Berlin

Umwelt

Senatsverwaltung
für Stadtentwicklung

Clean Air and Action Plan for Berlin 2005 - 2010

Preface

Clean air is a major factor in enhancing the quality of city life. As a result of a variety of efforts within the framework of Clean Air Plans, Berlin's air quality has been steadily improving since the 1980s. Today, concentrations of certain undesirable substances such as sulphur dioxide are so small that they are barely detectable. The last smog alert triggered by dramatic increases in sulphur dioxide and suspended solids occurred in 1991. As a result, Berlin was able to repeal its Winter Smog Ordinance.

Nonetheless, there is a need for continued action. Studies have shown that especially the air pollution by particulate matter has reached concentrations that may be hazardous to the public health. In recent years, excessive particulate matter and nitrogen dioxide values have been recorded in Berlin as well as in many other European cities, particularly in the vicinity of traffic. EU directives have translated these findings into more rigorous limit values. Clean Air and Action Plans must be developed for areas that are not in compliance.

The conceptual foundation for the Clean Air and Action Plan adopted by the Senate is the improvement of Berlin's air quality through effective, long-term measures that are compatible with the needs of the city. The Senate's strategy of focusing on the creation of a low emission zone within the boundaries of the metro circle line sets an example for the rest of Germany. As part of a two-step process starting in 2008, all vehicles operated within this area must comply with certain emission limit values. In addition, environmentally friendly alternatives such as local public transport and walking or cycling will be further developed and traffic organisation optimised.

However, the success of the Clean Air and Action Plan will also depend on support from Berlin's residents: walking short distances, travelling by bike or public transportation, installing particle filters in diesel cars, and driving in a smooth, fuel-efficient manner, avoiding excessive acceleration and braking. There are many ways in which each individual can make a personal contribution to improving the quality of the air.

Berlin will not be able to, all by itself, accomplish everything that is necessary to maintain clean air. As soon as possible, the Federal Government must establish the necessary framework for the implementation of a controllable, and thus effective, low emission zone. This includes the issuance of stickers for the identification of low-emission vehicles and the creation of suitable traffic signs to designate low emission zones. Also necessary will be a tightening of vehicle exhaust emission standards which must occur at the European level.

I am convinced that the Clean Air and Action Plan in front of you represents a well-balanced package of measures that can achieve lasting improvements in the quality of air and subsequently the quality of life in Berlin and that will make Berlin an even more attractive place to do business.

Ingeborg Junge-Reyer
Senator for Urban Development

Berlin

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Clean Air Plan and Action Plan for Berlin 2005 - 2010

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1 General introduction to the Clean Air Plan

European environmental legislation has established a new basis for the harmonised assessment and monitoring of air quality in cities in the form of Framework Directive 96/62/EC and two additional texts known as daughter directives. The directives were transposed into German law through amendments to the *Bundes-Immissionsschutzgesetz* [Federal Immission Control Act – *BImSchG*] and the 22nd Ordinance to the Act in autumn 2002. The Ordinance established specific limit values for the relevant air pollutants, along with measuring and assessment procedures. It adopted the European limit values for the air pollutants sulphur dioxide (SO_2), carbon monoxide (CO), benzene, nitrogen dioxide (NO_2) and particulate matter (PM10), some of which had become far more stringent compared with the previous EU limit values.

Once excessive air pollution has been detected, a Clean Air Plan must be prepared. In 2002, Berlin went above the limit values for nitrogen dioxide and particulate matter (PM10) pollution, including the margin of tolerance (sliding scale in annual increments up to the limit value), for the first time. The Berlin exceedance days cannot be considered isolated cases within Germany and Europe, as illustrated for particulate matter pollution in Diagram 1.1 below:

