), whereas some quantified neither the emission reduction nor the impact on air quality of the measures. As a consequence, sound conclusions as to whether the measures are sufficient to comply with the limit values can be drawn only for those cities and regions that have done a detailed analysis. Strictly speaking, this refers to NO_2 only as the attainment date for the limit values of PM10 was already in 2005. Therefore for PM10 compliance can be checked from monitoring data of 2005.

Table 17 gives an overview of the estimated or measured compliance of the cities and regions of the in-depth analysis.

Table 17: Compliance with limit values at the attainment date for the cities chosen for the in-depth analysis (x: no exceedance).

MS	**City**	**Pollutant(s)**	**Station**	**Main source**	**Compliance at attainment date**	
					NO_2 (2010)	PM10 (2005)
Austria	Graz	PM10, NO_2	UT	Traffic	No	No
Austria	Vienna	PM10, NO_2	UT	Traffic	No	No
Belgium	Brussels	PM10, NO_2	UT, UI	Traffic	Yes	No
Denmark	Copenhagen	NO_2	UT	Traffic	No	x
France	Paris	PM10, NO_2	T	Traffic	No	No
France	Marseille	NO_2	T	Traffic, Industry	n.a.	No
Germany	Munich	PM10, NO_2	UT	Traffic	No	No
Germany	Berlin	PM10, NO_2	UT	Traffic	No	No
Germany	Stuttgart	NO_2 (PM10)	UT	Traffic	No	No
Italy	Milan	PM10, NO_2	n.a.	Traffic	n.a.	No
Italy	Bozen	PM10	UT	Traffic	x	No
Netherlands	Amsterdam and other cities	NO_2	UT	Traffic	No	No
Slovakia	Bratislava	PM10, NO_2	n.a.	n.a.	n.a.	No
Slovakia	Košice	PM10	n.a.	n.a.	x	No
Spain	Madrid	PM10, NO_2	UT	Traffic	Yes	No
Spain	Barcelona	PM10, NO_2	SI	Industry	No	n.a.
Sweden	Stockholm	PM10	ST	Traffic	x	No
UK	London	PM10, NO_2	UT	Traffic	No	No

Hence even though in some cities a considerable improvement of air quality due to applied or planned measures can be expected, the measures were sufficient in none of the cities to attain the PM10 limit values by 2005. In London modelling data suggested that PM10 limit values should not be breached except on London Marylebone Rd (CERC 2003, see also the Appendix). This is supported by measurement data for 2005, which showed levels above both the annual mean and the daily mean limit value for this site and several additional sites[28].

[28] http://www.londonair.org.uk.

Non-attainment observed in almost all cities and regions chosen for the in-depth analysis might have several reasons, including:

Timing

- Planning (and subsequently also implementation) of measures started too late. As it can be seen in chapter 4.5.3 and also deduced from the P&P submitted to the Commission, in some regions many measures (such as studies to investigate the reason for the exceedance, feasibility studies for measures, development of emission inventory, development of traffic strategy) mark the very beginning of the planning process rather than the implementation of actual measures.
- Some efficient measures require several years of planning, examples are the congestion charge in London and Stockholm as well as the LEZ in London and Berlin (see chapter 5.6.1 and 5.6.2). Also for improvements in public transport such as extension of lines sound planning and substantial funding is necessary, and this usually takes time.

Implementation problems

- The public and political acceptance of measures - particularly for traffic measures is sometimes limited. Hence some measures might not be undertaken that would be efficient but do not have public or political acceptance. However the London and Stockholm congestion charge experiences indicate that with the help of a well prepared information campaign and public consultations this hurdle might be overcome.
- High costs of measures in combination with limited funding. This seems to be the case especially for public transport improvements.
- Legal competencies for applying certain measures are divided among different administrative levels or authorities. For example, in the case of Brussels it is mentioned that measures concerning parking are regulated by every single commune within the region and are therefore more difficult to implement. Other difficulties mentioned are conflicts of interest with transport departments (Munich) and commuters coming from municipalities outside the range of influence of the city administration (Madrid).

Technical difficulties

- Difficult source apportionment in the case of PM10 and inaccurate emission inventories.
- Greater real world emissions compared to legislative limits (EURO standards) as well as increase in primary NO_2 emissions of diesel vehicles (due to a marked increase in the relative share of NO_2 in NO_x)[29]. This might lead to an underestimation of projected emission reductions and therefore to implementation of insufficient measures.
- There is also still uncertainty about the date and ambition level of new EURO standards (EURO 5 and 6 for cars; EURO VI for HDV). Unfortunately, the Commission proposal for EURO 5 came in late 2005, so this regulation will have practically no effect on the compliance with NO_2 limit values in 2010.

[29] On September 19th 2006 a workshop was held in Brussels on the impact of direct emissions of NO_2 from road vehicles on NO_2 concentrations. The presentations are available via a CIRCA-website: http://forum.europa.eu.int/Public/irc/env/cafe_baseline/library?l=/cafe_ambient_quality/workshop_vehicles&vm=detailed&sb=Title

Other reasons

- High regional background concentrations of PM10. In several cities and regions, background concentrations are quite considerable and the scope for local and even regional emission reductions is limited. Sources of pollution are sometimes located in other states, sometimes even in non EU Member States. In some regions the limit values are exceeded even at rural background sites. If there is considerable transboundary air pollution, the Member States concerned shall consult one another with a view to finding a solution (Directive 96/62/EC, Art 8). No information on such consultations was provided in the respective P&P although such consultations have taken place, for example, between Poland and Germany.
- High overall concentrations. In some cities and regions the limit values are exceeded to an extent that even very drastic measures would not result in pollution levels below the limit value (an analysis done for Stuttgart has shown that for some road sections PM10 levels due to traffic emissions would have to be reduced by more than 70%, see Appendix).
- Inter-annual variations. Absolute pollution concentrations are strongly influenced by meteorological conditions; this is particularly true for PM10 and ozone. In some cases, measures might be sufficient to ensure compliance in average years, but not in years with very unfavourable dispersion conditions.

5.5.2 Cost effectiveness of measures

In about two thirds of the P&P analysed, the costs of measures have been estimated. In the other P&P, no or only partial information was provided (see Table 18). However, the costs accounted for are in most cases only those costs that have to be covered by public authorities. Hence measures that have to be financed by public authorities appear to be more costly than measures where the costs have to be borne by consumers, companies or others. This is especially true for measures regarding public transport improvements. A meaningful comparison of cost-effectiveness of different measures should include all costs, calculated with similar assumptions. In addition, a comparison of cost effectiveness can be done on the basis of the emission reduction potential. However, a comparison which also includes the effect on ambient concentrations would be more meaningful.

Some of the assessments include not only estimations of the costs and effects, but also of the benefits of measures. The benefits are usually health benefits expected from reduced exposure to air pollution caused by emission reductions; after monetarisation of benefits, these can be compared to costs.

A cost benefit analysis (CBA[30]) was done for Madrid and London (or rather the UK) as well as for several measures such as the congestion charge in Stockholm or the LEZ in London (DEFRA 2006, STOCKHOLMSFÖRSÖKET 2006, see also chapter 5.6.2; AEA TECHNOLOGY ENVIRONMENT 2003, see also chapter 5.6.1). For London an IAM was done as well, see below (MEDIAVILLA-SAHAGÚN & APSIMON 2006).

In Milan each measure was coarsely assessed in terms of costs, difficulties in implementing and benefits. In several cities, a range of costs per tonnes of emission reduction was estimated for some measures, but no effect on ambient concentration was calculated.

[30] For the CBA done in the CAFE programme see: http://ec.europa.eu/environment/air/cafe/general/keydocs.htm

Table 18: Quantification of emission reductions, effects on ambient air quality, assessment of costs and benefits of the P&P chosen for the in-depth analysis ("++": for all measures; ."+" for some measures, "–" not assessed).

MS	City	Emission reduction quantified (e.g., in t/year)	Effect on ambient air quality quantified	Assessment of costs included	Assessment of benefits included
Austria	Graz	+	–	+	–
Austria	Vienna	+	–	+	–
Belgium	Brussels	+	–	–	–
Denmark	Copenhagen	+	+	–	–
France	Paris	–	–	–	–
France	Marseille	–	–	+	–
Germany	Munich	+	+	–	–
Germany	Berlin	+	+	–	–
Germany	Stuttgart	+	+	+	–
Italy	Milan	–	–	+	–
Italy	Bozen	–	–	–	–
Netherlands	Amsterdam and other cities	+	+	–	–
Slovakia	Bratislava	–	–	–	–
Slovakia	Košice	–	–	–	–
Spain	Madrid	+	–	+	+
Spain	Barcelona	–	–	–	–
Sweden	Stockholm	+	–	–	–
UK	London	+	+	+	+

The most comprehensive analysis of costs and benefits has been undertaken for the review of the UK air quality strategy (DEFRA 2006). Even though this analysis was not mentioned in the UK's P&P as the latter was published before the review, the results are described below as they are of importance for this study. In the review a CBA of 14 measures and three combined measures was undertaken (Table 19). In addition, for some measures two or three different versions have been analysed. The monetary assessment is based on the changes of the impact of air pollutants on human health. These benefits are compared to the costs associated with the implementation of each of the measures.

Table 19: Description of measures assessed within the review of UK's air quality strategy (source: DEFRA 2006).

Measure	Description
A (Euro low)	New Euro standard V/VI – Low intensity
B (Euro high)	New Euro standard V/VI – High intensity
C (Early Euro low)	Programme of incentives for early uptake of Euro V and VI standards
D (Phase out)	Programme of incentives to phase out the most polluting vehicles (e.g. pre-Euro). Two versions of the measure have been assessed
E (LEV)	Programme of incentives to increase advancement of low emission vehicles
F (Road pricing)	Impact of a national road pricing scheme on air quality
G (LEZ)	Low emissions zone in London and 7 largest urban areas. Three versions of the measure have been assessed
H (Retrofit)	Retrofit Diesel Particulate Filters on HDVs and captive fleets (buses and coaches). Three different versions have been assessed.
I (Domcom coal)	Domestic combustion: switch from coal to natural gas or oil
J (Domcom NO_x)	Domestic combustion: product standards for gas fired appliances, which require tighter NO_x emission standards.
K (LCP)	Large combustion plant measure. Two elements of this measure have been assessed separately.
L (SCP)	Small combustion plant measure
M (VOC)	Reducing national VOC emissions by 10%
N (Shipping)	Shipping Measure through IMO
O (Early Euro low + LEV)	Combined measure
P (Early Euro low + SCP)	Combined measure
Q (Early Euro low + LEV + SCP)	Combined measure

Figure 21 shows the results of the CBA calculations given as net present values[31]. The 6 % range of (health) benefits relates to a 6 % drop in the mortality rate per 10 µg/m³ PM2.5 reduction, which was stated to be a less likely value, whereas the lower range (green bars) relates to a 1 % reduction, which was stated by the authors as being more likely.

[31] Since benefits and costs of a measure usually occur over many years, the assessment of the effectiveness of a project involves calculating and comparing the present value of benefits and costs. The present value is the current value of benefits and costs to be received in the future. A discount rate is used to reduce future benefits and costs to their present time equivalent. Benefits and costs for each of the years would be discounted to their present values, and added up to get the net present value or the sum of discounted net benefits over time. If the net present value of a project is positive, the project is worthwhile in terms of economic effectiveness.

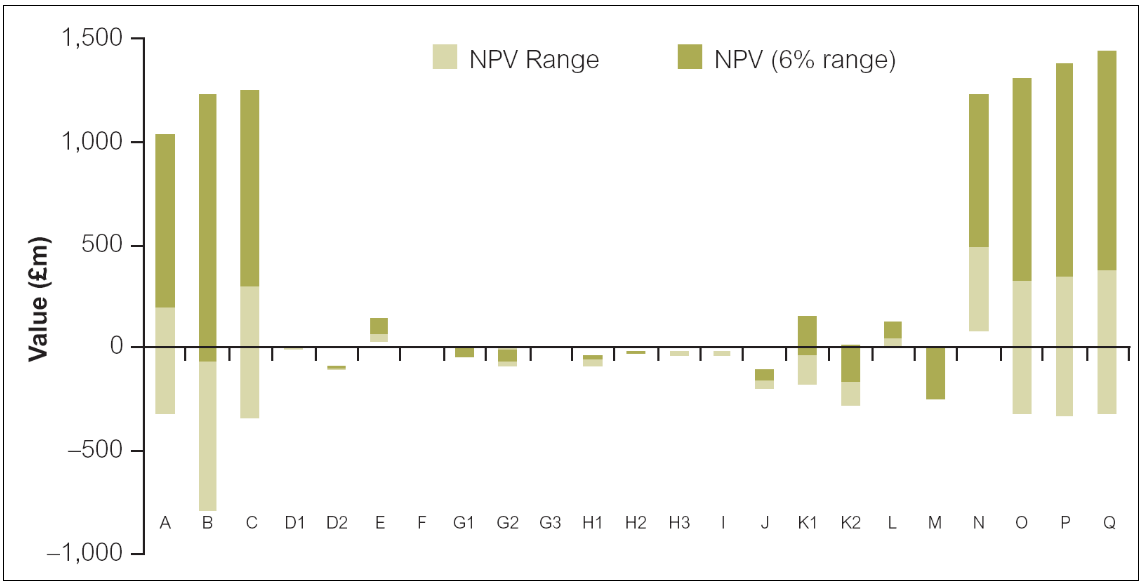

Figure 21: Net present values for measures assessed within the AQS review (source: DEFRA 2006)[32].

The measures most favourable in monetary cost benefit terms are:

- measure E (LEV; advancement of low emission vehicles),
- measure L (SCP; small combustion plants) and
- measure N (Shipping).

Some measures have negative net present values at the lower range of the impact estimates but positive net values at the higher end. These are:

- measure A (Euro low),
- measure B (Euro high), measure C (Early Euro low), measure K (LCP) and
- combined measures O, P, Q (combined measures),

where all except K might have a significant net present value at the upper end of the benefit range.

Measures D (Phase out), G (LEZ), H (Retrofit), I (Domcom coal), J (Domcom NO_x), and M (VOC) show negative annual net present values. However, the detailed analysis of the London LEZ clearly indicates a positive net benefit (AEA TECHNOLOGY ENVIRONMENT 2003). In addition, it was estimated that the London LEZ has implication for the whole of the UK as some 30 % of all lorries enter London each year and some 50 % of all coaches (DEFRA 2006).

Also for replacement of coal for domestic heating by natural gas or oil (measure I, Domcom coal), which showed a negative annual net present value for the whole of UK, locally the benefits might outweigh the costs. This was shown for the ban of bituminous coal in Dublin (AEA TECHNOLOGY ENVIRONMENT 2005).

[32] The NPVs for Measures D1 (phase out) and G3 (LEZ) are too small to be discernible at this scale. An NPV for Measure F (road pricing) has not been included as the present value of air quality benefits generated by this measure represents only a small fraction of the expected total annual NPV.

In addition to an UK wide CBA an IAM was done for London (MEDIAVILLA-SAHAGÚN & APSIMON 2006). 13 emission control strategies and 11 traffic management strategies as well as about 30 combined strategies have been modelled. For each of the measures and the scenarios annual implementation costs are provided. The strategies include:

- Various scenarios for different shares of buses and HDVs equipped with particle filters or fuel switches to CNG or LPG;
- Various LEZ scenarios;
- Different road user charges for central and inner London;
- Improvement in bus speeds and PT travel times in general;
- Scenarios for increased parking shares;
- Reduction in road capacity.

The optimisation was done under the premise that the PM10 limit value must be complied with by 2005. The strategies that resulted in achieving this goal for all three London zones (central, inner and outer London except one square covering a very busy road junction) were different scenarios of fuel switching, various LEZ schemes, public transport improvements, road user charges and increased parking shares in different combinations, with at least fuel switching included in the scenario for it to be effective.

The P&P for Madrid also contains a complete cost-benefit analysis (CIUDAD DE MADRID 2006). For each measure, the corresponding emission reduction was assessed and the effect of this emission reduction on air quality and exposure was estimated. This change in exposure was then related to an economic benefit using a transfer function. For the authority responsible for air quality planning, this cost-benefit analysis was also helpful to define the most effective actions to be taken, because the overall resources were limited.

Also those authorities that did not include cost effectiveness information in their P&P were asked to identify cost effective measures; they named the following (often based on expert judgement):

- infrastructure projects,
- regulations for energy efficient buildings,
- information campaigns,
- tax incentives for low-emission vehicles,
- retrofitting with diesel particle filters and
- traffic restrictions.

From the questionnaire and the P&P the following measures were named to be most efficient in terms of emission reductions regardless of cost considerations:

- tight emission limit values for industries,
- traffic restrictions dependent on EURO standard (in combination with retrofitting schemes, Bozen, Stuttgart, Milan[33]),
- congestion charge,
- LEZ,
- progressive scrapping of lorries with a rating < EURO 3,
- mobility management,
- enforcement of vehicle inspection,
- reduction of winter sanding,
- de-icing of roads with Calcium Magnesium Acetate[34] (CMA),
- enforcement of BAT application to industrial heating plants and power plants,
- more efficient manure management to reduce ammonia emissions,
- nationwide and Europe wide emission reduction of secondary PM precursors.

The difficulty to find reliable data on costs and benefits of measures also hampered the ex post evaluation of local and short term measures (AEA TECHNOLOGY ENVIRONMENT 2005, see also chapter 3.8 for a short summary). Within this study evidence was found that measures directed at emission improvements such as LEZ, motorway traffic flow management, fuel bans lead to bigger improvements and have larger benefits than broader transport or planning measures.

The ex ante and ex post cost effectiveness of environmental policies has been studied within the PANACEA[35] project (EEA 2005). Existing guidance documents of different countries are highlighted and proposals for a European guidance are given. On the PANACEA website good practice examples can be found in a database.

5.5.3 Legal status of measures

In most cases, the measures described in the plans and programmes are part of the regional legislation. In some cases, however, the measures are not yet part of binding legislation. Table 20 gives an overview of the legal status.

[33] In Milan the efficiency was judged concerning costs, difficulties in implementing and benefits. In the list given above only measures that were ranked highest are included.