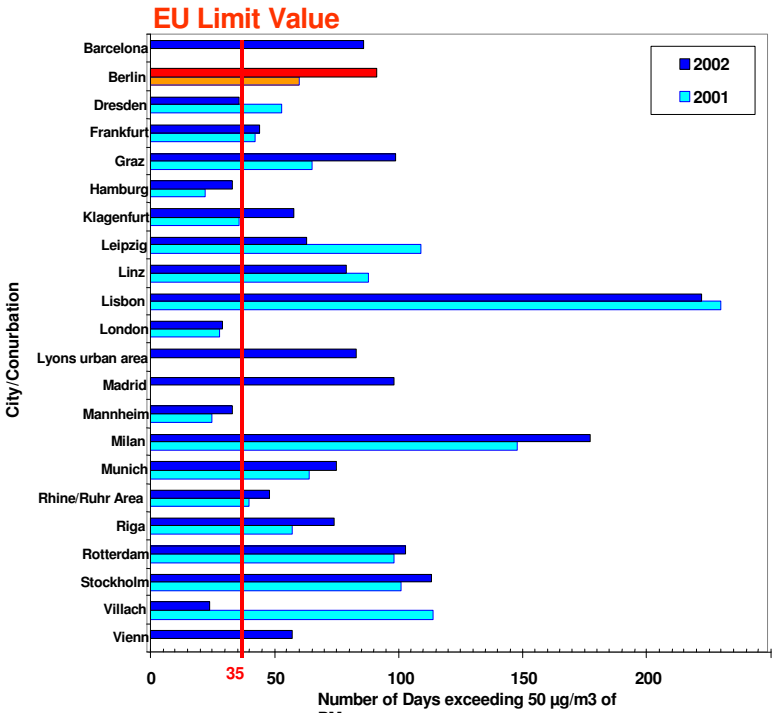


Diagram 1.1 Number of occasions on which the 24-hour limit value for particulate matter (PM10) was exceeded in selected European cities

Nitrogen dioxide is primarily released through combustion processes, with a small proportion being released directly, and the majority through chemical conversions. Particulate matter (PM10 – particles smaller than 10 micrometers (µm)) is composed of diesel soot, smoke from combustion processes, noxious gases from chemical reactions in the atmosphere, marine aerosols, and also resuspended crustal material.

For a long time, the pollution of Berlin´s air by the other pollutants listed above has ceased to be a problem, as the implementation in Berlin of clean air planning between 1994 and 2000 resulted in substantially reduced emissions in the areas of industry, domestic heating and transport (see Chapter 2). However, no direct extrapolations can be made from emissions to ambient air quality, i.e. the ground level concentrations in the air people breathe. Nonetheless, these ground level concentrations play a crucial role in the assessment of measures to be taken for the improvement of air quality. The ambient air quality is basically determined by the dispersion of pollutants from the source to the receptor. In this context, chemical reactions in the air and meteorological conditions play a major role, influencing the share of air pollution generated by each source sector in the local and regional area.

For this reason, the Senate Department of Urban Development started to examine the causes of PM pollution at an early stage. In June 2001, prior to the implementation of the 7th Amendment to the *Bundes-Immissionsschutzgesetz*, a study was commissioned to analyse the origins and source apportionment of particulate matter. Its results were to serve as the basis for a potential Clean Air Plan.

Several resource-intensive methods were used to ascertain that around 50% of the mean annual PM10 contribution is brought into the city from outside sources, with this amount increasing to up to 70% on days with high concentrations. The dusts originate from industry and transport located outside the agglomeration, along with other substances that are emitted several hundred kilometres away, and from resuspended crustal material in the form of suspended solids and fine sands. This proportion of particulate matter cannot be influenced by local measures taken in Berlin, and especially not as regards natural sources. Approximately 20% of total ambient particulate pollution in Berlin is attributable to exhaust emissions from diesel vehicles alone. Another 20% is caused by road traffic, through abrasion from tyres, brake linings and road surfaces, and by the resuspension of road dust. The remaining 10% arises from industrial plants, the heating of buildings and natural sources in Berlin.

When the limit values for particulate matter and NO_2 were first exceeded in 2002, an obligation to compile a Clean Air Plan was created. In 2003, feasibility studies were launched with regard to the measures to be implemented and the potential reductions in particulate matter and nitrogen oxide emissions throughout Berlin. The dispersion of pollutants was modelled, and pollution trends projected until 2010.

The harmonised Clean Air Plan required by the European Union was submitted to the *Umweltbundesamt* [Federal Environmental Agency] at the end of October, within the specified time limit. The Clean Air Plan reflected in the following report is directed at the general public, and thus provides a comprehensive description for a general audience of the pollution causes and problems, along with the measures intended to solve them.

The European guidelines require the Clean Air Plan to provide information on:

- pollutant readings,
- the number of times and extent to which the limit values were exceeded,
- the causes of limit values exceedances,
- pollutant emissions and the contributions of individual source sectors (e.g. industry, business, domestic heating, transport) to ground level pollution,
- the measures and a time frame for their implementation, and
- a forecast of the improvement to be attained.

The Clean Air Plan addressed in this report provides information on the legal background, outlines the prevailing situation and describes the causes of air pollution. The measures discussed are based on projections of the air pollution situation until 2010. Emphasis has been placed on explaining and assessing the wide range of potential measures. Data on the effect of these measures forms the basis for planning a clean air strategy for Berlin.

An annex in scientific / technical language contains the background information required by specialists and the European Commission to evaluate the Clean Air Plan. It primarily contains a comprehensive analysis of causes and an overview of the measures available. (Only available in German)

2 Clean air measures implemented in Berlin

For many years, air pollution caused by sulphur dioxide, carbon monoxide, benzene and lead has not been a problem in Berlin; major progress has already been made in this context.

However, Berlin has also moved considerably forward with regard to particulate matter (PM10) and nitrogen dioxide (NO_2) in recent years. Berlin already had adopted a Clean Air Plan for the period from 1994 to 2000. Supplementary clean air measures were implemented in Berlin even before the new European limit values were transposed into German law.
Remarkable results have been achieved, as demonstrated by the emission trends in Table 2.1.

	Data in Tons per Year (t/a)					
	1989	1994	2000	2002	Trend 2005	Trend 2010
Sulphur dioxide	**70801**	**17590**	**8868**	**7158**	**6674**	**6462**
Plants requiring a license	60470	10870	5683	4433	4100	3967
Domestic heating	8526	4890	2500	2400	2323	2268
Small business	75	70	60	60	50	40
Transport (motor vehicles only)	1440	1400	400	55	14	15
Transport (other)	140	140	75	75	68	60
Other sources	150	220	150	135	120	113
Nitrogen oxides	**69971**	**42417**	**26109**	**22141**	**19768**	**17536**
Plants requiring a license	41757	16172	8331	6499	6012	5817
Domestic heating	2704	3120	2860	2860	2657	2594
Small business	1200	700	190	185	160	125
Transport (motor vehicles only)	21410	19025	12400	10455	8876	7015
Transport (other)	1400	1300	1128	1128	1100	1072
Other sources	1500	2100	1200	1014	963	913
Carbon monoxide	**293705**	**203948**	**101828**	**69133**	**48236**	**39126**
Plants requiring a license	32443	3888	2028	1581	1462	1415
Domestic heating	68712	41560	8000	8000	7432	7256
Small business	1500	800	200	193	168	135
Transport (motor vehicles only)	182050	144200	76500	44259	24829	16730
Transport (other)	4000	3500	3100	3100	2945	2790
Other sources	5000	10000	12000	12000	11400	10800
Particulate matter (PM10)	**18180**	**8804**	**4728**	**4199**	**4041**	**3939**
Plants requiring a license	9563	3161	960	650	601	514
Domestic heating	2693	1148	131	132	98	85
Small business	250	220	160	153	149	145
Transport (motor vehicles only, exhaust)	2336	1135	667	394	311	238
Abrasion and resuspension by motor vehicles	1200	1150	997	1050	1113	1239
Transport (other)	238	190	124	130	121	112
Other sources	1900	1800	1690	1690	1648	1606
Volatile Organic compounds (VOC)	**103351**	**73703**	**32814**	**24251**	**20043**	**17691**
Plants requiring a license	11801	3473	2554	1966	1887	1863
Domestic heating	5250	2340	550	550	511	499
Small business	15500	15000	6500	6484	5511	4539
Transport (motor vehicles only)	49800	33890	12500	5661	3057	2208
Transport (other)	3000	2000	1710	1710	1590	1471
Other sources and households	18000	17000	9000	7880	7486	7112