[34] A substantial reduction of PM10 levels has been observed at roads in Stockholm and Klagenfurt during wintertime after application of CMA (NORMAN & JOHANSSON 2006, TU-GRAZ 2006).

[35] http://www.ecologic.de/projekte/3ea/panacea/index.php

Table 20: Legal status of the plans and programmes.

Austria	Graz	Ordinance of government of federal province of Styria. First ordinance from 2004. Draft of new ordinance circulated in 2006.
Austria	Vienna	Some measures are laid down in an ordinance, other measures that have not been implemented yet, are subject of an ongoing decision process.
Belgium	Brussels	The air quality plan is a government decision which defines the strategy, priorities and measures for the next ten years (although revisions will be made). It is binding for all administrative units of the region.
Denmark	Copenhagen	The measures are defined in national legislation (various statutory orders).
France	Paris	Air quality plans are required by national law for agglomerations with more than 250,000 inhabitants. The air quality plan of the region of Ile-de-France was approved by the préfet (governor) of the region and the préfets of the departments. The measures within the plan have the status of ordinances.
France	Marseille	The air quality plan was approved by the préfet (governor) of the region of Bouches-de-Rhône. The air quality plan has the status of an ordinance.
Germany	Munich	The air quality plan has been decided by the Bavarian State Ministry of the Environment, Public Health and Consumer Protection, hence it is binding for administration.
Germany	Berlin	Air quality plan has been decided by the senate of Berlin, hence it is legally binding.
Germany	Stuttgart	The AQ plan has been decided by the environmental ministry of the federal government, by the mayor of Stuttgart and by the president of the federal government. For some measures for traffic and facilities further ordinances are needed and have partly already been implemented.
Italy	Bozen	In the air quality ordinance, the air quality plan is defined as the main instrument for air quality improvement. The air quality plan was approved by the provincial government.
Italy	Milan	The “structural measures for air quality”, which were looked at in this study, are not the result of a statutory requirement, but a choice of additional measures.
Netherlands	National plan	The legal status for the AQ plan is very much related to the obligations in EU. For concrete measures, the instrumentation can take different forms, dependent on the character of a measure, e.g. guidelines for permits, legal regulations for subsidies or changes to the infrastructure.
Slovakia	Bratislava	n. a.
Slovakia	Košice	n. a.
Spain	Madrid	The plan was passed by a decree of the mayor.
Spain	Barcelona	Many regulatory actions are designed to prevent and correct atmospheric pollutions. However, as these actions are dispersed, work is ongoing to unite all these actions in one plan. As a first step a decree is currently worked out to declare the metropolitan area a Special Protection Zone.
Sweden	Stockholm	The air quality plan is based on a decision of the Swedish government and elaborated and implemented by the County Administrative Board.
UK	London	Producing a strategy is legally required, as is consulting on it (several rounds of consultation). The status of measures in the strategy is not set, nor is funding for the measures. The measures are not legally binding on the Mayor, but can be regarded as politically binding. The actions the Mayor requires of the 33 London local authorities have guidance status within the Mayor’s review of their work (which is legally allowed for).

As it can be derived from Table 20 most P&P have been decided by the local, regional or national government. Hence in principle they are legally binding for the respective authority and the measure should be implemented according to the schedule laid down within the different P&P.

5.5.4 Timeframe of the measures

The timeframe with which measures are implemented are obviously different for each measure. Figure 16 in chapter 4.5.3 shows that overall long term measures are prevailing as only 17 % are short term measures (less than a year); 15 % can be described as medium term measures (about a year) and 39 % are long term measures (analysis done for all reports on P&P). The timeframe of 29 % of the measures can be described as a combined one (short-, medium- and long-term measures).

Besides the time scale of the measure required within the report on P&P according to Commission Decision 2004/224/EC, the actual date of implementing each measure is crucial for compliance at the attainment date. This information was checked in the P&P selected for the in-depth analysis. In 7 of the 18 P&P, implementation dates were given for each measure. In the other P&P, a destinction between short, medium and long-term measures only was given. Several respondents pointed out that the actual dates of implementation depended on factors like the passing of additional ordinances by regional governments or allocation of funding. In such cases, the timetable of at least some measures was not available at the time the plans and programmes were established.

The timeframe of measures is an important point to be checked when P&P are evaluated. In the evaluation reports which were available for the present study (see chapter 5.2.2), timeframes for some measures were shifted and the reason for such shifts were explained.

5.5.5 Potentially effective measures that were not implemented

In an ideal world, one would expect that a variety of different measures are assessed and that the most cost effective ones (or those where benefits outweigh costs) are implemented. The measures described in the P&P and named in the questionnaires do obviously not contain all conceivable measures, often not even the most cost effective ones (as costs were often not assessed). In the interviews and questionnaires, the following reasons were mentioned why potentially cost effective measures were not (or could not be) taken:

- The local authority does not have the legal competence to implement a certain measure. Taxation (e.g. of fuels), road pricing and emission limit values for vehicles and industry are the most prominent examples.
- Limited funding. This seems to be the case especially for public transport improvements.
- The measure might place a disproportionate burden on specific groups within the public or companies. Examples are severe traffic restrictions (e.g. for vehicles with even or odd number plates).

As potentially efficient measures the following were named:

- LEZ and environmental zones;
- Substantial reduction of use of studded tyres;
- Rerouting of lorries;
- Stricter emission standards for lorries and passenger cars;
- Traffic restrictions for vehicles with even or odd number plates.

The latter has been evaluated in detail for Stuttgart (REGIERUNGSPRÄSIDIUM STUTTGART 2004). Figure 22 shows the result of a model calculation. The measure would apply on days with elevated PM levels and would address all vehicles with even or odd number plates which would be prohibited from circulating every other day within the city of Stuttgart. It was expected that this measure would result in a reduction of PM and NO_x emissions to about 60 % compared to days without restrictions. It was estimated that about 20 % of the trips would be shifted to vehicles permitted to circulate on the respective days. The number of exceedance days would be drastically reduced, even though at the monitoring site Neckartor the limit value would still be breached. The PM10 concentrations are predicted to be reduced to about 78 % at Neckartor and to 86-88 % at the other sites compared to the current situation.

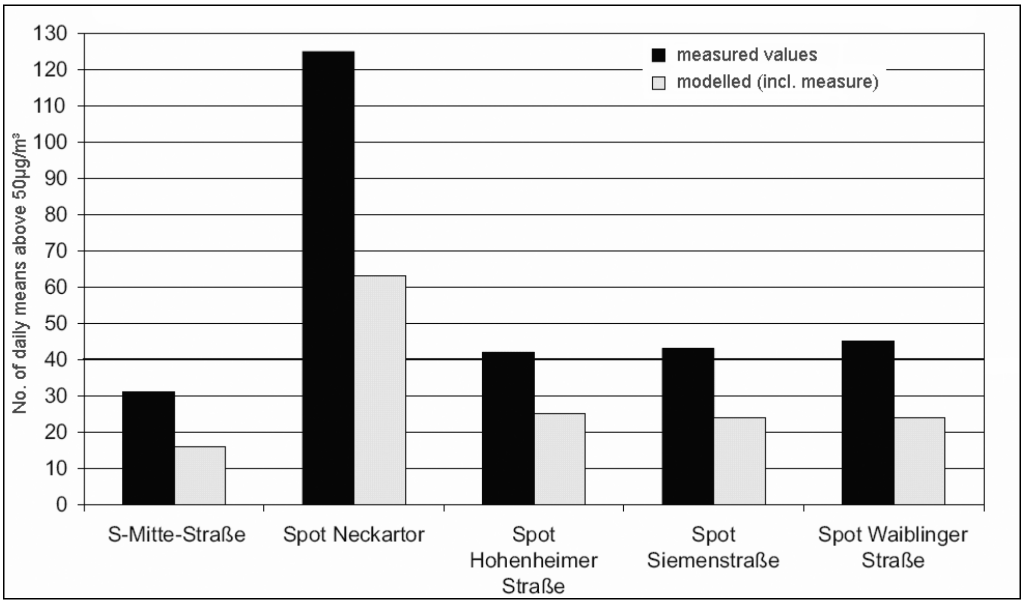

Figure 22: Number of daily means of PM10 above 50 µg/m³ measured at various sites in Stuttgart compared to modelled number of daily means above 50 µg/m³ in the case of traffic restrictions for vehicles with even or odd number plates (source: REGIERUNGSPRÄSIDIUM STUTTGART 2004).

However, as it was expected that this measure would place a disproportionate burden on people and business in Stuttgart it was not implemented.

5.5.6 Measures explicitly implemented to achieve EU air quality limit values

It can be expected that air quality planning started in most cities in Europe well before it became a requirement due to exceedance of EU air quality limit values. Furthermore for some measures, improvement of air quality is a by-product but not the main focus. Hence not all measures presented in the P&P are driven by air quality considerations. Especially infrastructure projects, either for road traffic or public transport, are reported to be taken for different reasons.

Therefore, those persons responsible for air quality planning were asked if the measures laid down in P&P were planned specifically due to exceedance situations, or if they would have been taken anyway. In three regions, all measures in the P&P were developed exclusively for air quality purposes. In several other cases, air quality issues were seen as a catalyst to accelerate the implementation of the measures.

5.5.7 Obstacles to and problems with the identification, selection and implementing of measures

With the help of the questionnaire, major obstacles and problems that hampered the identification, selection and implementation of measures were identified.

Usually in the beginning of a planning process, there is modelling of the current state of air quality, prediction of future air quality and identification of the major sources that contribute to the observed pollutant levels. The main problems in accomplishing this were found to be:

- **Inadequate precision of emission data**. Especially in the case of PM10 emission inventories were found to either lack important sources such as fugitive ones and natural sources or to be rather inaccurate (e.g. non exhaust traffic emissions of PM10, plant production). For NO_2 and partly also for PM10, it was found that discrepancies between emission factors used for inventories and real world emissions considerably increased the uncertainties of future air quality predictions.
- **Imprecise emission projections.** Air quality predictions are based on emission projections on national and European level as well as on projections of future background concentrations. As projections try to quantify the unknown future, there will always be some uncertainty associated with any estimate of projected emissions.
- **Source apportionment of PM**. Due to incomplete emission inventories, natural sources and formation of secondary particles (with organic secondary particles not yet well understood) a quantitative assignment of sources to pollutant levels is complex and most often imprecise.
- **Model uncertainties**. The intrinsic uncertainties of models add to the uncertainties described above.
- **Meteorological variability**. Pollutant levels vary substantially from year to year due to meteorological variations. E.g. in 2003 central Europe experienced widespread exceedances of PM levels in February and March due to long-lasting adverse dispersion conditions. The year after, levels were much lower in some regions. Abatement planning faces the problem to address either typical meteorological situations and by that risking to breach the limit values in "extreme" years, or to address the worst case, which might increase the costs of the measures.
- **Measurement uncertainties**. In the case of PM10, measurement data derived by either the reference method (gravimetry) or by continuous monitoring are not necessarily fully comparable, which makes an informative assessment difficult.

The above listed problems also hamper the selection of efficient measures:

- **Effectiveness of measures**. For many measures the effectiveness especially for fugitive PM emissions and "soft" measures (information campaigns, public transport improvements etc.) is not well known. Non-exhaust emissions contribute substantially to overall traffic emissions. However, the efficiency of measures such as street cleaning is very uncertain; results of studies are often contradictory (INGENIEURBÜRO LOHMEYER 2004). Also, individual measures do have often a limited impact; nevertheless, the impact will be significant if such measures are combined with other measures.
- **Selection process**. Within the selection process usually not only effectiveness but also political and public acceptance has to be considered. Hence effective measures that are not deemed popular might be disregarded right from the beginning.

Problems with implementing measures are also dependent on the sources affected. Traffic and transport were most often named as the sources where measures are difficult to implement. The reasons are:

- **Low acceptance by the people affected**, often in combination with strong transport and traffic lobbying associations. However, in the case of the congestion charge in London, there were fewer protests from drivers than anticipated (QURESHI 2006), and the congestion charge trial scheme in Stockholm was approved by a majority of the population in the city of Stockholm in a referendum on September 17th.
- **Financial limitations**. This seems to be the case especially for public transport improvements.
- **Responsibilities divided amongst several authorities**. This is also true for measures in other sectors.

Measures for construction sites were also named as being difficult to implement in practice. In alpine regions wood combustion for heating is widespread; its contribution to PM levels can be substantial. Measures to tackle wood combustion meet with very low acceptance and might take a very long time until they become effective. In addition, increasing oil prices and climate change considerations are strong drivers for an increase in biomass burning.

Also, general societal developments can pose problems for air quality planning. The respondents named the trends towards suburbanization and increasing individual traffic as the biggest problem. Furthermore financial limitations of the communities and economic stagnation in some MS in general hamper the implementation of measures, e.g. concerning investment in cleaner vehicles or public transport infrastructure.

Factors that support and facilitate the planning process were named to be as follows:

- Communication and participation of all stakeholders (authorities, trade organisations, NGOs, public) during planning and implementation;
- Awareness raising and information of the public about air quality issues;
- Strong political commitment.

5.6 Description of selected measures

Of the measures described in the P&P of the cities and regions chosen for the in-depth analysis several measures are described in detail in the following. These measures were selected as they are either efficient with respect to emission reduction and costs or are deemed to be rather innovative. However, it has to be noted that a detailed cost benefit analysis has been undertaken only for a few measures in the P&P (see chapter 5.5.2). Hence no comprehensive analysis of all measures regarding cost efficiency was possible.

The measures described in detail are:

- Low Emission Zones (Berlin, Munich – DE, Sweden, London – UK)
- Congestion charge (London – UK, Stockholm – SE)
- Traffic restrictions during episodes (Graz – AT, Bozen – IT)
- Speed limit restrictions (Graz, Vienna – AT, Berlin, Munich – DE, Paris – FR)
- Retrofitting of diesel vehicles with particle traps (several cities)
- Public transport improvement (several cities)
- Domestic heating (Bozen – IT, Graz – AT)
- Ecological management of construction sites (Vienna – AT; Berlin, Stuttgart – DE, London –UK)
- Measures on stationary sources (Marseille – F, Košice – SK)

Most of these measures are also listed in Annex XV of the draft AQ Directive prepared within the CAFE process.

An overview of additional measures undertaken within the cities of the in-depth analysis is given in the Appendix.

There are also several databases available that comprise measures at different scales, for different sources and pollutants (see chapter 6.5.2).

General note:

The effectiveness of measures with respect to a reduction of air pollution is dependent *inter alia* on these parameters:

- Spatial extension;
- Time of implementation and duration;
- Number of exemptions;
- Number of people for whom the exposure is reduced.

In addition, the current legal framework does not separate different PM components, even though health studies indicate that different constituents might contribute more or less to health impacts. Therefore, the inclusion of critical sources (e.g. primary PM emissions from combustion) can be seen as preferable compared to the reduction of other PM constituents.

E.g. a general but small reduction of diesel particles might be more effective with respect to health than a substantial but only locally effective reduction of construction dust. It should also be mentioned that the first DD requires that measures to reduce PM10 shall also aim to reduce concentrations of PM2.5.

When comparing the reduction potentials given in the following chapters it has to be further noted that the numbers given for different cities might not be strictly comparable. E.g. different methodologies might be used for calculating vehicle emissions. Some methodologies such as COPERT[36] used in the UK might give different results for local scale emission calculations compared to the handbook[37] of emission factors used in AT, DE, NL and CH. Also, the calculation of non-exhaust emissions can vary considerably.

5.6.1 Low Emission Zones (Sweden, London – UK, Berlin, Munich – DE)

Low Emission Zones (LEZ) are areas within a city where access for motor vehicles is restricted. Usually the restriction is coupled to a certain emission criterion (EURO class) of the vehicles. LEZ were established in **Sweden** already in 1996 in the cities of Stockholm, Gothenburg and Malmö (AEA TECHNOLOGY ENVIRONMENT 2003). The LEZ in Stockholm covers an area where about 30% of the population lives. Within this area the vehicles either have to comply with a certain EURO class or are subject to a fee. Windscreen stickers identify older vehicles. The zone does not have any particular signage which made implementation relatively simple and cheap. To facilitate supervision, the Swedish cities have introduced a system of stickers for vehicles allowed to enter the environmental zone (WORKING GROUP ON ENVIRONMENTAL ZONES 2005). From January 2002 on within these cities (and the city of Lund), HDVs must not be older than 8 years to enter the LEZ except if certain after treatment systems have been installed. It has been estimated that the NO_x emissions in Stockholm from HDV were reduced by 10%, the PM emissions by 40% in the year 2000, relative to the reductions achieved without the zone.

In **London** a feasibility study for a LEZ was part of the Clean Air Strategy (GREATER LONDON AUTHORITY 2002). In this study, which includes also an assessment of socioeconomic effects, detailed calculations of emissions and air quality were performed and stakeholders were consulted. In addition, various options concerning spatial extension and vehicles covered have been analysed (AEA TECHNOLOGY ENVIRONMENT 2003)[38]. In the meantime planning has advanced and further environmental impact studies have been conducted[39].

A consultation on the scheme order proposed is running from 13 November to 2 February 2007[40]. It is proposed that the scheme would come into effect in three stages based on vehicle type (see Figure 23). It would potentially begin in early 2008 with the heaviest diesel-engine Heavy Goods Vehicles (HGVs) – over 12 tonnes in weight, followed by lighter diesel-engine HGVs – between 3.5 and 12 tonnes, buses and coaches in summer 2008, and heavier diesel-engine Light Goods Vehicles (LGVs) – under 3.5 tonnes and diesel-engine minibuses in autumn 2010 (TFL 2006a). A minor amount of vehicles (e.g. retrofitted ones) will need to register in order to be identified as a compliant vehicle. The LEZ would be enforced by automatic number plate recognition cameras as for the Congestion Charge (see chapter 5.6.2). Supplementary information is available at the TfL website (**www.tfl.gov.uk/lezlondon**).

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[36] COmputer Programme to calculate Emissions from Road Transport, see **http://lat.eng.auth.gr/copert/**

[37] Handbook Emission Factors for Road Transport, see **http://www.umweltbundesamt.at/en/hbefa/**

[38] **http://www.tfl.gov.uk/tfl/low-emission-zone/default.asp**

[39] **http://www.tfl.gov.uk/tfl/low-emission-zone/reportlibrary.asp**

[40] **http://www.tfl.gov.uk/tfl/low-emission-zone/consultation.asp**. It is worthwhile mentioning that the related documents are available in 18 different languages.