Table 2.1 Emissions in Berlin broken down by source sector

As a result of timely guidelines issued by the licensing authorities, industrial plant emissions have long stayed below the levels specified by the Technical Instructions on Air Quality Control, even though compliance with these will not be mandatory until 2007. Admittedly, the total number of industrial plants in Berlin declined slightly between 1996 and 2000. However, significant reductions in emissions were due to changes in the type of fuel used in industrial combustion plants, from coal to oil or natural gas, for example. Further decreases were achieved by installing flue gas scrubbers and electrostatic precipitators. The installation inter alia of cloth and fibrous filters in coffee-roasting establishments, asphalt plants and construction waste processing plants has signalled the adoption of state-of-the-art technology in this sector as well.

Emissions from domestic heating systems were substantially reduced by improving building hull (thermal insulation, new windows), by replacing inefficient power plants, and also by switching from coal to fuel oil, natural gas and district heating. Over 450,000 households in Berlin had coal-burning stoves in 1990, while today this figure has dwindled to only 80,000. This success has resulted from a greater availability of district heating and a subsequent increase in the numbers of households served from around 450,000 to the current level of 580,000. Likewise, the number of households with modern gas heating rosed from 300,000 to 460,000. The promotion of solar thermal plants and photovoltaics brought alternative energy sources out of their niche. Between 1991 and 2001, the *Land* [federal state] of Berlin allocated a total of around 5 billion euros within the framework of various programmes to assist with the rehabilitation of old housing stocks.

Nitrogen oxide emissions declined:

- by 50% in the industrial sector between 1994 and 2000. By the end of 2005, they will decrease by another 25% as compared to 2000;
- by 35% for motor vehicle traffic between 1994 and 2000. The modernisation of the vehicle fleet will lead to a further reduction of 29% by the end of 2005.

Particulate matter (PM10) pollution dropped:

- by 88% in domestic heating emissions between 1994 and 2000, with a further reduction of approximately 25% expected by the end of 2005 as compared to the year 2000;
- by 70% in industrial plants between 1994 and 2000, with a further decline of approximately one third likely to occur before the end of 2005, and
- by 40% in vehicle exhaust emissions between 1994 and 2000, with a further halving of these emissions expected to take place by the end of 2005.

In the transport sector, diesel soot emissions were primarily reduced due to progress in exhaust control technology through the retrofitting of particle traps and use of vehicles powered by natural gas. Over the past few years, 1,000 of the 1,400 *BVG* [Berlin municipal public transport company] public buses in Berlin have already been retrofitted with soot filters, 25% of the *BSR*'s [Berlin municipal waste management company] garbage trucks currently run on natural gas, and the Berlin Police acquired its first 150 vehicles equipped with soot filters in 2004.

Twelve natural gas filling stations were opened within the framework of *TUT (Tausend-Umwelt-Taxen für Berlin)* [1,000 Green Taxis for Berlin], a joint project launched by the Federal Ministry of the Environment, GASAG [Berlin's gas works corporation] and the Senate Department of Urban Development. Berlin is receiving assistance under the EU's TELLUS programme to promote the introduction of heavy-duty vehicles fuelled by natural gas. As a result, the thousandth natural gas vehicle was put into circulation in Berlin in December 2004.

The fact that the black carbon concentration on major roads has decreased by almost 40% over the past 6 years is proof of the success of these measures. However, their effect on PM10 pollution is rather marginal as exhaust emissions from diesel engines account for only about 20% of the total PM10 concentration.

3 Current problems and general framework

3.1 Legal framework and new limit values for air quality

The new EU limit values for air quality, which were transposed into German law in 2002, must be met by a set deadline and may not subsequently be exceeded. The aim of establishing these limit values is to "avoid, prevent and reduce harmful effects on human health and the environment".

Table 3.1 shows the limit values and corresponding deadlines for compliance set for the pollutants in excess of these limit values, which are relevant when planning measures.

Averaging Period	Limit Value	Deadline for Compliance
24 hours	50 µg/m^3 PM_{10}	01.01.2005
	35 exceedances/year	
1 year	40 µg/m^3 PM_{10}	01.01.2005
1 hour	200 µg/m^3 NO_2	01.01.2010
	18 exceedances/year	
1 year	40 µg/m^3 NO_2	01.01.2010

Tab. 3.1 Air quality limit values for particulate matter (PM10) and nitrogen dioxide

The Senate Department of Urban Development is the authority responsible for air quality control in Berlin, and must act to ensure compliance with these limit values.

The following two situations should be distinguished:

(i) In cases where the limit values are exceeded prior to the attainment dates, measures must be taken to ensure timely compliance with the limit values.
When the limit values and so-called margins of tolerance are exceeded, the planning of appropriate measures takes the form of a Clean Air Plan. This plan establishes the measures required in the affected area to ensure timely attainment of the limit values, and must be submitted within two years.

(ii) In cases where there is a risk that limit values will continue to be exceeded after the deadline for compliance, despite the measures implemented under (i), an Action Plan must be compiled. This plan should outline measures to be taken in the short term to minimise that risk or to reduce the period during which the limit values are in fact exceeded. The measures can also be long-lasting in nature, particularly where their objective is to avoid exceeding limit values with a one-year period of definition, as is the case for nitrogen dioxide and PM10.

In 2002, air quality was assessed for the first time on the basis of the new limit values. As the total of limit value plus margin of tolerance was exceeded for particulate matter (24-hour value) and nitrogen dioxide (mean annual value), a Clean Air Plan had to be prepared, which was forwarded to the EU by the deadline under the harmonised procedure.

Despite the introduction of additional measures, the risk remains that the 24-hour PM limit value may be exceeded even after the pertinent deadline expires in 2005. In fact, even though the meteorological conditions were favourable in 2004, the limit values were exceeded on more than the 35 days permitted (see Diagram 3.3). Therefore, an Action Plan must be compiled concurrently. Consequently, the Action Plan for particulate matter will be submitted as a component of the Clean Air Plan.

A progress report must be drawn up every three years on the level of implementation of each Clean Air Plan submitted, with the plan being supplemented by additional measures where necessary. Berlin must thus fulfil this requirement by the end of September 2007. The Federal Government is responsible for forwarding the documents to the European Commission. No similar reporting requirement exists for Action Plans.

The measures in the Clean Air Plan and Action Plan must fulfil the following legal requirements:

- The measures must be directed at all air pollution emission sources or source sectors who contribute to limit value exceedances. Burdens must be shared "on the basis of a pro-rata allocation of costs and in accordance with the principle of proportionality".

- The measures – for example, potential traffic restrictions in certain streets – should not result in any limit value exceedances elsewhere.

- The aim of complying with the limit values also extends to local hot spots. Local conditions must be carefully analysed when developing local traffic measures to avoid displacement effects.

The public must be consulted in the preparation of the plans.

Summary:

- A Clean Air Plan has been compiled for Berlin. Its objective is compliance with the limit values.
- An Action Plan for PM10 was submitted for integration into the Clean Air Plan, as there is a risk that the 24-hour limit value for PM10 will be exceeded in the compliance year of 2005.
- Action Plan measures must be implemented as quickly as possible. They must be capable of minimising the risk of limit value exceedances or reducing the period during which the limit values are in fact exceeded.
- Measures must be appropriate and proportionate to the emission sources. They should not result in any deterioration elsewhere.

3.2 Analysis of the situation: limit values exceedances

Compliance with the new EU limit values represents a challenge for Berlin, and for many other large German and European cities. Tab. 3.2 summarises the results of the assessment of Berlin's air quality in relation to the limit values.