Vehicle type and definitions	European vehicle class(es)	Proposed date of LEZ scheme implementation	Proposed vehicle emission standard required to drive in the LEZ at no charge
Heavier HGVs Goods vehicles exceeding 12 tonnes (gross vehicle weight)	N_3	February 2008	Euro III for PM
		January 2012	Euro IV for PM
Lighter HGVs Goods vehicles between 3.5 and 12 tonnes (gross vehicle weight)	N_2	July 2008	Euro III for PM
		January 2012	Euro IV for PM
Buses and coaches Passenger vehicles with more than eight seats plus the driver's seat exceeding 5 tonnes (gross vehicle weight)	M_3	July 2008	Euro III for PM
		January 2012	Euro IV for PM
Heavier LGVs Goods vehicles between 1.205 tonnes (unladen) and 3.5 tonnes (gross vehicle weight)	N_1 – class II & class III	October 2010	Euro III for PM
Minibuses Passenger vehicles with more than eight seats plus the driver's seat below 5 tonnes (gross vehicle weight)	M_2	October 2010	Euro III for PM

Figure 23: Proposed vehicle standards and date for driving in the LEZ without charge (source: TFL 2006a).

HDVs, buses and coaches that do not comply with the emission standards are subject to a daily charge of £ 200 (290 €), and £ 100 (195 €) for non-compliant heavy LGVs and minibuses.

Table 21 and Table 22 shows the expected reductions of area and population exposed to NO_2 and PM10 levels above the LV. Figure 24 shows the results of model calculations for the annual means of PM10 for the year 2012, which is the one showing the largest differences (SCOTT WILSON 2006). The area where NO_2 exceedances occur is reduced by up to 15.6%, the area with PM10 exceedances is reduced by up to 26.7% for the daily mean LV. The population exposed to concentrations above the LV is reduced by a similar percentage.

Overall emissions of NO_x are reduced by about 4% in the year 2008 and 10% in the year 2012 (total area). PM10 emissions are reduced by 2.6% in 2008 and 6.6% in 2012.

Table 21: Reduction in areas and populations exposed to concentrations above the annual mean nitrogen dioxide objective with LEZ in Greater London (Source: AEA Technology; from SCOTT WILSON 2006).

Year	Area >40 µg/m^3		Reduction in Population Exposed >40 µg/m^3	
	km^2	% reduction	1,000s	% reduction
2008 + LEZ	8.2	5.2%	81	5.9%
2010 + LEZ	3.3	3.7%	33	4.6%
2012 + LEZ	12.2	15.6%	107	17.1%
2015 + LEZ	4.1	7.4%	36	8.1%

Table 22: Reduction in areas and populations exposed to concentrations above the 2004 daily mean PM10 objective and the 2010 provisional daily mean and annual mean PM10 objective with LEZ in Greater London (Source: AEA Technology; from SCOTT WILSON 2006).

Year	Reduction in Area >35 days above 50 µg/m^3		Reduction in Population Exposed >35 days above 50 µg/m^3	
	km^2	% reduction	1,000s	% reduction
2008 + LEZ	0.2	7.4%	0.7	4.9%
2010 + LEZ	0.2	12.4%	0.9	12.6%
2012 + LEZ	0.3	26.7%	1.1	21.4%
2015 + LEZ	<0.1	11.0%	0.4	11.3%

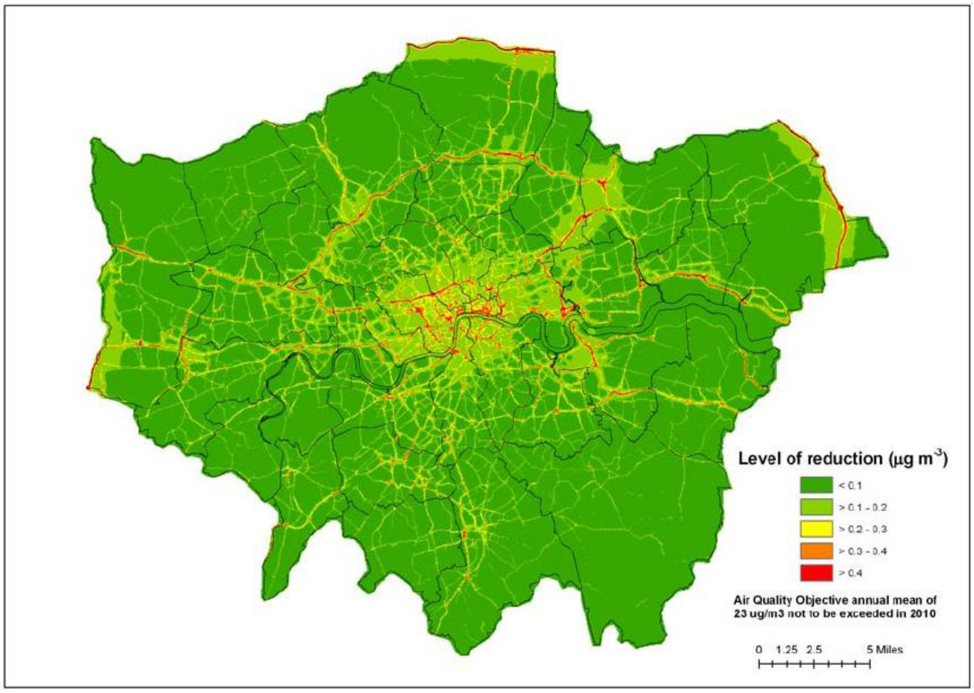

Figure 24: Difference in annual mean PM10 in Greater London in 2012 with LEZ (Source: AEA; from SCOTT WILSON 2006).

Cars are not subject to restrictions under a LEZ scheme due to the large number of cars, which would make compliance checking very complex and expensive, and due to social inequity problems as older cars are predominately owned by low income households[41]. Also the cost-effectiveness of tackling cars is rather low and the socio-economic costs would be very high. Hence cars are not addressed for the time being. However, via a low emission strategy high emitters are tackled as well.

Various options for compliance checking have been analysed regarding costs (AEA TECHNOLOGY ENVIRONMENT 2003). These are within a range from 60 m € for a manual system (total capital costs and 10 year operating costs) to 215 m € for a stand-alone system of cameras across London. Due to the high costs of the latter, a system based on the Congestion Charge system with a small number of additional cameras was suggested to be used.

A detailed description and evaluation of the already implemented Swedish and the planned London LEZ scheme is included in an “ex-post” evaluation of short-term and local measures in the CAFE context (AEA TECHNOLOGY ENVIRONMENT 2005, see also chapter 3.8).

In **Berlin** a LEZ will be established in 2008 in order to reduce NO_x and PM emissions. The LEZ will be restricted to the inner city area enclosed by a local train circle line. It will cover an area of about 88 km², which is about a tenth of the whole city area where more than 1 Mio. people live. A detailed analysis of the impact of various options has been performed (IVU 2005). Based on this analysis the LEZ will be implemented in a two stage approach. From 2008 to 2010 diesel vehicles must meet at least the Euro II emission standard. About 1.5 million vehi-

[41] These considerations were less relevant for the congestion charge, as for the congestion charge the financial benefit to reduce congestion and improve public transport was more important.

cles are registered in Berlin. Out of these about 70,000 diesel cars and 40,000 lorries do not meet this standard. It is expected that in 2008 about 40,000 diesel cars and 30,000 lorries might be affected by the LEZ. From 2010 on Euro III and a retrofitted particle trap is required to enter the LEZ. Thanks to a recently adopted nation-wide labelling scheme for Germany[42], an additional 30.000 gasoline cars will be affected, which do not have the requisite catalytic converter. With the help of this measure the number of residents affected by PM levels above the limit value should be reduced by 23%. Also, outside the zone a reduction of about 10% of people exposed to elevated levels is expected (see also Figure 25).

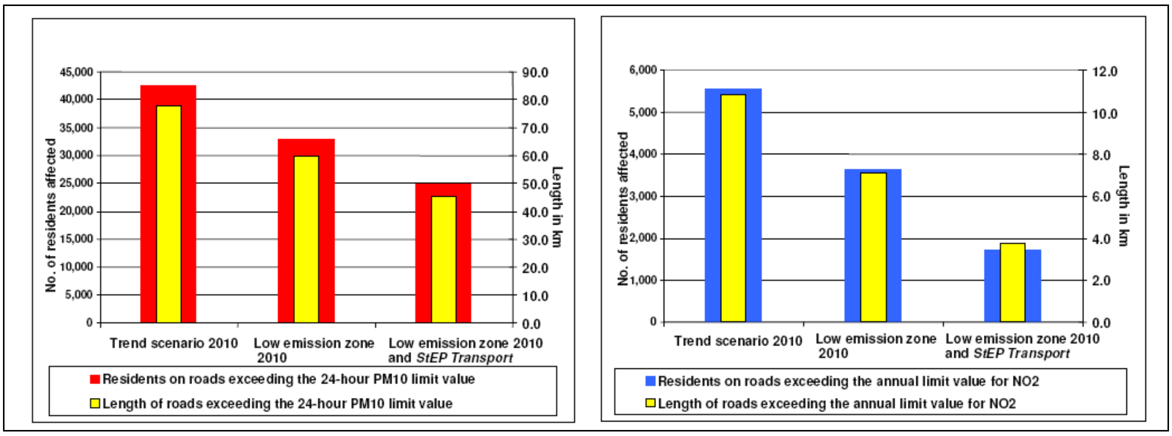

Figure 25: Sections of road in the inner city exceeding the 24-hour PM10 limit value (left) and the mean annual value for nitrogen dioxide (right), plus the number of residents affected in different reduction scenarios (source: SENATSVERWALTUNG FÜR STADTENTWICKLUNG 2005a).

Compliance with the required emission standard is checked with windscreen stickers set out in the national labelling regulation, which do have colours dependent on the Euro standard. Hence the costs for compliance checking and for establishing the scheme can be expected to be rather low (even though no figures are given).

Also in **Munich** a LEZ will be established from 1st of October 2007 on[43]. Vehicles with emission standard Euro 1 or below will not be allowed to enter an area of about 44 km², which is about 15% of the total city area. About 426,000 people live in this area, which is about 33% of the total population. The area is surrounded by a main road ("Mittlerer Ring"). The main road itself is not part of the LEZ. From 1st of October 2009 onwards, vehicles with emission standard "Schadstoffklasse 2" or below, which corresponds more or less to Euro 2, will not be allowed to enter the LEZ. For NO_x emissions a reduction of 4.6% in the LEZ is estimated, the PM exhaust emission should be reduced by about 17% (IVU 2006a). A reduction of air pollution by up to 20% in some inner city road is expected. An evaluation is planned for one year after installing the LEZ. Figure 26 shows the relative reduction of PM10 annual mean values following the introduction of the LEZ (IVU 2006).

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[42] Draft Order enacting and amending provisions on the marking of low-emission motor vehicles, Notification Number : 2006/254/D

[43] http://www.muenchen.de/Rathaus/rgu/vorsorge_schutz/luft/luftqualitaet/feinstaub/127233/#umweltzone

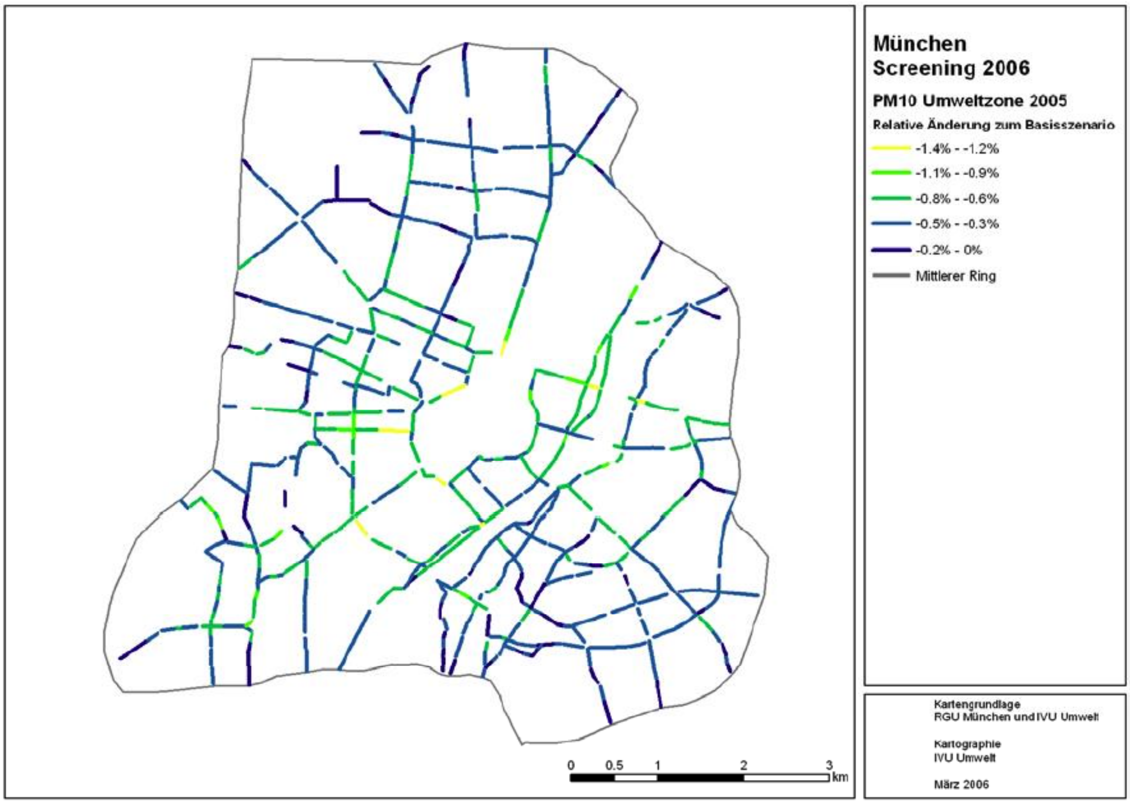

Figure 26: Relative changes of PM10 annual mean levels following the introduction of a LEZ (source: IVU 2006a).

In a recent study for DG ENV, possibilities for the EU were explored regarding the support of the implementation of technical measures to reduce emissions from existing HDV and captive fleets (SADLER CONSULTANTS 2006). An EU-wide certification scheme for retrofits was clearly identified as policy priority to enable LEZ without risking conflicts with the EU freedom of movement policy. In this study it was also mentioned that further LEZ are planned or will at least be allowed by national legislation. These are: The Netherlands (allowed from 1/4/07), Denmark (allowed from 1/7/08).

Further information concerning environmental zones can also be found in a report[44] from a Working Group set up under the Joint Expert Group on Transport and Environment to provide advice to the European Commission (WORKING GROUP ON ENVIRONMENTAL ZONES 2005).

Extension to other cities and regions: Within the ex-post analysis of short-term and local measures, an extension to other cities has been analysed in detail. It was found that even if there are some limitations (see below) an LEZ can also be established in other cities (AEA TECHNOLOGY ENVIRONMENT 2005).

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[44] The report can be downloaded from: http://forum.europa.eu.int/Public/irc/env/transport/library?l=/working_reports/wg1_zones_reportpdf/_EN_1.0_&a=d

Co-benefits: An LEZ obviously promotes the proliferation of newer vehicles, which usually will emit fewer air pollutants, possibly fewer GHGs and less noise. The vehicle and retrofit equipment manufacturing sector will also benefit. In addition, newer vehicles are usually safer.

Limitations: Even though an LEZ can be one of the most cost-effective measures to reduce emissions and improve air quality on a large scale, it can be seen as a development that would have come sooner or later anyhow. An LEZ seems to be more suited for large urban areas as, depending on the compliance checking scheme, the costs of the necessary equipment can be considerable. It obviously has an economic impact for companies and people who have to buy new or retrofitted vehicles. This impact can be disproportionate for certain companies with specialised vehicle fleets. In order to take that into account, a transition period could be introduced, allowing the residents and businesses concerned to retrofit or adapt their vehicles.

5.6.2 Congestion charge (London – UK, Stockholm – SE)

In February 2003 a congestion charge[45] (CC) scheme started in Central London. Several annual reports and evaluation studies have been published since then (TFL 2006, BEEVERS & CARSLAW 2005, AEAT 2005). Hence only a short summary of some relevant aspects is given here. The CC covers an area of 22 km² where vehicles are subject to a charge, for driving or parking within the CC area between 07:00 and 18:30, Monday to Friday, excluding weekends and public holidays. The charge was 5 £ (about 7 €) at the beginning and was raised to 8 £ (about 11.5 €) in July 2005. Residents in the area get a discount of 90%, certain vehicle types[46] and persons are exempted. The charge has resulted in a reduction of vehicles entering the zone by about 17% of total traffic and 31% of potentially chargeable vehicles (Figure 27), which also reduced congestions by about 30 %.

[45] http://www.cclondon.com/

[46] Vehicles over 3,500 kg must meet at least the so-called band 2 criteria on the TransportEnergy PowerShift register. This means that the vehicle must meet Euro III standards or cleaner. Vehicles under 3,500 kg must meet at least the band 4 criteria of this register, which means that these vehicles must be at least 40% cleaner with respect to NOx and HC emissions than the Euro IV standard. The details can be found on the CC homepage (http://www.cclondon.com/exemptions.shtml). The register can be found at www.powershift.org.uk.

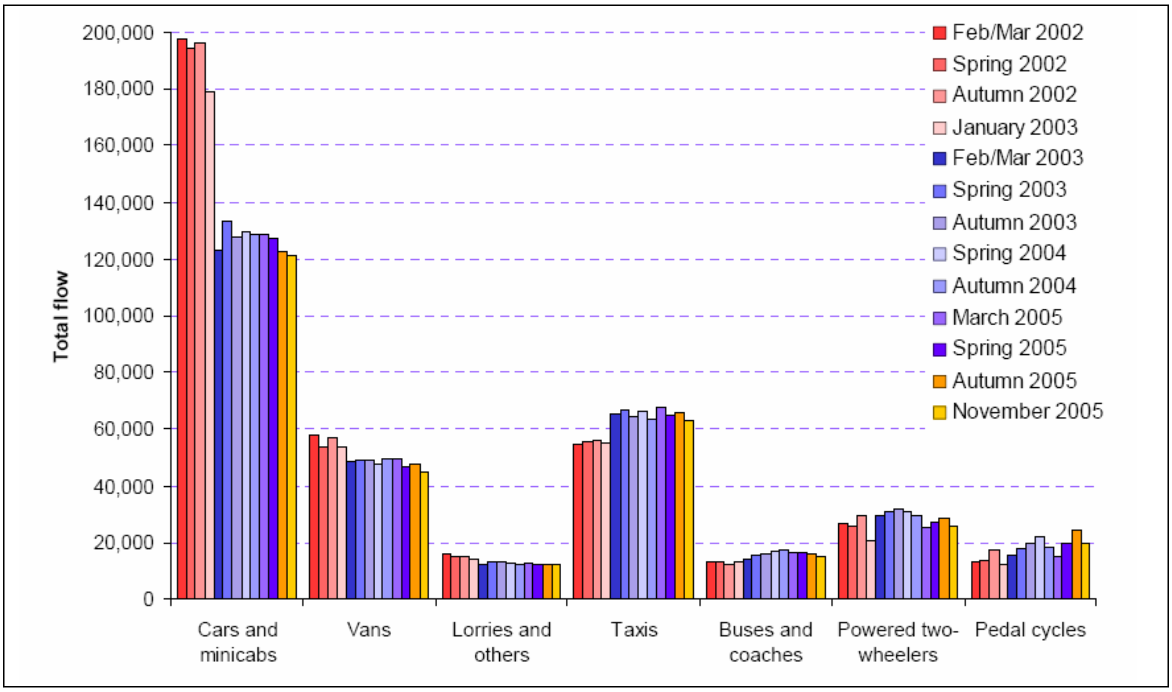

Figure 27: Traffic entering the charging zone during charging hours between February 2002 and November 2005 (source: TfL 2006). The congestion charge entered into force on 17th February 2003.

Even though the main focus of the CC was not air quality but a reduction of congestion, a reduction of NO_x and PM10 emissions from traffic between 2002 and 2003 by about 13 % and 15 %, respectively, occurred. About half of the people who stopped driving into the CC zone switched to public transport. So far, no negative social or economic impacts have been recorded. The annual net charge revenue is about £100 million (144 million €) which by law has to be invested back into public transport. Table 23 gives an overview of the scheme operating costs and the charge payments. In Table 24 the operating costs and the benefits for road users are compared. The net overall benefit for people in London is about £ 90 million (130 million €).

Table 23: Summary of principal financial impacts. (£ millions, 2005 prices and values, charge at £5). Source: TfL 2006.

Scheme operating costs	
TfL administration	-5
TfL contractors	-85
Charge and penalty payments	
Charge payments	120
Penalty charge payments	70
Total net charge revenues	**100**
Other costs and fare income	
TfL extra buses	-20
Extra public transport fares	15

Table 24: Summary of principal annual operating costs and road user benefits. (£ millions, 2005 prices and values, charge at £5). Source: TFL 2006.

		Scheme operating costs	Travel benefits	Compliance costs	Net benefits
Scheme operating and other costs					
TfL administration		-5			
TfL contractors		-85			
TfL extra buses		-20			
Sub-total – scheme costs		**-110**			
Scheme benefits					
Car users	– business		65	-10	55
	– journey to work, other		45	-10	35
Vans, lorries	– business		35	-10	25
Taxis	– business		30	0	30
	– journey to work, other		10	0	10
Buses	– business		2	0	2
	– journey to work, other		40	0	40
Deterred	– business		-5		-5
	– journey to work, other		-20		-20
Reduced accidents			15		15
Reduced CO_2 emissions			3		3
Other resource savings			10		10
Sub-total – road user and other benefits			**230**	**-30**	**200**
Total net annual benefits					**90**

The CC is accompanied by a five year monitoring programme that assesses traffic patterns, public transport and passenger groups, social impacts including vulnerable groups, business and economic effects as well as environmental impacts, particularly air quality (QURESHI 2006). From 17th February 2007 on the CC zone will be extended to the west of the current zone, which will about double the area. The introduction of the CC and each change of the CC have been accompanied by a public consultation process. In addition, the introduction of the CC was a central part of the Mayor's manifesto for election.

Whereas the London congestion charge can be regarded as a permanent measure, the Stockholm congestion charge is in trial phase. The trial phase began on 22nd August 2005 with extended public transport facilities (16 new bus lines). Charging itself started on 3rd January 2006 and concluded on 31st July 2006. In summer 2006 an evaluation was undertaken and on 17th September a referendum on the permanent implementation was held. In this referendum about 52% voted in favour of the CC. The formal decision as to whether the CC will be continued rests however with the central government. Whereas in the inner city people voted in favour of the CC, the CC was rejected in the municipalities in the immediate surroundings. The budget for the trial period is about SEK 3.3 billion (about 350 million €). As in London, only the inner city area is subject to a charge on entering or leaving the zone. Contrary to London the charges are dependent on the time of day. During peak hours the charge is SEK 20 (about 2.1 €), which drops to SEK 10 outside peak hours. The maximum charge for one day is SEK 60 (6.4 €). Exemptions from the charge are similar to London (e.g. for emergency vehicles, taxis, disability and social services, disabled persons); in Stockholm exemptions were also made for some low emission vehicles. The charge is paid via a transponder system that detects vehicles at 18 streets entering the inner city (Figure 28). If no transponder is installed, the licence plate will be photographed and the charge can be paid within 14 days at selected shops or via internet. As the inner city area of Stockholm is situated on islands relatively few detection units are sufficient to detect all vehicles entering or leaving this area.

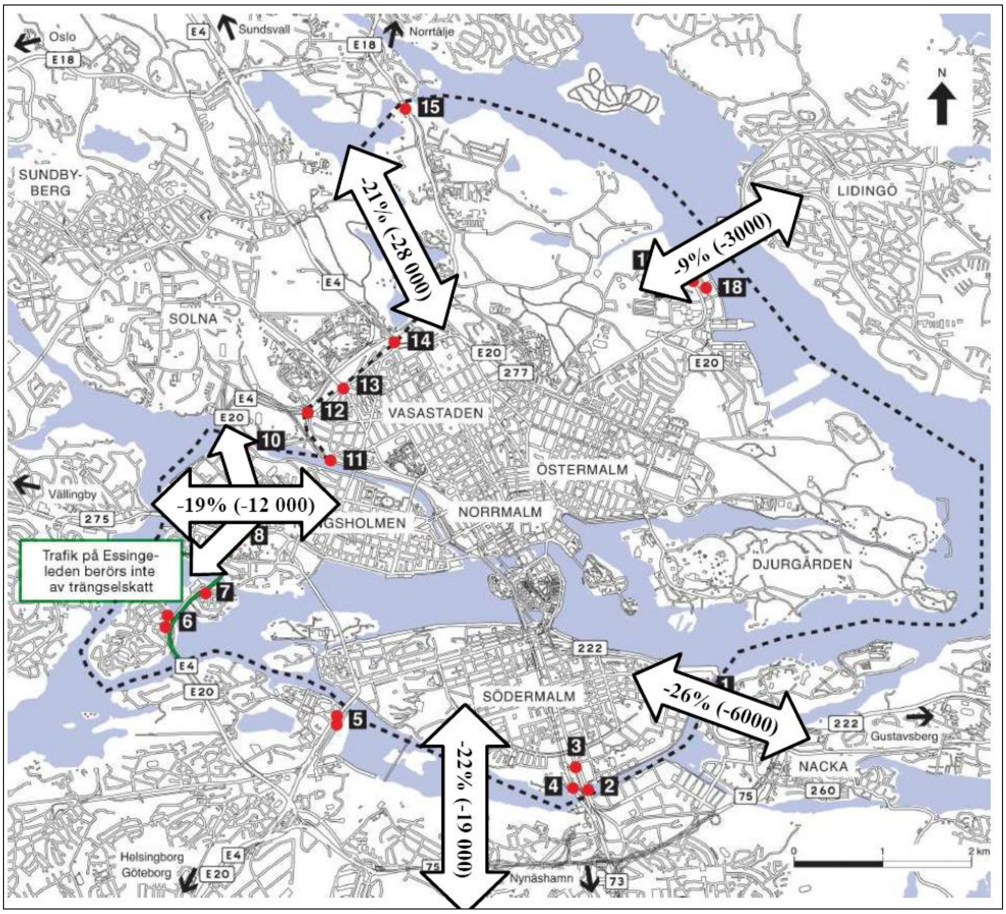

Figure 28: Charging points at the boundary of the inner city area and changes in traffic flow during the charge period (6:30 – 18:30). Source: STOCKHOLMSFÖRSÖKET 2006.

In an evaluation study it was shown that traffic volumes went down by more than 20 %, which was considerable more than anticipated (STOCKHOLMSFÖRSÖKET 2006, 2006a, 2006b). Of those not taking the car most chose public transport, a few percent chose to use the park-and-ride facilities; others chose to take a bypass road outside the CC zone, or not to travel at all. Car-sharing did not increase. The reduction in traffic volume resulted in a decrease of PM emissions by 13% in the Inner city, 3.4% for the City of Stockholm and approx. 1.5% for Greater Stockholm. These percentages include the effects of increased bus traffic. It is estimated that the emission reductions lead to a decrease in average NO_x levels by 5 - 10 µg/m³ and by 2 - 3 µg/m³ in average PM10 levels at most (Figure 29). For one of the most polluted streets in Stockholm Hornsgatan the reduction in PM10 levels is 5 %, which is sufficient to meet the annual mean limit value. However the limit value for the daily mean will still be exceeded. On the retail trade the CC seems to have only a minor impact. Shopping malls and department stores have developed in the same way as in the rest of Sweden. For smaller shops no conclusions can be drawn yet.

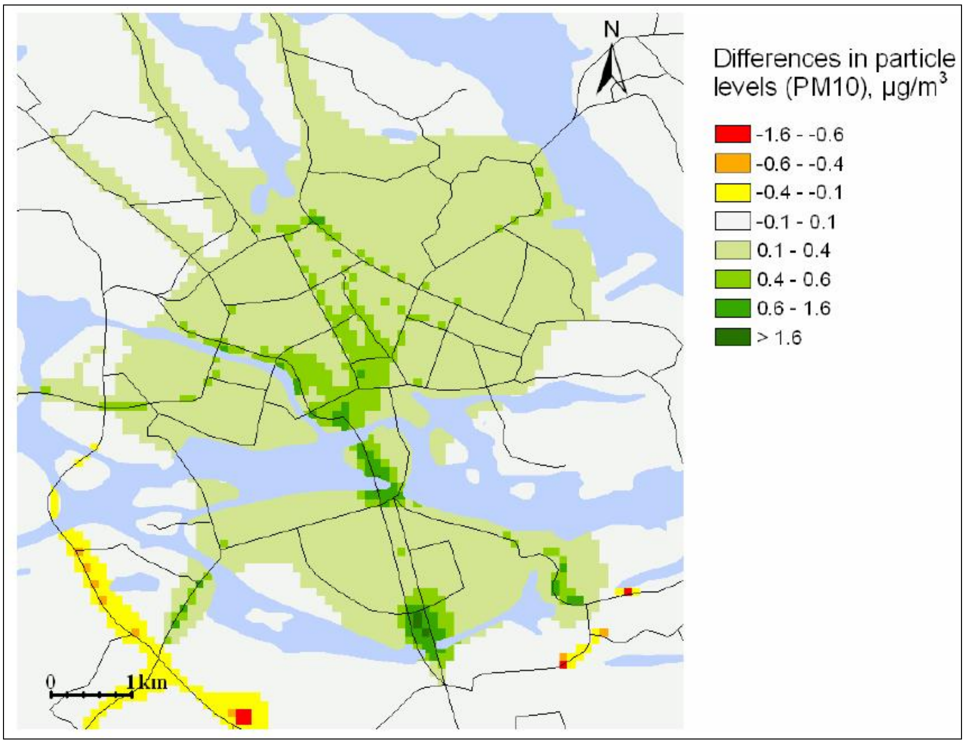

Figure 29: Changes in levels of particles (PM10, mean annual levels) with the Stockholm Trial scheme compared with levels without the congestion charge for 2006. Within the green areas the levels are lower, within yellow to red areas there is an increase in levels. In the inner city changes refer to rooftop level (source: STOCKHOLMSFÖRSÖKET 2006).

Costs and benefits of the Stockholm Trial scheme have been calculated using cost-benefit analysis based on people's so-called willingness-to-pay (WTP)[47]. This procedure is necessary since values for the type of costs and benefits caused by the Stockholm trial scheme are not (or not sufficiently) reflected in market prices and hence cannot be directly monetarized (= transferred into monetary terms). In this case costs include changes in the mode of travel or congestion tax payments, benefits from shorter journey times, reduced emissions, improved traffic safety, health benefits or revenue from the congestion tax.

For an overall evaluation, costs are deducted from benefits. The environmental effects following the congestion tax, for instance, would yield a beneficial effect for society of 90 million SEK (9.6 million €), comprising reduced emissions, positive effects on health due to reduced emissions, reduced environmental damage. In the long run – i.e. if the congestion tax were to be made a permanent system – the benefits would clearly outweigh the costs; depending on how the CBA is performed, the net benefit is equivalent to between app. 0.4-0.6 billion SEK (42-64 million €). If the costs and benefits of the congestion system are only calculated for the Trial period, then the costs are higher than the benefits (the net cost is equivalent to app. 2.7 billion SEK (290 million €), mostly accounted for by the initial investment and the operation of the congestion charging system itself). This is to be expected, since the time period is too short to yield substantial benefits. However, from a strictly economic viewpoint, in an overall

[47] WTP is assessed for effects following the introduction of the congestion tax system, for example, the willingness to pay for shorter journey times, reduced emissions or safer traffic. Usually WTP is assessed using questionnaires.

evaluation the initial costs should actually be disregarded as they represent sunk costs[48]. Comparing the net costs of the initial period with the long-term net benefit implies that the initial cost of 2.7 billion SEK would be repaid in the form of social benefits within four years (mostly accounted for by tax revenue and environmental benefits). This is a comparatively short period as compared with similar public investments (e.g. infrastructure, public transport), which usually have amortisation times of 15 to 25 years.

The congestion charge system has also been compared to other possible measures such as ring roads around Stockholm. A western ring road would result in a reduction of traffic of 14 % across the inner city bridges and would cost about 15 billion SEK (1.6 billion €), an eastern ring road would result in a 11 % decline of traffic in the city and would cost about 20 billion SEK (2.14 billion €). A zero tax on public transport would result in 3 % less car traffic in the county and would cost about 5 billion SEK (0.5 billion €). In total, the initial costs of these measures are substantially higher than those of the congestion charge system. However, as the report notes, the congestion charge system is not directly comparable to the investments mentioned before and hence they should not be seen as a substitute but as a complementary measure.

As clean vehicles[49] are exempted from the CC, the proportion of these vehicles travelling in and out of the Stockholm inner city area has more than doubled (0.8 percentage points in 2005 compared to 2.6 percentage points in 2006). In total approximately 1.4% of the cars in Stockholm County are now clean vehicles.

Extension to other cities and regions: The possibility and the limitations of extending the London CC to other cities has been analysed in detail in the ex-post analysis of short-term and local measures (AEA TECHNOLOGY ENVIRONMENT 2005). In London a ring road around the Central London facilitated the implementation of the CC. This is also the case in Stockholm where the inner city is situated on an island with a limited number of entering roads. The CC area should have a certain size as depending on the scheme the implementation costs might be high. A CC is most suited for larger cities with a good public transport infrastructure. An appropriate charging boundary has to be defined for each individual city. Furthermore, the issue of diverted traffic has to be addressed. Public acceptance can be dependent on whether a congestion problem exists or not as otherwise a CC might simply be seen as an additional tax. The introduction of a CC scheme needs thorough preparation to tackle political and public acceptance problems as well as technical issues.

Co-benefits: The CC schemes in London as well as in Stockholm have led to a considerable emission reduction of air pollutants and GHGs, and furthermore congestion and the number of accidents were reduced. Due to reduced journey times there are socio-economic benefits for private car users and commercial vehicles.

Limitations: The capital costs of the scheme are rather high. Furthermore a CC is regressive, in the sense that low income car owners are more strongly affected.

[48] In economics and in business decision-making, sunk costs are costs that have already been incurred and which cannot be recovered to any significant degree.

[49] Cars that are equipped with technology for partial or total operation using electricity, alcohol or gas.

5.6.3 Traffic restrictions during episodes (Graz – AT, Bozen - IT)

In two regions (Graz and Bozen – Südtirol), traffic restrictions are planned for episodes of high PM pollution.

In Bozen – Südtirol, the air quality plan distinguishes between a multi-year preventive programme and an action plan (Table 25). The preventive programme contains restrictions for Euro 0 and certain motorbikes during rush hours in the environmental zones, and a complete restriction for these vehicles in the core zone. These restrictions will be extended to additional vehicles (Euro 1, Diesel vehicles etc.) in a stepwise procedure in the coming years. The preventive programme contains also restrictions for Euro 0, and Euro 1 heavy duty vehicles (> 7.5 tonnes) on the motorway (Brennerautobahn A22).

Table 25: Multi-year preventive programme, province of Bozen-Südtirol.

Vehicle type or emission reduction system	**Multi-year programme**			**Action plan**
	Unlimited zone	**Environmental zone**	**Pedestrian zone**	**Environmental zone and pedestrian zone**
Euro 0 and two-stroke engines without catalyst	Nov. 2009	Nov. 2006	Nov. 2006	Nov. 2006
Euro 1 and two-stroke engines with catalyst	Nov. 2009	Nov. 2007	Nov. 2007	Nov. 2006
Diesel cars Euro 2, 3 and 4 (no particle filter)	-	Nov. 2009	Nov. 2009	Nov. 2006
Diesel LDV Euro 2, 3 and 4 (no particle filter)	-	Nov. 2009	Nov. 2008	Nov. 2006
Diesel lorries Euro 2 und 3 (no particle filter)	-	Nov. 2008	Nov. 2008	Nov. 2006
Diesel cars with particle filter < 80%	-	-	-	Nov. 2009
Diesel cars with particle filter > 80%	-	-	-	-
Petrol cars from Euro 2 and four-cycle engine	-	-	-	-
Natural gas, Hybrid cars etc.	-	-	-	-

In addition to this preventive programme, an action plan comes into force if the daily average PM10 concentration exceeds 50 µg/m³ for more than five consecutive days (first step) and for more than five additional consecutive days (second step). In the first step in designated environmental zones, trips with Euro 0, Euro 1 and diesel vehicles without particle filters are prohibited from 7 am to 7 pm. It is planned to apply this restriction to diesel vehicles with particle filters (efficiency < 80 %) in 2009. The action plan remains in force as long as the daily average PM10 concentration remains above 50 µg/m³. With the second step, a complete restriction for all vehicles, except with at least two persons on board is applied.