Components	Greatest Sources of Pollution	Situation in Berlin	Action Needed
Sulphur dioxide	Long-distance transport of sulphur dioxide, domestic heating, power plants, industry, currently also traffic (diesel engines)	**No longer a problem**	-
Carbon monoxide	Transport, stove heaters	**No longer a problem**	-
Benzene	Transport (petrol engines)	**Problem solved**: EU limit value is no longer being exceeded, continued downward trend	The transport-related measures introduced are sufficient to ensure continued compliance with limit values
Nitrogen dioxide	Transport, domestic heating, industry & power plants	**Serious problem:** EU limit value for 2010 exceeded at all traffic measuring points; margin of tolerance exceeded	Additional measures required in Berlin and across the EU, mainly in the transport sector
Particulate matter (PM10)	Transport, private households (incl. domestic heating), Long-distance transport of secondary PM, industry, construction, biological material (e.g. pollen)	**Very serious problem:** EU limit value for 2005 exceeded frequently in the vicinity of traffic and sometimes in inner city residential areas; margin of tolerance exceeded	Additional measures needed in several sectors in Berlin and on national level and EU-wide; in Berlin mainly for transport
Ozone	Ozone is almost never emitted, but is instead a produced in the atmosphere from nitrogen oxides and hydrocarbons. Sources are: transport, power plants, industry, private households; at least a third of ozone concentration is of natural origin; only a very small part of the pollution is caused locally	**Serious problem:** EU target values and long-term objectives exceeded in residential areas and the outskirts of the city	Additional measures required at the national and EU levels

Tab. 3.2 Summarised assessment of air quality in Berlin

As a result of the measures described in Chapter 2, sulphur dioxide and carbon monoxide levels are well beneath the limit values. Benzene pollution in Berlin's network of major roads has also fallen to one quarter of the values recorded at the beginning of the 1990s; consequently, since 2003, the benzene level on all major roads has been below the limit value to be met by 2010.

Nitrogen dioxide, particulate matter (PM 10) and ozone continue to pose a problem for air quality control.

This report will not discuss ozone in greater detail. Due to the interregional and occasionally transboundary nature of the ozone problem, the responsibility for developing specific programmes addressing the exceedance of target values rests with the Federal Government.

Conversely, measures for compliance with the limit values for nitrogen dioxide and PM10 are the responsibility of the *Land* of Berlin.

The following conclusions can be drawn based on the measurements from previous years and the modelling performed for 2002:

- There was almost no decline in the multi-year trend for particulate matter and nitrogen dioxide pollution (see Diagram 3.1 for particulate matter and Diagram 3.2 for nitrogen dioxide). The high PM10 values in 2002 and 2003 and the decline in 2004 are primarily weather-related.

- However, black carbon concentrations, which are particularly hazardous to health, have decreased by almost 40% in recent years (see the black line in Diagram 3.1), as a result, *inter alia,* of improvements in vehicle exhaust technology such as the installation of particle traps in *BVG* buses.