In the province of Bozen – Südtirol, experiences have already been gained with traffic restrictions in earlier years. Acceptance of such measures is generally low, but improved schemes, especially targeting highly polluting vehicles, are expected to be more effective. Clearly distinguishable reductions in air pollution were found during periods when traffic was reduced by 30 to 40 %.

The new ordinance with measures to reduce air pollution in the province of Styria (including Graz), which is coming into effect in the winter of 2006/2007, prohibits circulation for diesel vehicles without particle filter if high PM10 concentrations persist over a period of 5 days. The concentration threshold is 75 µg/m³ (daily average) in 2006/2007 and will be 50 µg/m³ thereafter.

Extension to other cities and regions: Traffic restrictions during high pollution episodes constitute an effective short-term measure to reduce air pollution and may be extended to other cities and regions as well.

Co-benefits: Traffic restrictions also result in reduced noise and energy consumption. Because temporal restrictions are mainly aimed at air pollution reduction, this remains the main benefit.

Limitations: The main limitation of this measure is the lack of acceptance associated with traffic restrictions. In the examples shown here, the strategy is to build up acceptance by a stepwise introduction of these measures. As an adhoc traffic ban triggered by pollution episodes can hardly be anticipated, certain exemptions, in particular for commercial traffic, might be necessary so as to ensure supply of the affected city areas with essential goods and services.

5.6.4 Speed limit restrictions (Graz, Vienna – AT, Berlin, Munich – DE, Paris – FR)

Changes in speed limits are reported for the cities of Graz, Vienna, Berlin, Munich and Paris; these cities were considered for the in-depth analysis. From the information about the P&P under Commission Decision 2004/224/EC, which has been fed into a database, it could be deduced that also in Linz and Upper Austria, Erfurt, Halle, Frankfurt/Oder, Hannover and Braunschweig (Germany), Strasbourg, Agglomération de Dunkerque and Nancy (France) speed limit restrictions were applied.

Detailed analyses of the impacts of lower speed limits on emissions and air quality have been done for Graz and Berlin. Furthermore, in the ex-post analysis of short-term and local measures speed restrictions in Rotterdam have been investigated (AEA TECHNOLOGY ENVIRONMENT 2005); in Austria the influence of speed limits has been calculated for all motorways as well as in more detail for some parts of motorways in alpine valleys.

For the agglomeration Graz the influence of a reduction of speed limits from 50 kph to 30 kph on the main roads within the city (on minor roads the speed limit is restricted to 30 kph), from 100 kph to 80 kph on rural roads outside the city and from 130 kph to 100 kph on motorways has been calculated (FVT 2003). The speed restrictions resulted in a reduction of both NO_x and PM emissions (exhaust only) by 8 %. The PM emissions of the whole Graz area are reduced by 2.6 %. No cost estimate or CBA was undertaken within this study.

Within the HEAVEN project[50] the influence of a reduction of the speed limit on a specific road in Berlin was investigated. It was shown by modelling that NO_2 levels would be reduced by about 4% and PM10 levels by about 3% (HEAVEN 2002). However, measurements of vehicle speed showed that the actual speed was reduced only from 44 kph to 40 kph. Only during official speed checks was the average speed reduced almost to the allowed level.

On rural roads and motorways in Austria the influence of the reduction of speed has been analysed. A speed limit for passenger cars and light duty vehicles of 80 kph instead of 100 kph on highways would result in a reduction of PM emissions by 16%, of NO_x emissions by 18% and of CO_2 emissions by 6%. On motorways a reduction from 130 kph to 100 kph would result in a re-

[50] "Healthier Environment through the Abatement of Vehicle Emissions and Noise". HEAVEN was an RTD project of the Information Society Technologies (IST) Programme. This project lasted for a period of three years (2000-2002). See also: http://heaven.rec.org/

duction of PM emissions by 17%, NO_x emissions would be reduced by 36%, CO_2 emissions by 12% (HAUSBERGER 2003).

On highways in Austria the influence of different speed limits and enforcement schemes has been analysed (FVT 2006). A reduction from 130 kph (the current general speed limit) to 100 kph would result in a NO_x emission reduction of 25% for passenger cars and 33% for light duty vehicles (see Figure 30). PM emissions would be reduced for both vehicle types by 31% (Figure 31). If enforced by section control, NO_x emissions would be reduced by 37% for passenger cars and 48% for light duty vehicles, PM emissions by 48% and 46%. A further reduction to 80 kph would result in an additional reduction of both pollutants and for both vehicle types.

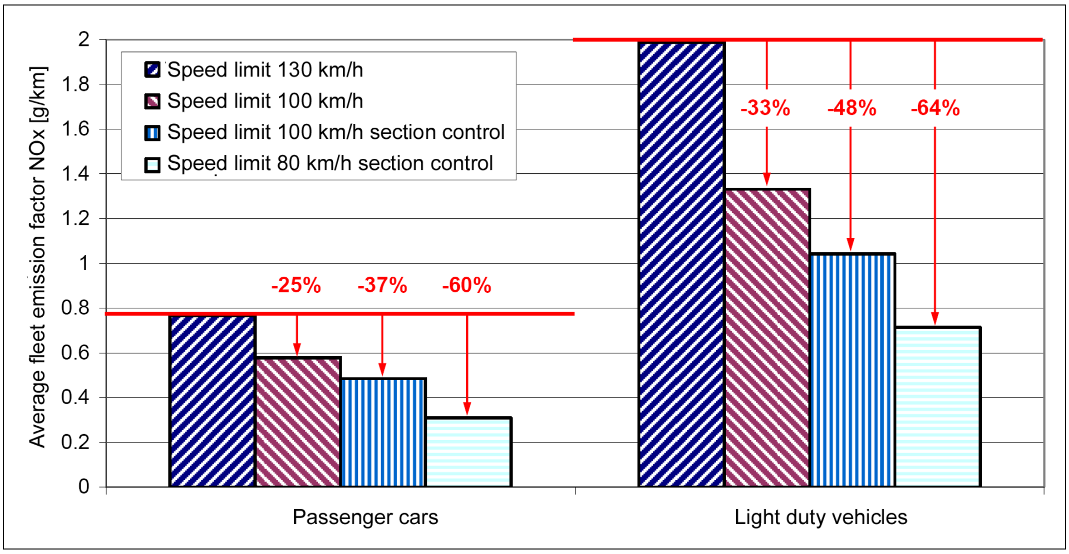

Figure 30: NO_x emission factors of the average fleet of passenger cars and light duty vehicles on motorways for Austria in the year 2006 (source: FVT 2006). "Section control": speed permanently monitored on motorway sections.

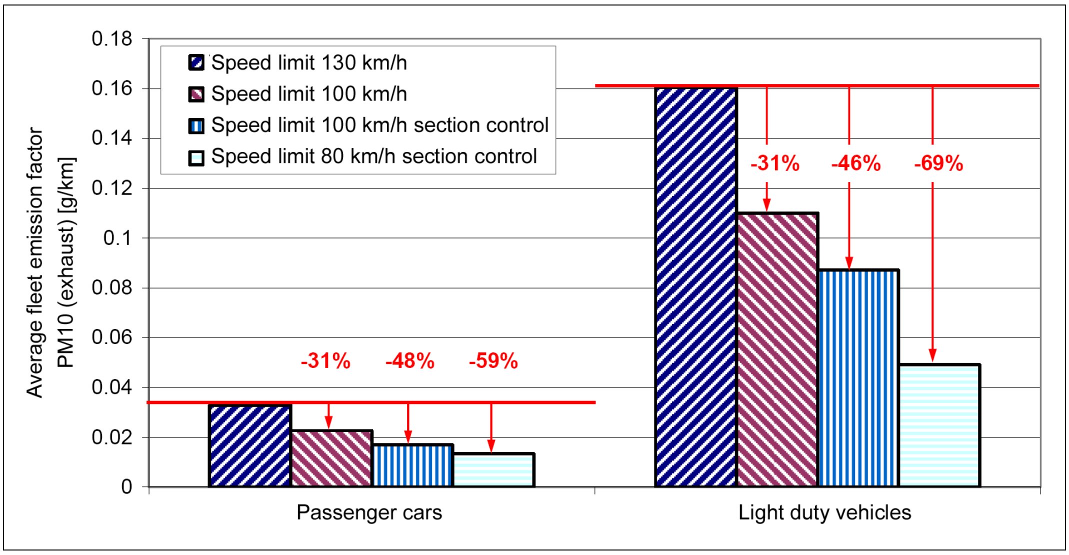

Figure 31: PM emission factors (exhaust only) of the average fleet of passenger cars and light duty vehicles on motorways for Austria in the year 2006 (source: FVT 2006). "Section control": speed permanently monitored on motorway sections.

Similar results were found for the A12 Inn valley motorway and the A10 Tauern motorway in Austria (FVT 2003a, 2004, 200a). In this study also the emission reduction of the overall fleet, i.e. including HDVs, which would not be affected by a speed limit, was considered. The overall NO_x emission reduction would be 11% for a certain section of the Inn valley motorway, which is considerably less than the reduction for passenger cars and LDV alone as HDVs contribute about 2/3 of the overall NO_x emissions from traffic. A reduction of the speed limit for HDVs from 80 kph to 60 kph was found to increase emissions due to unfavourable engine load conditions at lower speeds. For the A10 the overall reduction of NO_x emissions would be 9% and 16% for PM emissions (exhaust only). Recent AQ measurements at the A10 confirm these emission reductions. Whereas from April 2003 to October 2004 (speed limit 130 kph for passenger cars) the NO_x concentrations were 93.5 ppb, between April 2005 and Oktober 2006 (speed limit 100 kph) the NO_x concentrations were 87.0 ppb (personal communication A. Kranabetter). Furthermore a considerable decrease in accidents was found. However, it has to be noted that in Austria a rather high share (about 50%) of passenger cars are equipped with a diesel engine. Hence these numbers might be different for other vehicle fleets.

A reduction of the speed limit on a motorway in Rotterdam has been analysed in detail in the ex-post analysis of short-term and local measures (AEA TECHNOLOGY ENVIRONMENT 2005). Within this study also a CBA was undertaken.

In Rotterdam a speed limit of 80 kph instead of 120 kph is enforced on a 3.5 km section of the A13 city ring road. This road carries more than 150,000 vehicles per day and is prone to congestion. The speed limit is enforced by cameras and registration number recognition software (“section control”). The implementation of the lower speed limit was accompanied by an extensive monitoring campaign and model simulations. NO_x emissions within the speed control zone were reduced by 15 to 25%, PM10 emissions by 25 to 35%. NO_2 levels at 50 m from the roadside were reduced by 5 µg/m³, PM10 levels by 4 µg/m³. The contribution to pollution levels from the A13 was reduced by 25% for NO_2 and 34% for PM10 up to 200 m from the roadside.

As ancillary benefits, a reduction of CO_2 emissions by 15%, of noise impacts by 50%, and of collisions also by 50% have been reported. It is expected that this scheme should benefit air quality for at least 10 years.

The capital cost for the technology and infrastructure is about €1.2 million with annual running costs of €50,000. Using a social discount rate of 4%, the present value of the scheme is estimated to be €1.56million with an annualised value of €192,000. The quantified annual benefits of the reduced NO_x and PM10 emissions were estimated to be €616,000 for NO_x and €1,215,000 for PM10. Compared to the annualised costs the benefits clearly outweigh the costs.

To summarize, emission reductions following lower speed limits are largest for (diesel) passenger cars and LDVs on motorways when reducing the speed from 130 or 120 kph to 100 or 80 kph as emission factors increase rapidly from about 100 kph up. Additional emission reductions can be achieved by strict enforcement of the speed limit, e.g. by a section control. At lower speeds, effects are much smaller as emission factors for modern vehicles hardly differ between 30 and 70 kph. At this speed, traffic flow influences emissions to a larger extent than the speed itself. For HDVs, which often contribute considerable to emissions on motorways, reduced speed limits (lower than 80 kph) on motorways can be counterproductive; however strict enforcement of the speed limit can reduce emissions as well.

Extension to other cities and regions: As there are no technological barriers extension to other cities and regions should be easy. The efficiency with respect to air quality improvements is dependent on the local situation, mainly on the traffic flow, actual speed, on the fleet composition and accompanying speed checks.

Co-benefits: A reduction in PM and NO_x emissions also leads to reduced GHG emissions and reduced emissions of other pollutants. Noise, congestion and the number of road accidents are usually also reduced, whereas road capacity can be increased.

Limitations: At speeds between 30 and 70 kph, which might be the typical speed limits within a city, the influence of different speed limits depends more on the effects on the traffic flow regardless of a strong influence on noise and the severeness of collisions. Travel times may but need not increase if congestion is reduced.

5.6.5 Retrofitting of diesel vehicles with particle traps (several cities)

Retrofitting schemes are suggested or have already been applied in the cities of Graz (AT), Berlin (DE), Stuttgart (DE), Bozen (IT), London (UK). In the case of Graz and Bozen retrofitting of private vehicles is subsidized, in addition to retrofitting schemes for vehicles under public control. In Berlin, Stuttgart and London public vehicles (mostly buses) are retrofitted.

In Graz, retrofitting of diesel engines with particle filters is subsidised by the province of Styria (€ 300 for passenger cars, € 700 for lorries and buses) and by the city of Graz (€ 100 for passenger cars, € 300 for lorries and buses). The scheme applies to full flow particle filters as well as partial particle filters (flow-through filter systems, which prevent at least 40 % of PM emissions).

Besides financial incentives, additional factors are important to persuade drivers to retrofit their cars. In Bozen – Südtirol, it was found that an important incentive to install a particle filter is that retrofitted cars are exempt from traffic restrictions during high-pollution periods (see chapter 5.6.3). On the other hand, retrofitting also helps promotion of LEZ, and permits stricter emissions standards.

The effects of particle filters on air quality were estimated for the city of Berlin (IVU 2005). It was found that with an implementation rate of particle filters of 100 %, the number of days with exceedances of the PM10 limit value would be reduced by 12 per year. With an implementation rate of 40 %, the number of days would be reduced by 5 per year.

Various options for reducing PM and/or NO_x emissions from HDVs by retrofitting have recently been studied in a project for the EC (SADLER CONSULTANT 2006). It is worth mentioning the technologies that have been identified as the most promising ones for retrofitting are:

- Exhaust emissions retrofit measures
  - Diesel Oxidation Catalyst (DOC)
  - Diesel Particulate Filter (DPF)
  - Exhaust Gas Recirculation (EGR)
  - Selective Catalytic Reduction (SCR)
  - SCR+DPF
  - Re-engining
- Alternative liquid fuels
  - Diesel Water Emulsion (DWE)
- Alternative gaseous fuels
  - Dual-fuel Natural Gas
  - Dual-fuel Bio-methane

Extension to other cities and regions: As this measure is mainly a financial incentive for car owners, it can easily be applied to all cities and regions. However, factors like car fleet composition, car drivers' willingness to pay and additional incentives should be taken into account.

Co-benefits: This measure focuses primarily on PM emission reduction. Therefore, no important co-benefits exist.

Limitations: The main limitation associated with this measure is the high cost. A comparison of costs and benefits, including car drivers' willingness to pay should be made in advance.

5.6.6 Public transport improvement (several cities)

In many cases, improvement of public transport was given much room within the plans and programmes. For example, the air quality plan for Graz contains a total of 13 measures related to public transport.

In the area of public transport, one can distinguish between the following types of measures:

- Increased frequency: The P&P for Graz contain several examples of increased frequency of buses and trains. In the P&P for Stuttgart, increased frequencies of trains in the evenings are planned. To increase frequency in rail transport, infrastructure improvements (higher capacity of rail network) are required in many cases (as e.g. laid out in the P&P for Graz). Therefore, such measures take several years to be implemented.
- New buses: As new buses usually have lower emissions and higher comfort and quality, they can improve air quality and the attractiveness of public transport. As an alternative, buses can be retrofitted with emission reduction devices.
- Improvement of spatial coverage (additional lines): In Stockholm, additional bus lines were installed during the congestion charge trial period. The main problems associated with additional bus lines tend to be the costs and the time required until such lines are accepted and used by new customers.
- Attractiveness of public transport: Modern buses and trains, safe infrastructure and simple use are important aspects, which usually are not included in P&P, but addressed in the corresponding transport plans (see also chapter 5.3.1). For example, the transport plan for Paris lists a variety of measures to improve the attractiveness of public transport. In the P&P for Munich, improvements of the interface between bike use and public transport are

foreseen. Finally, bus lanes (e.g. Madrid) are another way of improving the attractiveness of public transport.

- Financial incentives to use public transport: In Stuttgart, reduced fare tickets were introduced for passengers travelling after 9 am, as an incentive for more passengers. Also, the P&P for Graz includes reduced fares for public transport. Although such measures are associated with costs for the respective government and/or public transport service, the overall ratio of benefits and costs proved to be favourable, as e.g. a study in the city of Strasbourg showed (AEA TECHNOLOGY ENVIRONMENT 2005).
- Information about availability of public transport: Information campaigns are important, e.g. for commuters, collaboration with companies. In Graz, an information service is available for companies on the use of public transport by their employees.

Extension to other cities and regions: Most measures in the area of public transport listed in the P&P studied here are similar and can therefore be extended to other cities as well. Differences which have to be taken into account are the infrastructure available and the experiences gained concerning the willingness of passengers to use new services.

Co-benefits: Improvement of public transport has several co-benefits in addition to air quality improvement. Effective supply and use of public transport may also contribute to congestion and noise reduction, and to a reduction of GHG emissions. It also benefits those on lower incomes, since these population groups are usually strongly dependent on effective public transport.

Limitations: The main limitations of measures in the area of public transport are costs and acceptance. As costs are high and it takes time until new services are accepted, the overall effect of public transport measures may be limited. The role of public transport in regions where short-term measures are planned in case of high pollution periods should be closely watched. Also, for short term measures it is important that sufficient capacity is available, which might not be the case in every city.

5.6.7 Domestic heating (Bozen – IT, Graz – AT)

In the province of Bozen – South Tyrol, the latest version of the air quality plan, which will come into effect towards the end of 2006, includes restrictions on domestic heating (AUTONOME PROVINZ BOZEN-SÜDTIROL 2006). Once the daily average PM10 concentration exceeds 50 µg/m³ for more than five consecutive days, the population will be advised to reduce wood heating. After eight consecutive days, a ban on using wood heating will come into force for buildings where an alternative heating system exists.

It was pointed out that in order to effectively launch such a measure, several problems have to be dealt with:

- Wood is known and accepted as a climate-neutral energy source. Therefore, a conflict with greenhouse gas emission goals exists which cannot be solved but has to be communicated in a credible way (for example: do not burn rubbish, treated wood, plastics, etc.; use dry wood only; do not overload the stove; replace the old stoves by modern ones (e.g. based on pellets) which emit less PM).
- Compliance with the wood burning bans is difficult to ensure. Preventive control and information in cooperation with the municipality is very important.

Besides this specific short-term measure, plans and programmes contain various medium-to long-term measures in the area of domestic heating. For example, the plans and programmes for Graz include a comprehensive list of measures:

- Stricter limit values for new heating facilities
- Closing down old heating facilities
- Extended checks of heating facilities
- Consideration of heating emissions in urban development
- Incentives to replace old heating facilities
- Incentives to reduce energy consumption
- Incentives to use solar energy or district heat for hot water supply
- Information and counselling concerning energy consumption

Extension to other cities and regions: Given the specific situation of Bozen concerning topography and firewood use and the problems of communicating and enforcing a ban on wood heating, this measure may be difficult to implement in other cities and regions.

On the other hand, the comprehensive list of measures developed for Graz may be suitable for other regions as well.

Co-benefits: Heating is an interesting sector in terms of its co-benefits, because in most cases there are synergies with other environmental goals (greenhouse gas reduction, sustainable energy use). These synergies exist if measures focus on more efficient energy use.

However, as shown for the wood burning restrictions in Bozen, there may also be conflicts with these environmental goals.

Limitations: The main limitations for measures in the domestic heating sectors are costs associated with new heating facilities, difficulties with emission control and individual heating habits of inhabitants. Restrictions of biomass burning lead to a conflict with greenhouse gas emission goals and therefore require plausible communication.

5.6.8 Environmental management of construction sites (Vienna – AT, Berlin – DE, London – UK)

A considerable proportion of heavy duty traffic within a city is due to construction site traffic. For Vienna, it was estimated that 32% of the inner city lorry traffic is due to construction work (ULI 2005). Also, other activities at construction sites may contribute to PM levels. Hence emission reductions at construction sites are considered for several cities.

For major urban development sites in Vienna it is planned to include air quality issues from the beginning of the planning process. This includes a reduction of traffic during construction as well as after completion. During construction activities it is planned to transport as many goods as possible via rail. The feasibility of this approach has been shown during the EU-LIFE project RUMBA (**http://www.rumba-info.at**), which started in November 2001 and ended in 2004. In RUMBA the fuel consumption for a construction site could be reduced by 85% as a considerable part of the traffic was done via rail. In the meantime, at other large construction sites for several large apartment buildings ("Kabelwerk", "Thürnlhofgasse") rail transport has been used as a means for reducing road traffic. At the construction site Thürnlhofgasse where about 1,000 flats are being built (January 2007), transport by lorries has been allowed only for travel distances up to 15 km. For larger distances either rail transport has to be used or a fee of 75 € per journey has to be paid. The same applies to the emission standard for lorries, with fees payable for EURO 1 and 2 vehicles. Thus it has been achieved that 90 % of vehicles complied with EURO 3 standards. Also, the distance the lorries travelled overall could be reduced from 1.2 million km to 150,000 km (DER STANDARD 10.02.2007). However, RUMBA also showed that transport via rail might be more expensive under the current traffic policies even if a railroad connection is nearby. For the construction of a large apartment block, the cost of the transport of precast concrete parts by rail was 10% higher, for excavation transport the cost was twice as much. The higher cost of the excavation transport was partly due to the fact that in this particular case the excavated material transported by rail had to be landfilled, whereas if transported by road, it could be reused.

In addition to construction site traffic further measures will be applied to urban development sites. This includes high-capacity public transport facilities nearby, zero emission office buildings etc.

In Berlin the Potsdamer Platz and the Lehrter Bahnhof were rebuilt between 1993 and 2006. The construction site was the largest in an inner city area in Europe. The construction logistics were done by a company founded especially for this site (Baulog). Most of the excavation and the concrete was transported by rail and ship. Thereby the emissions of pollutants could be reduced by about 25%. The companies stated that the costs were higher compared to conventional road transport (RUMBA 2003). However, it has to be considered that the centralised logistics also led to savings as work on schedule was assured. In addition a survey of the involved companies showed that for 71% of the companies the construction work would not have been possible without central logistics.

In Stuttgart a dust avoidance plan is also obligatory for large construction sites. Possible measures that are part of this plan are usage of vehicles with particle filters only, bituminous surfacing of the roads at the site, cleaning of roads and tyres, enclosures for belt conveyors.

In London a best practice construction guide was drafted in the beginning of 2006 (GREATER LONDON AUTHORITY 2006). The consultation ended in April 2006 and an updated guide was published in November 2006[51].

This guide classifies construction sites in three categories with low, medium or high risk from pollutants to the surrounding neighbourhood. This is done with the help of a score sheet where the surrounding environment, the size and the duration of the construction site as well as the construction activities are classified. For each of the three risk categories an increasing number of measures are foreseen. Prior to any works a statement should be submitted that describes the work to be carried out and the machinery to be used with the focus on dust generating activities. The degree of detail depends on the risk category. Within this statement an on-site responsible person has to be identified.

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[51] **http://www.london.gov.uk/mayor/environment/air_quality/construction-dust.jsp**

The dust control measures suggested in the best practice guidelines comprise pre-site preparation, measures for haul routes, control measures for site entrances and exits, measures for sites that operate crushing plants or cement batching facilities, measures for earthworks and excavation as well as stockpiles, storage mounds and demolition activities. The on-road vehicles should at least comply with the emission standards proposed for the London LEZ. Off-road vehicles should at least use fuel equivalent to ultra low sulphur diesel at all sites; at high risk sites off-road machinery with power outputs over 37 kW should be fitted with diesel particle filters.

At medium and high risk sites monitoring is required, at high risk sites a procedure in case of elevated levels has to be defined. Also nearby rail and ship transport should be used at high risk sites.

In Switzerland already in September 2002 an ordinance entered into force that contains measures for all kinds of air polluting activities at construction sites with the main focus on particles[52] (BUWAL 2002). The most important measures are:

- Particle filters for all construction machinery with engines above 37 kW starting in September 2003;
- Particle filters for all construction machinery with engines above 18 kW starting in September 2006;
- Defined requirements for mechanical, thermal and chemical processes.

These measures have to be applied to all construction sites of a certain size, location and duration[53]. Smaller sites do have to apply certain good practice measures.

Previous to implementing the ordinance a simple CBA was done. It showed that PM exhaust emissions from construction machinery are responsible for about 25% of all PM exhaust emissions in Switzerland. The avoided health impacts by installing particle filters on construction machinery were estimated to be about CHF 4 billion (about € 2.5 billion) in monetary terms. However, the costs for retrofitting the construction machinery with particle filters or replacing it would cost about CHF 1.36 billion (about € 0.85 billion) between now and 2020. Hence the health benefits clearly exceed the costs of this measure (BUWAL 2003).

In Styria a guidance document[54] that contains similar measures was recently published (STMK LANDESREGIERUNG 2006b).

Extension to other cities and regions: Transport of goods for large construction sites via rail or ship is dependent on a nearby rail siding or waterway. If this is the case, these alternative means of transport can reduce emissions from construction traffic considerably. Nevertheless, the suitability has to be proved by a case-by-case analysis. Environmental management of construction sites in general is not site specific.

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[52] http://www.umwelt-schweiz.ch/buwal/de/fachgebiete/fg_luft/vorschriften/industrie_gewerbe/

[53] Within cities these are construction sites that last for more than one year and cover an area of more than 4000 m² and a cubature of more than 10,000 m³. At rural sites the respective limits are 1.5 years, 10,000 m² and 20,000 m³.

[54] http://www.umwelt.steiermark.at/cms/dokumente/10469584_12709351/5489472c/Baustellenleitfadenl.pdf

Co-benefits: A reduction of lorry traffic in general is accompanied by a reduction of air pollutants, GHG and noise. The emissions of diesel locomotives and ships as well as noise emissions have to be considered.

Limitations: Ecological management of construction sites can hardly be considered to be enforceable at small sites. As stated above transport via rail or ship is dependent on nearby facilities. In the RUMBA project it was found that most of the companies are not used to alternative means of transport. Also higher costs in some cases can limit applicability. In practice also compliance checking was found to be problematic.

5.6.9 Measures on large stationary sources (Marseille – F, Košice – SK)

Large stationary sources (industry, power plants) contribute to NO_2 and SO_2 exceedances in many cases. In the Marseille area, which is characterised by large-scale chemical and aluminium industries, measures on large point sources are a main focus of the air quality plan. The following types of measures are included:

- Change of fuel type for certain facilities
- Usage limit for certain facilities
- Additional emission control for large facilities
- Short-term measures (restrictions) during NO_2 and SO_2 pollution episodes
- Additional measures concerning ozone, with a distinction between regular and "urgent" measures, depending on ozone level.

Similarly, industry-specific measures are an important part of the plans and programmes for Košice. For a large steel factory and power plant in the Košice area, specific measures to reduce PM10 emissions (replacement of facilities, filter systems) are listed.

Extension to other cities and regions: Compared to traffic-related measures, industrial measures are very specific and cannot normally be extended to other cities and regions without modifications. To plan such measures in other regions, specific information on best available technology is more appropriate than information from other plans and programmes.

Co-benefits: Depending on the specific situation, measures in the industry sector may have additional benefits for energy efficiency, workplace conditions and reliability of facilities.

Limitations: Industry-related measures listed in the plans and programmes reviewed are in many cases cost-intensive and therefore it may take time until all measures required are implemented by the industries concerned. Filter systems which are applied to an existing facility lead to a reduction of energy efficiency of this facility. It was also mentioned in the interviews that measures which go beyond generally accepted standards (emission thresholds) are difficult to implement.

6 RECOMMENDATIONS FOR IMPROVEMENTS OF THE PLANNING PROCESS

During the in-depth analysis (chapter 5) and the quantitative analysis of all reported P&P (chapter 4) information on difficulties encountered during the planning process and implementing measures was received that inhibits the MS from complying with the LV by the attainment date. At the stakeholder workshop, ways to overcome these problems were discussed (see minutes in the Annex). Before discussing possible improvements, the experience with US State Implementation Plans (chapter 6.1) is discussed. Chapter 6.2 summarizes the findings of the EEB snapshot report; chapter 6.3 summarizes those of the in-depth analysis described in chapter 5. Based on these results, chapter 6.5 describes several options to improve the planning process. In addition, chapter 7 describes possible ways to improve the reporting process.

6.1 The US experience

The differences between the US and the EU planning process are described in detail in a study done by Milieu Ltd. (MILIEU 2004, see also chapter 3.7). Furthermore, the US AQ management as a whole is explained in a recent review (NRC 2004). In the US, a so called State Implementation Program (SIP) is required if National Ambient Air Quality Standards (NAAQS) of several "criteria pollutants" are exceeded. NAAQS have been established for the criteria pollutants PM10, PM2.5, O_3, NO_2, SO_2, CO and Lead. Depending on how severely the NAAQS are exceeded, the SIP must meet different requirements to demonstrate attainment by a certain date. This date is dependent on the severity of the exceedance. The SIP has to be approved by the US Environment Protection Agency (EPA); if it is approved, the SIP becomes enforceable as a matter of federal and state law. Otherwise the SIP has to be reviewed. If it is still inadequate or completely missing it might be replaced by a Federal Implementation Plan. EPA has several possibilities to enforce compliance (MILIEU 2004):

- **Reclassification**. EPA can reclassify an ozone non-attainment area ranked below 'severe' that fails to achieve attainment to the next higher classification. Once reclassified, a new SIP is required with more stringent pollution control measures.
- **Sanction**. There are two types of sanctions: "2-to-1" emission offsets and the withholding of federal highway funds. The former requires newly constructed or expanded major stationary sources to reduce emissions from other facilities twice the amount they project to emit at the new development. Under the federal highway fund sanction, funds for transportation projects within the non-attainment area are withheld, with the exception of projects designed to improve safety, transit, and air quality.
- **Integration**. Close integration of air quality and transportation planning authorities is required to make their plans conform with each other. These regulations mainly affect the procedure by which metropolitan planning organizations develop a transportation improvement programme, which identifies major highway and transit projects that the area will undertake.
- **Penalty fee**. Local governments within severe and extreme ozone non-attainment areas are allowed to collect a penalty fee from major stationary sources in case of failure of timely attainment.

As major strengths of the SIP process, the following points – amongst others – have been identified (NRC 2004):

- The requirement for providing an emissions inventory has facilitated the development of a uniform methodology for quantifying emissions.
- As an air quality modelling analysis is also required, the development of sophisticated models has been promoted.
- The sequence of attainment dates for O_3 depending on the severity of the exceedances provides a more reasonable and flexible timetable for authorities.
- Federally mandated emission-control measures have eased the burden of state and local authorities in developing SIPs.

As limitations to the SIP process, the following issues have been discussed (NRC 2004):

- Even though a considerable reduction of emissions has been achieved, the control measures through the SIP process have not resulted in attainment for O_3 and PM in many areas in the US.
- The process is said to have become overly bureaucratic, which hampers the tracking of progress and the assessment of performance.
- As attainment has to be demonstrated within a SIP, too much emphasis is placed on uncertain emission-based modelling simulations.
- As a SIP has to be developed individually for each pollutant it is difficult to consider multi-pollutant strategies.
- Sufficient mechanisms and governmental infrastructure for addressing multi-state aspects are lacking.

From the above mentioned strengths and weaknesses of the SIP the following conclusions can be drawn:

- Mandatory emission inventories, air quality modelling and projections can foster an efficient planning process. However, the burden for small local authorities might be considerable and quality standards for these instruments are needed.

6.2 Experience from the EEB snapshot report

On the basis of the EEB snapshot report (see chapter 3.6) the following recommendations can be given (EEB 2005):

- An easier access to P&P submitted by the MS to the EC should be established;
- Implementation of proposed measures is often not assured. Therefore a clear timeframe and a binding political commitment should be given;
- Also financing of the measures is not assured. Hence a clear indication should be made of how much each of the proposed measures costs and how it might be financed;
- Projections as to how AQ will evolve are often missing. It is therefore often not clear if the measures suffice to comply with LV by the attainment date. Thus the use of AQ projections should be enforced.
- Coherency with national policies (e.g. for road infrastructure extensions) and NEC plans should be established.

6.3 Problems encountered in the in-depth analysis

The in-depth-analysis showed that in most cases compliance with the limit values was not reached or will not be reached by the attainment date (see chapter 5.5.1). The main problems seem to be:

- **Timing**. Planning (and subsequently also implementation) of measures may have started too late. Additionally, some efficient measures require several years of planning (e.g. LEZ, a CC schemes or improvements of public transport infrastructure).
- **Implementation problems**. The political and public acceptance of measures, and especially traffic measures, is sometimes limited. Also, high costs of some measures in combination with limited funding hamper a rapid implementation. Furthermore the legal competencies for applying certain measures are divided among different administrative levels or authorities.
- **Technical difficulties**. Difficult source apportionment in the case of PM10 and inaccurate emission inventories also hamper the identification of relevant sources. In addition, the underestimation of real world emission factors compared to EURO standards (and therefore overoptimistic expectations for the results of EURO standards) as well as an increase in primary NO_2 emissions[55] of diesel vehicles might lead to an underestimation of projected emission reductions and therefore to the implementation of insufficient measures. Furthermore there is also still uncertainty about the date and ambition level of new EURO standards.
- **Other reasons**. High regional background concentrations and/or high overall concentrations of PM10 require profound and widespread measures. Additionally, inter-annual variations of meteorological conditions and related variations in pollutant concentrations bring uncertainty into the required emission reduction.

[55] On September 19th 2006 a workshop was held in Brussels on the impact of direct emissions of NO_2 from road vehicles on NO_2 concentrations. The presentations are available via a CIRCA-website: http://forum.europa.eu.int/Public/irc/env/cafe_baseline/library?l=/cafe_ambient_quality/workshop_vehicles&vm=detailed&sb=Title

At the stakeholder workshop also problems and ways to overcome them were discussed in a working group. The following additional problems were mentioned:

- The ongoing discussion about changes (and weakening) of PM10 LV in the European parliament discourages authorities from implementing measures to comply with this LV;
- The effectiveness of certain measures is not known well enough.
- Some measures to lower GHG emissions can lead to an increase in emissions of classic air pollutants. This is true especially for biomass burning and diesel vehicles;
- Financial resources and manpower within regional and local authorities might be inadequate to set up an effective planning process.

Most of the problems listed above cannot easily be solved immediately. There are however many ongoing projects and processes that support the necessary improvements. These improvements might take place partly on EU but also on national level.