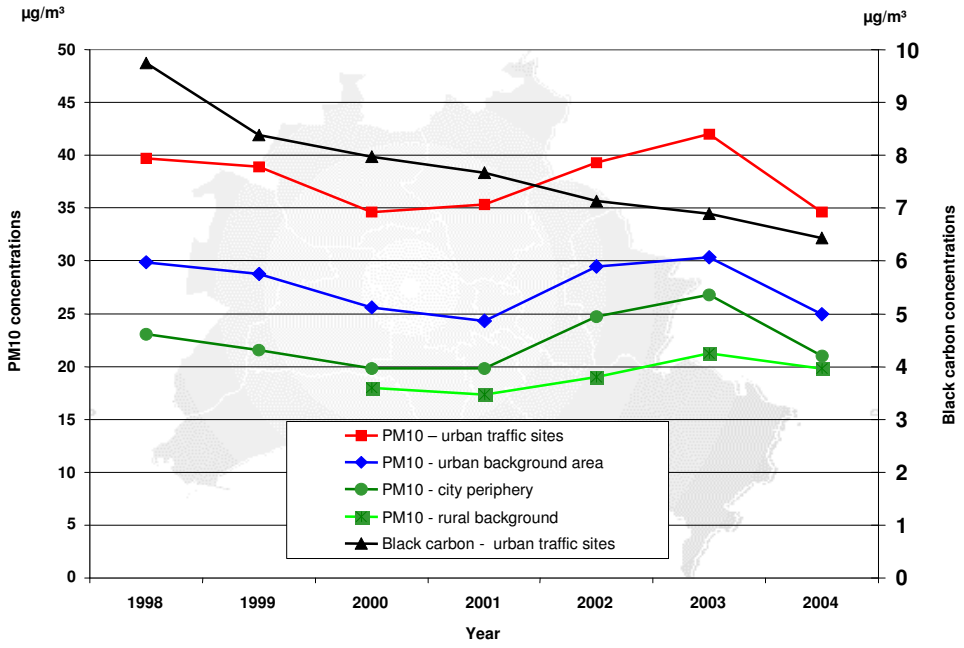


Diagram 3.1 Multi-year trends in PM10 and black carbon concentrations in Berlin

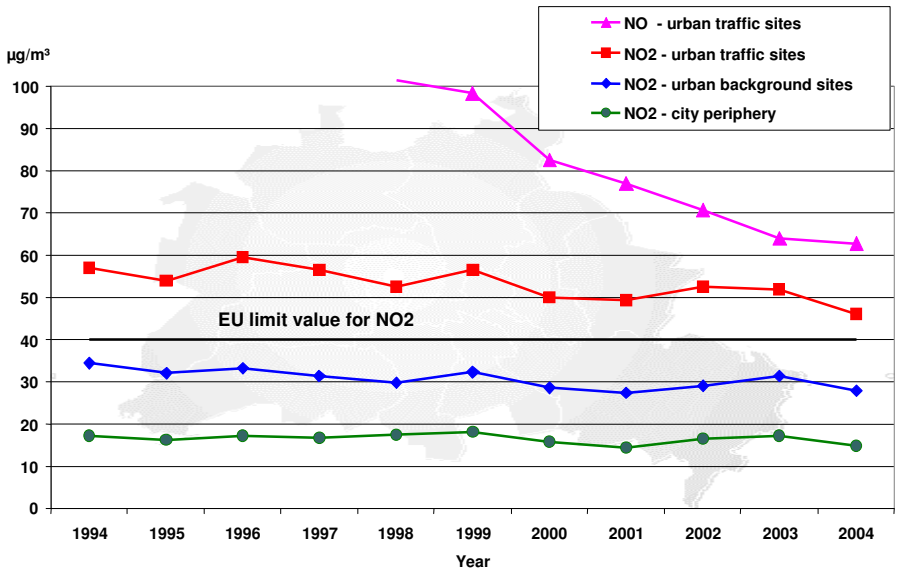


Diagram 3.2 Multi-year trends in nitrogen dioxide and nitrogen monoxide values in Berlin

- The limit values for particulate matter (24-hour value) (see Diagram 3.3) and nitrogen dioxide (annual value) were exceeded at all traffic-exposed measuring stations. The calculations for 2002 show further exceedances across the entire network of major roads (see Diagram 3.4). The 24-hour limit value for particulate matter was exceeded on all of the road sections marked in red. This amounts to approximately 450 km of road and impacts over 190,000 residents. Most of the residents affected live in the "*großer Hundekopf*" area[1] and along the large radial roads. Very few residents are affected by the city motorway – whose high pollution levels make it stand out clearly on the concentration map – as it is located relatively far from the nearest houses and its open position ensures that the air becomes well mixed.

- There is vast compliance with the less stringent limit values for nitrogen dioxide (1-hour mean) and particulate matter (annual mean).

[1] Area of the inner city enclosed by the metro circle line [S-Bahn]

- PM limit value exceedances can fluctuate strongly from year to year depending on the weather. Unfavourable climatic conditions prevailed in 2002 and were even worse in 2003, particularly during winter. Therefore, the 24-hour PM limit value was exceeded on more than 100 days. The situation was very different in 2004, when frequent westerly winds and higher wind speeds ensured that the limit values were exceeded on just over 40 occasions (see Diagram 3.3).
- In favourable years like 2004, the threshold daily value of 50 µg/m³ is frequently exceeded by only a few micrograms. By making comparatively minor improvements, a large number of such non-compliance events can be avoided and their number brought below the limit value of 35 days, as will be possible in Berlin due to the long-term measures described in Chapter 5.