6.4 Recommendations from the stakeholder workshop

At the stakeholder workshop, held in Brussels on 9th October 2006, possible ways to improve P&P were discussed in three working groups[56]. The findings related to the planning process are summarized in the following (findings related to reporting of P&P are presented in chapter 7.2):

- The elaboration of an emission inventory and the use of AQ modelling should be made mandatory;
- Coherency between plans for AQ, CC, NEC and transport plans should be established;
- Exchange of good practice examples (as well as examples of unsuccessful measures) should be encouraged;
- Regular evaluations during the planning and implementation of measures should be established. These should include monitoring, emission inventories and activity data; a thorough ex-post analysis and the selection of appropriate indicators to assess the success of measures are recommended;
- Stringent measures on the EU level (e.g., EURO standards) were seen as essential to comply with limit values;
- Public awareness should be raised. Furthermore, the planning process should be made more transparent to the public.

6.5 Options to further improve the planning process

Improvements of the planning process at the European and national level seem necessary to assure compliance, which is not the case now in many cities and regions throughout Europe.

In general terms, important elements of the planning process are:

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[56] The presentations as well as the minutes of the workshop can be downloaded from a CIRCA website: http://forum.europa.eu.int/Public/irc/env/cafe_baseline/library?l=/cafe_ambient_quality/workshop_programmes&vm=detailed&sb=Title

- Strategic and long term planning;
- Establishment of a framework to identify (cost-)effective measures;
- Integrated approach that covers different environmental issues;
- Raising of public awareness to gain support for implementing measures;
- Public information campaigns;
- Public consultations;
- Involvement of all necessary stakeholders from the beginning of the planning process;
- Coherent presentation of measures (which also requires an integrated approach);
- Consultations with other authorities and MS to avoid redundancy.

In order to apply for an extension of the attainment date as foreseen in the new AQ Dir (this Directive is currently discussed in Parliament and Council) it will most probably be necessary to meet certain requirements. These include the availability of a plan and programme which includes all the necessary information according to Annex IV of the current AQ FWD. Some of the plans and programmes assessed during this study do not meet these requirements. In the following chapters several options for improving the planning process are given that have been identified at the stakeholder workshop and during the analysis of P&P. Chapter 7 gives recommendations for improvements in the reporting of P&P.

6.5.1 Mandatory emission inventories and AQ modelling

An up-to-date emission inventory that comprises all relevant sources is a prerequisite for AQ planning and modelling. This inventory should cover the years within which exceedances of LV were encountered. A projection of future emission levels is necessary in order to estimate the required extent of the measures. The spatial resolution of the emission inventory should be suitable for the spatial extent of the exceedance situation as well as of the AQ modelling.

AQ modelling on the other hand is a necessary tool to estimate the area of exceedance as well as the effectiveness of measures. AQ models are available for different spatial scales and topographic situations. The German Federal State of North Rhine-Westphalia e.g. supports the local authorities with a web based high resolution street model (DIEGMANN & HARTMANN 2006).

The COST Actions 728[57] and 732[58] presently focus on the quality assurance and on recommendations for the proper application of AQ models for regional transport and for street canyons respectively.

The available meteorological input is also essential for AQ modelling. In this context, we refer to the recommendations of COST Action 715[59] concerning "Meteorology applied to urban air pollution problems" (FISHER ET AL. 2006).

In many cases, nested model approaches seem to be best for considering regional and even long range transport as well as very local emission scenarios e.g. within a district or single

[57]Enhancing Mesoscale Meteorological Modelling Capabilities for Air Pollution and Dispersion Applications; http://www.cost728.org/

[58] Quality Assurance and Improvement of Micro-Scale Meteorological Models; http://www.mi.uni-hamburg.de/COST_732.464.0.html

[59]Meteorology applied to Urban Air Pollution Problems; http://www2.dmu.dk/atmosphericenvironment/cost715.htm

street canyon as e.g. the nested REM/CALGRID model runs for Berlin. In other cases, a focus on the local concentrations within a complex building structure as e.g. modelled with ADMS Urban for London is justified if the regional background is well characterized by measurements or known from larger scale modelling.

6.5.2 Exchange of good practice examples

As AQ problems are widespread in the EU, certain measures already implemented in one MS might be suitable as well in other MS and communities. This report contains selected examples of successful measures. In addition to success stories also failures (e.g. measures that were less effective than expected or could not be implemented at all) should be made public as well to avoid the same experience in other communities. Several ways to exchange good practice examples (and failures) are conceivable:

- A database of measures. Such a database[60] was established e.g. during the “ex post” evaluation of short term and local measures (AEA TECHNOLOGY ENVIRONMENT 2005, see chapter 3.8). Also within the INTEGAIRE[61] project a collection of good practice examples was undertaken. On a national scale in some MS databases (or a description) of measures have been set up as well (e.g. in the UK[62]; in Germany all P&P are available via a database[63]. Furthermore in Germany a database for traffic measures has recently been elaborated and will be published soon[64]). The main problem of a once established database is to guarantee its regular update (e.g. the INTEGAIRE database is currently not updated due to lack in funding).
- An institutionalized exchange of information among interested authorities. This could include e.g. regular meetings on a European level as well as meetings on a national level. The outcome of such meetings should be made available e.g. via a website.
- A web-based forum. A restricted system could be set up that allows users to add examples of measures and results of their studies
- Good practice examples may also be used as a basis for guidelines (see chapter 6.5.3),

6.5.3 Guidelines

Local and regional authorities often lack resources (financial and staff) to set up a comprehensive planning process on their own. Hence guidelines to support them and help avoid redundancy seem useful and necessary. Especially in the UK an extensive set of guidelines elaborated by DEFRA is available[65]. For action plans guidelines are given as well[66]. There is also a Beacon scheme that highlights excellent and innovative plans[67]. Furthermore the UK supports

[60] The database can be downloaded from: http://www.airquality.co.uk/archive/reports/reports.php?action=category&section_id=9

[61] http://www.integaire.org/database-new/gpdb.php?m=0

[62] http://www.casellastanger.com/actionplan_helpdesk/best_practice.asp

[63] http://www.env-it.de/luftdaten/download/public/html/Luftreinhalteplaene/uballl.htm

[64] personal communication A. Baum, Federal Highway Research Institute, Bergisch Gladbach, Germany.

[65] http://www.defra.gov.uk/environment/airquality/local/guidance/index.htm

[66] http://nscaorguk.site.securepod.com/pages/topics_and_issues/air_quality_guidance.cfm

[67] http://www.idea-knowledge.gov.uk/idk/core/page.do?pageId=5096139

its authorities with a helpdesk[68]. For LEZ the requirements for guidelines have been suggested in a recent study (SADLER CONSULTANTS 2006).

For the Urban Thematic Strategy[69] it is foreseen that the EC provides guidelines as well. Technical guidance should be given in 2007 on integrated environmental management and sustainable urban transport, drawing on experiences and giving good practice examples. Reference will be made to the most relevant EU environmental legislation e.g. air, noise, water, waste and energy efficiency directives. Furthermore support will be given for the exchange of good practice and for demonstration projects on urban issues for local and regional authorities through these instruments. The EC will assess the feasibility of establishing a thematic portal for local authorities.

In order to account for natural sources, guidelines are currently elaborated by the Joint Research Centre (JRC) in Ispra under a contract of the EC. A workshop[70] to support this project was held in Ispra on 12th and 13th October 2006.

Furthermore the EC has initiated an update of the CORINAIR emission guidebook, especially to improve the quality of PM emission inventories as PM2.5 will most probably be included in the revision of the NEC Directive.

AIR4EU is a FP6 research project that started in 2004 and will be finalised at the end of 2006. It will provide recommendations on Air Quality assessment by monitoring and modelling for regulated pollutants in Europe (**http://www.air4eu.nl/).** The recommendations will cover in the field of monitoring issues such as network design for pairing urban and background monitoring sites, meteorological monitoring, traffic data for hotspot sites, data quality procedures. For modelling recommendations will be given *inter alia* for uncertainty analysis, validation, quality of input data and calculation of population exposure.

6.5.4 Evaluation of the planning process

Within this contract, available information of air quality plans prepared according to the AQ FWD were assessed. However, information on the effectiveness of measures was only available in a few cases. In addition, some measures require time to become effective. It is expected that new information on these items will become available in the next few years. Therefore, the effectiveness of the measures planned and implemented should be evaluated on a regular basis. This evaluation should cover effects on activity, emissions, AQ as well as planned and actual expenses. To undertake an evaluation, appropriate indicators to monitor the progress have to be available from the beginning. It is recommended that the evaluation results should be made available to the EC and to other authorities in order to profit from the experiences gained (see also chapter 7). A thorough evaluation has e.g. been done by the UK for the national AQ strategy[71] (AEA TECHNOLOGY ENVIRONMENT 2004), for the local air quality management process in the UK (AQC 2002) and by Germany (IVU 2006). The results of these evaluations are described in chapter 5.2.2).

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[68] **http://www.casellastanger.com/actionplan_helpdesk/index.asp**

[69] **http://ec.europa.eu/environment/urban/thematic_strategy.htm**

[70] The presentations can be downloaded from: **http://natsources.jrc.it/**

[71] **http://www.defra.gov.uk/environment/airquality/publications/stratevaluation/index.htm**

In order to evaluate the effectiveness of measures, suitable indicators are necessary. With the help of an indicator the effect of certain measures must be determined in a quantitative way. Because in many cases the effect of single measures on air quality cannot be quantified directly, indicators should also be based on activity data or emission data or both. Possible indicators for traffic might be *inter alia*:

- Activity data for traffic including:
  - Number of vehicles on a certain road section or area;
  - Number of passengers using (specific) public transport facilities
  - Number of specific vehicles (e.g. lorries) on a certain road or area;
  - Average speed of vehicles;
  - Specific fuel sold in a certain area;
  - …
- Emission data for traffic:
  - Number of vehicles with specific emission factors or age;
  - Calculated emission reduction in certain sub-sectors or areas;
  - Number of vehicles with specific after-treatment systems (e.g. diesel particle filters);
  - …

Examples of possible indicators for residential heating are:

- Number of old stoves replaced;
- Number of households with district heating;
- Number of buildings insulated;
- Amount of fuel used separated by different fuels

Examples of possible indicators for industry are:

- Emission limit values for certain installations;
- Annual emissions

6.5.5 Coherency with other plans and policies

Measures to improve AQ might have an effect on other media or in different areas. These effects can be synergistic or antagonistic. On the other hand various policies can have an influence on AQ. The most important ones are policies to tackle climate change and transport policies. Policies for agriculture, noise and energy efficiency are of importance as well. Climate change policies in general should improve AQ and vice versa as both aim at reducing activity and emissions. Problems arise, however, for biomass burning and diesel vehicles. Both are encouraged to reduce GHG emissions, but lead to increased PM emissions. This conflict is often difficult to communicate. Hence stringent emission limits for both biomass burning and diesel vehicles are important in order to prevent discrediting of either climate change or AQ measures. It has to be noted that filter technologies to handle AQ problems in general might lead to an increase in energy consumption.

As traffic was most often named to be the main cause for exceedances, transport policies are of great importance to AQ planning. However, these policies are not aligned in some cases as it has been shown in the EEB snapshot report (EEB 2005, see chapter 3.6). For example, whereas the AQ P&P foresees a reduction of traffic volume, the transport policy foresees an extension of the road network which in many cases leads to an increase in traffic volume.

Hence for successful AQ planning it seems inevitable to undertake an integrated approach. Within such an approach, different policies (AQ, climate change, noise, transport, energy efficiency, agriculture) and the respective stakeholders have to be taken into account. Guidance for such an approach will be provided under the Urban Thematic Strategy (see chapter 6.5.3). In practice the main problem might be the distribution of responsibilities among different authorities and administrative levels.

6.5.6 Political commitment and public support

A problem often cited by AQ experts is the lack of political commitment to implement certain measures. Without commitment, even those measures that can be regarded as rather mild such as speed restrictions cannot be implemented. On the other hand with strong political commitment (accompanied by awareness raising campaigns and public consultations) even stringent measures such as a congestion charge (London, Stockholm) and traffic restrictions (province of Bozen – Südtirol, Milan) were implemented (see chapters 5.6.2and 5.6.3).

The extension of the attainment date as foreseen in the currently discussed new AQ Dir. might increase the political commitment as only those cities are eligible for an extension that have developed an ambitious P&P.

6.5.7 Measures on Community level

A number of effective measures can most effectively be implemented at an EU wide level. These measures include:

- Adoption of a revised NEC Directive which should also include national emission ceilings for PM2.5 and ambitious ceilings for NO_x, SO_2, NMVOC and NH_3.
- Early introduction of tight emissions standards for cars and heavy duty vehicles

In addition, the Commission could support the preparation of guidelines for national/regional/local authorities and consider a mechanism for retrofit certification (e.g. for currently planned LEZ) (SADLER CONSULTANt 2006).

6.6 Open questions, need for further research

There are some technical difficulties that hamper the planning process. Some of these have been identified in the in-depth analysis and the stakeholder workshop. Need for research and clarification exists *inter alia* for the following issues:

- Effectiveness of measures;
- Real world emission factors of vehicles;
- Future emission factors of passenger cars and lorries;
- Changing NO/NO_2 ratio of diesel exhaust emissions;
- Improvement of emission inventories esp. for fugitive emissions (resuspension, construction work).

To summarise, the evaluation of plans and programmes as well as the check for compliance at the attainment date showed that timely planning is a prerequisite for the successful implementation of measures. Due to the long time scale of many measures and due to common implementation difficulties, it is critical to thoroughly plan all measures. The analysis showed that compliance is feasible only if the measures are based on good planning.

7 RECOMMENDATIONS FOR IMPROVEMENT OF REPORTING OF P&P

A working group to draft guidelines for implementing P&P under AQ FWD (WORKING GROUP ON IMPLEMENTATION 2003) was established by DG ENV. These guidelines were published in 2003 and were the basis for Commission Decision 2004/224/EC for laying down arrangements for the submission of information on plans or programmes required under Council Directive 96/62/EC. The guidelines suggested seven forms that include information about the responsible authority, a description of the exceedance situation, expected future concentrations and measures to improve air quality. An Excel spreadsheet[72] was prepared to facilitate the submission of this information in a harmonised way. Most of the recent information on P&P was submitted to the Commission either by using the Excel spreadsheet or a similar tabular structure (see chapter 4.1). However, the analysis of the information on P&P has shown that there are considerable differences between the various forms submitted by the MS. There are also some problems with incomplete or erroneous forms. In addition, the in-depth analysis within this project and other studies have shown that some further information would be needed to allow evaluation of the information on P&P, to monitor the progress of implementation, link to other plans or policies etc.

In section 7.1, problems encountered during the present studies are listed. These concern differences between member states, problems with the excel spreadsheet, and problems encountered in the P&P analysed in detail. Section 7.2 lists areas of improvement which were discussed in the stakeholder workshop. Based on these problems and areas of improvement, recommendations for improvement of reporting are given in section 7.3.

7.1 Problems encountered in the analysis

Within the in-depth analysis and the quantitative analysis of all reports on P&P some problems and missing information have been identified either in the reports on P&P or in the draft guidelines and the P&P themselves.

The reports on P&P vary considerably between MS. The main differences are:

- **Different geographical scope**. Reports on P&P cover a very wide geographical range from local situations covering just one exceedance situation to the whole country (NL, UK). In the UK example, a whole set of strategies is referred to in the report on P&P.
- **Different degree of merging** exceedance situations.
- **Different level of detail given for measures**. Some measures are described in detail, for others, the description is not sufficient enough to clarify the type of measure.

The main problems and mistakes encountered in the Excel spreadsheets are:

- **Incomplete forms**. Important information is often missing. This concerns information on the exceedance situations (e.g. estimate of the population exposed), or on the measures (e.g costs, time scale, indicators). In some cases the information might simply not be available, in others the information might not have been provided. In this context, it has to be

[72] The spreadsheet in different EU languages can be downloaded from: http://ec.europa.eu/environment/air/ambient.htm, the English form is available under: http://ec.europa.eu/environment/air/pdf/form_en.xls.

noted that most of the information is mandatory because it reflects the requirements of Annex IV of Directive 1996/62/EC (see chapter 4.5).

- **Changed Excel spreadsheets**. In some cases the spreadsheets were altered, e.g. by adding or deleting rows. This makes evaluation more time-consuming, because the forms have to be changed back to the standard format before importing the information into the database.
- **Additional information**. In some cases, additional information was entered in fields which are not foreseen for information. Even though this information is often valuable, it cannot be included into the database easily.
- **Erroneous input**. Some fields were not filled in with the expected input, e.g. for the type of stations where the exceedance situations occurred.
- **Language**. The Excel spreadsheets are available in different EU languages; this is not the case however for the draft guidelines from the Working Group on Implementation.
- **Outdated hyperlinks**. In some cases the link to the P&P given in the Excel spreadsheet was not valid any more. Hence it might be difficult to get hold of the P&P. This also refers to email addresses of the responsible person.
- **CDR incomplete**. The Central Data Repository[73] (CDR) of the EEA does not contain all reports on P&P.

Some of the problems mentioned above hamper inclusion of the information on P&P in a database.

The in-depth-analysis (chapter 5) identified the following main areas of reporting where improvement is possible:

- Cost estimates for the measures are often not given (or available).
- The effectiveness of measures with respect to emission reductions and AQ improvement is often not given.
- The timescale of the reduction is given in the information on P&P, however, the information on when the measure will be implemented (which date) is not given.
- The legal status of the measures varies. In some cases measures are listed for which a declaration of intent was made only.
- Often no feedback loops are indicated, neither to adjust measures nor between different authorities.
- There is also no institutionalised feedback from the EC to the MS nor is there a regular evaluation concerning reports on P&P or P&P themselves, e.g. as it is the case for emission reporting within the Convention on LRTAP system.
- Cross border cooperation was not mentioned in any of the P&P, even though transboundary AP considerably contributes to AQ in some regions. The AQ directive foresees consultation between MS with the presence of the Commission, although no formal procedure is foreseen in this case.

[73] http://cdr.eionet.europa.eu/

7.2 Areas of improvement discussed in the stakeholder workshop

In the stakeholder workshop, possible improvements of the reporting procedure of P&P were discussed. Participants made suggestions which are related to information exchange, practical guidance, and an overall strategy.

Concerning information exchange, it was suggested that access of member states to available information should be facilitated, timely uploading of information promoted, and the information harmonized. It was also suggested that an analysis or comparison of submitted information should be made available and finally, information on the financing of reported measures be included.

Improvements of the implementing provisions by providing guidance were suggested in the following areas: Technical guidance, guidelines for indicators and criteria for time extension. Exposure should also be used as an indicator and guidelines or best practice examples were suggested specifically for each pollutant. It was also suggested that based on the assessment of available plans and programmes, an overall strategy on planning should be developed.

7.3 Recommendations for improvement of the reports and the guidelines

From the problems and areas of improvement listed above, several recommendations can be deduced. The most ones that can most easily be applied are minor changes to the Excel spreadsheet and to the draft guidelines (WORKING GROUP ON IMPLEMENTATION 2003).The following points are recommended, based on the analysis and feedback from stakeholders:

- The Excel spreadsheet should be changed in order to prevent erroneous input, e.g. with the help of drop down menus.
- To prevent changes to the spreadsheet it should be locked, except for the cells where input is required.
- Minor clarifications may be made in the guidelines, e.g. a clearer explanation of “measures beyond those resulting from existing legislation”.

To facilitate the evaluation of the reports on P&P and to gain more insight into the effectiveness of the suggested measures, some information additional to what is already necessary would be helpful. The following additional information is recommended:

- An indication of the legal status of the measures and the P&P itself.
- Information on the projected emission reduction associated with the measure.
- Information on costs of measures.
- The date when the measure will be implemented and become fully effective as currently only the timescale of the reduction is given in the information on P&P.
- Levels of effectiveness with respect to emission reductions and AQ improvement of individual measures (if possible) or of the P&P as a whole. Currently only the estimated level has to be given for the years when the limit value has to be met.
- An indication of feedback loops and cooperation with other authorities would be helpful.
- Reporting of additional indicators of the effectiveness of measures other than AQ monitoring should be encouraged.

The following additional recommendations related to the role of the Commission are given:

- An institutionalised and regular feedback from the EC as well as a regular evaluation of the submitted reports on P&P (and the P&P) should be implemented. This could be done in a way similar (but maybe less sophisticated) to emission reporting within the Convention on the LRTAP system, which involves feedback loops with the countries.
- Cross border cooperation, should be encouraged and supported by the Commission. This may include consultation between member states in case of transboundary pollution, but also an exchange of experience related to the planning and implementation of measures.
- The reports should be regularly fed into the database to facilitate quantitative analysis.
- Furthermore it is recommended that all reports on P&P as well as the P&P themselves should be uploaded to the CDR of the EEA without delay.

To summarize, the procedure for completing the forms should be simplified by providing a more "comfortable" excel file and updated guidelines. However, the information to be entered should not be reduced and the overall structure does not need to be changed.

8 ABBREVIATIONS

AQ .... Air Quality

BAT .... Best Available Technology

CAA .... Clean Air Act

CBA .... Cost-Benefit Analysis

CC .... Congestion Charge (sometimes also Climate Change)

CDR..................... Central Data Repository (http://cdr.eionet.europa.eu/)

CO .... Carbon Monoxide

DD .... Daughter Directive

DG ENV............... Directorate General – Environment of the European Commission

EC .... European Commission

EMEP .... Co-operative programme for monitoring and evaluation of the long-range transmissions of air pollutants in Europe (http://www.emep.int/)

EPA .... Environmental Protection Agency (www.epa.gov)

EU .... European Union

FWD .... Frame Work Directive

GHG .... Green House Gas

HDV .... Heavy Duty Vehicle

IAM .... Integrated Assessment Modelling

IIASA .... International Institute for Applied Systems Analysis (http://www.iiasa.ac.at/)

JRC...................... Joint Research Centre

LCP...................... Large Combustion Plant

LDV...................... Light Duty Vehicle

LEZ .... Low Emission Zone(s)

LRTAP .... Long Range Transboundary Air Pollution

LV .... Limit Value

MS .... Member State

NAAQS .... National Ambient Air Quality Standards

NEC .... National Emission Ceilings

NO .... Nitrogen Oxide

NO_2...................... Nitrogen Dioxide

NO_x...................... Nitrogen Oxides, a combination of NO_2, NO and N_2O

P&P .... Plans and Programme(s)

P+R .... Park and Ride

PM10 .... Particulate Matter less than 10 µm

PM2.5 .... Particulate Matter less than 2.5 µm

ppb....................... parts per billion

RAINS.................. Regional Air Pollution Information and Simulation

SIP....................... State Implementation Plan

SO_2 .... Sulphur Dioxide

SUTP .... Sustainable Urban Transport Plan

UNECE .... United Nations Economic Commission for Europe (**www.unece.org**)

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ANNEX: MINUTES OF THE STAKEHOLDER WORKSHOP

Workshop 'Assessment of plans and programmes' on 9.10.2006, Brussels

The workshop, which was hosted by DG ENV and Umweltbundesamt (Austria), was attended by about 60 experts (representatives of several European Member States and other stakeholders). The presentations are available at a CIRCA website:

http://forum.europa.eu.int/Public/irc/env/cafe_baseline/library?l=/cafe_ambient_quality/workshop_programmes&vm=detailed&sb=Title

Background

The Air Quality Framework Directive (96/62/EC; AQ FWD) and its four Daughter Directives (DD) set air quality objectives which have to be attained by a certain date.

In case the sum of a limit value and margin of tolerance is exceeded in a zone prior to the attainment date, plans or programmes have to be established and implemented to ensure that the limit or target values are achieved by the attainment date defined in the Directive.

The first plans or programmes were due after exceedances of the sum of the limit value and the margin of tolerance of the pollutants covered by the 1st DD (1999/30/EC) in 2001. A number of plans or programmes (P&P) have been elaborated since then and information on these plans has been submitted to the European Commission.

The European Commission has contracted the Austrian Federal Environment Agency (Umweltbundesamt) to assess the 'Plans and Programmes reported under 1996/62/EC' in order to analyse the experiences gained in various Member States.

The aim of the workshop was to present and discuss the main findings of an in-depth analysis of P&P with stakeholders and to discuss recommendations for their improvement. The results of the workshop will be incorporated into the final report of this project, which will be submitted to the Commission before 21st December 2006.

Introduction to the workshop

Marianne Klingbeil, Head of Clean Air & Transport Unit, DG Environment, gave the introductory address for this workshop. She highlighted the proactive approach of DG ENV which was also behind the decision to hold this workshop. The aim of the contract with Umweltbundesamt is to assess the effectiveness of plans and programmes (P&P). She also mentioned ongoing negotiations on the revision of the air quality legislation. Another important aspect is the dissemination of best practice examples.

Jürgen Schneider from Umweltbundesamt gave on overview of the overall project and of the aims of this workshop. He provided a short introduction to the legal requirements for P&P. He highlighted preliminary results, especially the recommendations, which would be discussed with the stakeholders. Feedback from the stakeholders was essential for elaboration of the recommendations.

Lorenz Moosmann (Umweltbundesamt) presented a quantitative analysis of the reports on the P&P that had been submitted to the European Commission (EC) by April 2006. He noted that for the final report the database would be updated and all reports on P&P received by the end of October would be considered. For the analysis presented about 100 reports on P&P were taken into account. These contained about 370 exceedance situations and 1300 measures. These reports were fed into a database to facilitate the analysis. Most exceedance situations were reported for PM10, followed by NO_2 and SO_2. The available P&P cover most of Europe, nevertheless information from some Member States was still missing. Traffic was named as the most important cause of PM10 and NO_2 exceedances. The timescale, the spatial scale and the types of measures showed a large variety throughout Europe. As the main reason for not taking specific measures, a lack in legal competence was named, followed by costs. As an indicator to monitor progress of the measures, air quality (AQ) monitoring was mentioned most often.

Andrej Kobe (EC, DG ENV) urged those countries that had not submitted P&P so far to do this as soon as possible. He highlighted furthermore that for time extensions to be granted, the quality of the P&P would be important. Implementing new measures without further delay might also reduce the loss of further lives; he also mentioned some results from CAFE, indicating that the benefits of reduction measures usually outweigh the costs of measures to improve AQ.

In the draft final report some Member States were cited as not having submitted P&P. Jürgen Schneider assured that the contractor would double-check available information and include all P&P which had been submitted to the EC for the final report.

Experiences

In the second part of the workshop experiences from several MS were shown.

László Kacsóh (German Umweltbundesamt) presented the results of a study contracted by the Ministry and the German Umweltbundesamt. This study scrutinized the effectiveness of measures to reduce PM and NO_2 exceedances in Germany. He stressed that the federal structure of Germany causes implementation problems as the competencies of the federal government are limited. The public view of there being no evident AQ problem also hampers the implementation of measures.

He concisely described the areas of exceedance in Germany and the contribution of emissions on different spatial scales to the exceedances. It is expected that NO_2 limit values (LV) will be exceeded in 2010. He noted that for Stuttgart, traffic would have to be reduced by 60-70 % in order to comply with the LV. Furthermore conflicting environmental policies were mentioned. These include mainly the promotion of biomass burning as well as the contradictory PM/NO issue as far as traffic is concerned.

Alessandra Fino and Valentina Pucci (Ministero dell'Ambiente e della Tutela del Territorio e del Mare -Direzione generale per la salvaguardia ambientale- IV Divisione IAM) presented AQ policy and examples of measures in Italy. Measures were described for the province of Bozen and the region of Lombardy, as well as other local initiatives from the regions and autonomous provinces of the Padena Basin. In the last part of the presentation, additional national measures and studies and activities to improve the scientific background for these measures were presented.

Kerstin Meyer (EEB) EEB – NGO Assessment of plans and programme

The European Environmental Bureau (EEB) prepared four reports on the implementation of key directives. For one of these reports (the assessment of plans and programmes to reduce particulate matter pollution) questionnaires were sent to EEB member organisations and data from 30 cities were analysed[74].

From the new member states, there were no P&P but other information on air quality planning was available. In general, the information was easily available on the internet.

Besides many complementing measures, some measures contradicting air quality improvement were found in the plans and programmes. In 12 out of 24 cities, no plans or programmes were adopted before the year 2005.

An indicative ranking of plans, based on the proposed measures, was presented. Measures mentioned most frequently were charges for parking space and promotion of alternative transport. Low emission zones were planned in three cities only. Some measures were not only introduced to reduce PM pollution, but also for other reasons like supporting tourism in the city centre.

It was found that it is important to clarify at what time individual measures in the plan will be implemented. In many cases, there were delays, e.g. due to various levels of administration. More than half of the plans failed to show how the measures will be financed, and projections regarding the impact on air quality and the time scale of this effect were often missing.

Janet Dixon (DEFRA, UK) presented AQ planning in the UK. She showed in which zones in the UK LV are breached. Most problems occur for PM10 and NO_2 in Greater London. Concentrations are determined by measurements as well as by modelling. The UK P&P cover all levels from local to international. She mentioned various national activities such as a review of the national AQ strategy, road side testing of vehicles, Air Transport White Paper, transport plans, climate change programmes, etc. The review of the AQ strategy showed that the health benefits clearly exceeded the cost. Within the review of the UK AQ strategy also a cost-benefit analysis for various scenarios was undertaken. Results for scenario Q (accelerated introduction of new Euro standards, low emission vehicles, measures for small combustion plants) were shown in more detail. These included model calculations for the whole of the UK and estimations for the road length where NO_2 LV are still exceeded in 2020.

To close the gap in London several measures such as congestion charge extension, renewal of the London bus fleet, and a Low Emission Zone (LEZ) are foreseen.

On a local level many action plans are in place or being planned. Most of them deal with traffic; domestic heating is a problem in Northern Ireland only.

The main problems identified in the planning process were source apportionment, calculation of re-suspension, underestimation of real world emission factors, increase in primary NO_2 at roadsides, inter-annual variation of meteorology, timescale of measures, and difficulty in quantifying effects. On a local level, a lack of resources and staff was noted as well as difficulties in engaging other internal departments and external organisations.

[74] http://www.eeb.org/activities/air/EEB_Snapshot_Report_Air.pdf

It was recommended that modelling should be used for reporting P&P, that an EU-wide certification of retrofits should be developed as well as an EU standard labelling scheme to assist the implementation of LEZ and to encourage a Europe-wide exchange of good and best practices.

Experiences with AQ planning in Portugal were presented by **Ana Isabel Miranda** (Universidade de Aveiro) and **Francisco Ferreira** (Universidade Nova de Lisboa). Problems occur mostly for PM10 in the cities of Lisbon and Porto. Exceedances are caused by local sources, however there is also a strong contribution from natural sources esp. Saharan dust und wild fires. In winter also wood burning contributes to elevated PM levels. The P&P was submitted to the EC in June 2005, however due to legal problems it could not be implemented yet. To improve AQ a no-traffic zone was established in Lisbon. The effectiveness was shown by a measurement campaign, which revealed considerably lower levels within the zone. Street cleaning was tested as well, however this measure proved to be problematic as drinking water had to be used during a drought period. For several measures an evaluation was undertaken.

P&P for Styria and the city of Graz were presented by **Andreas Schopper** (Regional Government of Styria, Austria). The main problem in Graz is PM10 mostly due to the climatological situation with low wind speed and long lasting adverse disperse conditions rather than high emission densities. Traffic was identified as the major local source, about one third results from domestic heating. Long range transport of air pollutants has a relatively low share (less than 10 %).

The P&P in Styria focuses on the one hand on ordinances in order to comply with the Austrian Air Quality Protection Act, and on the other hand on additional measures taken by the regional government. To improve AQ, speed restrictions as well as traffic restrictions for Heavy Duty Vehicles (HDVs) and passenger cars are foreseen for pollution episodes (similar to Bozen). More severe restrictions (bans on even or odd number plates) were not implemented due to severe organisational problems (availability of public transport, etc). Diesel particle filters (DPF) for machinery will become obligatory to reduce emissions from construction sites. Furthermore good practice guidelines were developed for communities within air quality management regions. It is also foreseen to launch a programme to replace for old wood stoves by low emitting heating devices. Financial subsidies up to 100 % are granted by Styria to encourage replacement.

Results of the in-depth analysis were presented by **Christian Nagl** (Umweltbundesamt)

In this presentation, the criteria for selecting cities and an overview of the cities chosen for the in-depth analysis were given. Compliance with the PM10 limit value by the attainment date was not achieved in the selected cities, and only a few cities predicted compliance with the NO_2 limit value by 2010.

The reasons for non-compliance were found to be timing, implementation problems (public support, high costs, legal responsibilities), technical difficulties (inaccurate emission data) and other reasons like high background levels.

Besides air quality plans, transport plans were available for several cities. In some cases, there is cooperation between transport and air quality planning and environmental goals are stated in transport plans.

Concerning the effectiveness of measures, an overview was given of those plans and programmes that included information on emission reduction, effect on air quality, analysis of costs, and assessment of benefits. Information on cost and benefits was missing in many cases.

The following supporting factors were found to be crucial in the planning process: communication and participation of stakeholders, strong political commitment, and dissemination of information to the public. Based on these supporting factors, an overview was given of the preliminary recommendations which were to be discussed in the workshops in the afternoon.

In the presentation, the following conclusions were drawn: Compliance by the attainment date is rarely achieved; often, the effect of measures is not assessed and public and political support is lacking. Therefore, an integrative approach is essential to air quality planning.

Preliminary recommendations were given to be discussed in the working groups in the afternoon. These were also shortly described in the draft final report.

In the discussion, the need for technical guidance, e.g. concerning the definition of background concentrations, was pointed out. It was also pointed out that in Poland cooperation between regions is organized specifically for their common air quality problems. Other clarifications were made concerning the state of the Warszawa air quality plan and compliance with the NO_2 limit value in Copenhagen (the latter will most probably not be achieved, contrary to expectations).

As one of the reasons for the delay of the Berlin P&P it was pointed out that emission factors had not been received in time. The regions find themselves at the end of a chain and are crucially dependent on data. Similarly, federal regulations are needed for some measures. Finally, financial support is also critical.

It was suggested to set up a central website with links to all P&P, as it is done in Germany. It was also noted that P&P can and should be uploaded to the CDR of the EIONET database.

It was pointed out that the effect of legislation was overestimated for heavy-duty vehicles, and that there was also an underestimation for light vehicles. In the years to come, the relevance of sources will change due to already decided measures in the automotive sector. Therefore, these effects should be taken into account in air quality planning.

As cooperation between member states is included in existing legislation, MS are invited to make use of this possibility. Currently Germany, Poland and Belgium have held bilateral consultations. Concerning the transmission of P&P, most infringement procedures are now closed because missing P&P were transmitted. The new AQ Directive proposal includes options for time extensions, for which strict rules will apply.

Working groups

In three working groups, the following topics were discussed:

1. How can the planning process be improved on a local, regional, national and international level?

Suggestions were made concerning a mandatory emission inventory, modelling, coherency between air quality plans and other plans, exchange of good practice examples and regular evaluation during planning and implementation.

2. How can the implementing provisions be improved?

Suggestions were made concerning the exchange of information (from the member states to the Commission and vice versa), providing a clear planning strategy, and several forms of guidance documents (e.g. criteria for time extension, or for indicators).

3. What are major obstacles and ways to overcome them?

As major obstacles the following points were mentioned: A lack of political commitment, the ongoing discussion about weakening the PM10 LV, uncertainties concerning emission factors and the effectiveness of measures, conflicts with climate change

To overcome these major obstacles, the raising of public awareness, consistency with measures in the area of climate change, dissemination of good practice examples and examples of failure, and guidance for indicators were suggested. Also, various research needs (mainly to improve emission inventories) were pointed out to facilitate air quality planning.

After the working groups, the suggestion of using exposure targets was discussed. A workshop on cost-effective measures to reduce urban air pollution to be held at IIASA in Laxenburg in November was announced. It was pointed out that it is crucial to determine the future development of AQ levels and that clear guidance has to be provided on what kind of information is required.

For the draft final report forwarded to the participants, feedback to the Umweltbundesamt team was requested by the end of October.

In his closing statement, **D. Johnstone** (EC, DG ENV) pointed out two prerequisites for successful air quality planning: Information on all aspects of the air quality situation has to be available and better cooperation between various authorities is needed. For the granting of time extensions in order to achieve the limit values, as foreseen in the upcoming revision of air quality legislation, the quality of the plans and programmes will be of key importance.

DG Environment will publish two guidance documents related to the urban thematic strategy in 2007, and a green paper on urban transport will be published. In DG Environment, guidance on low emission zones is also foreseen.

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