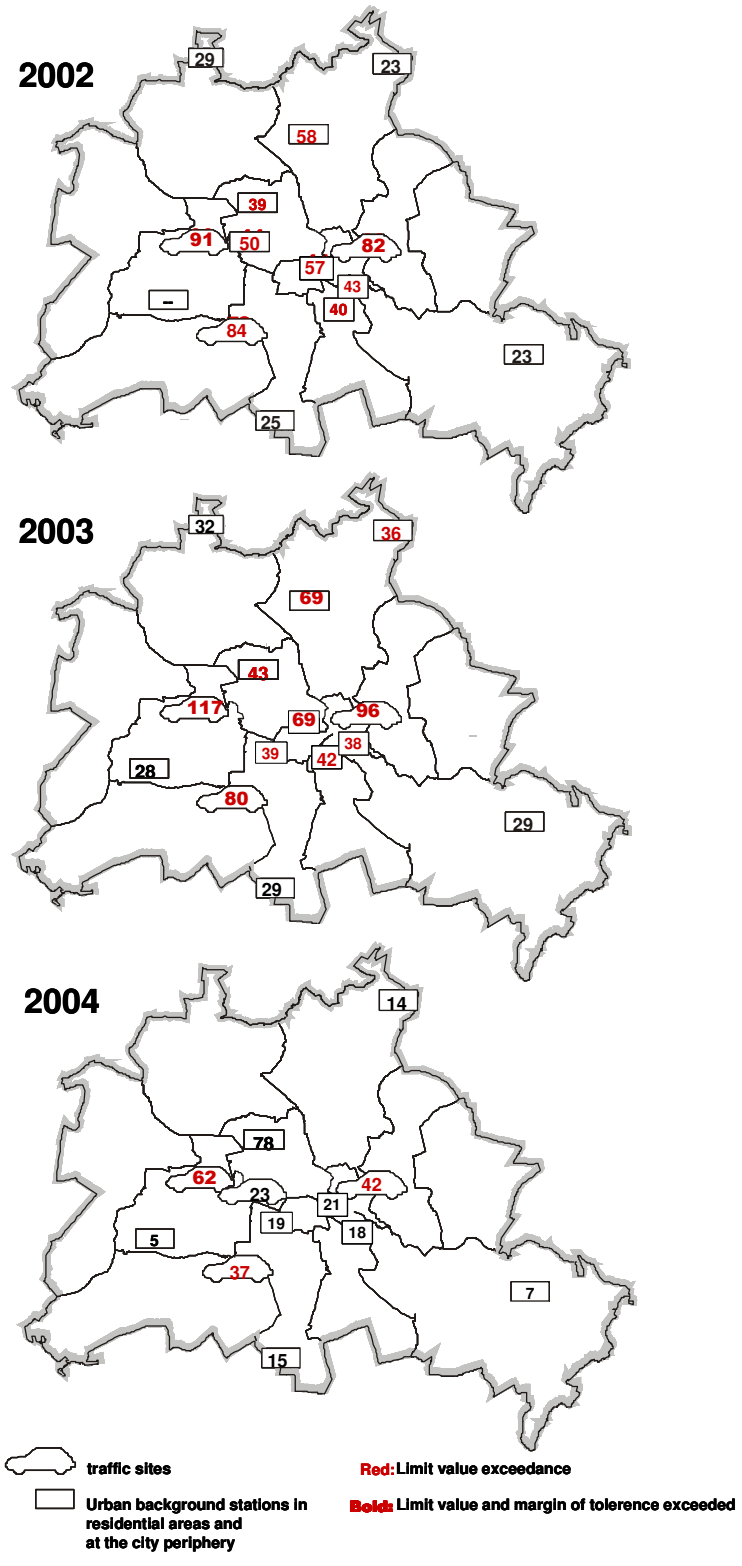
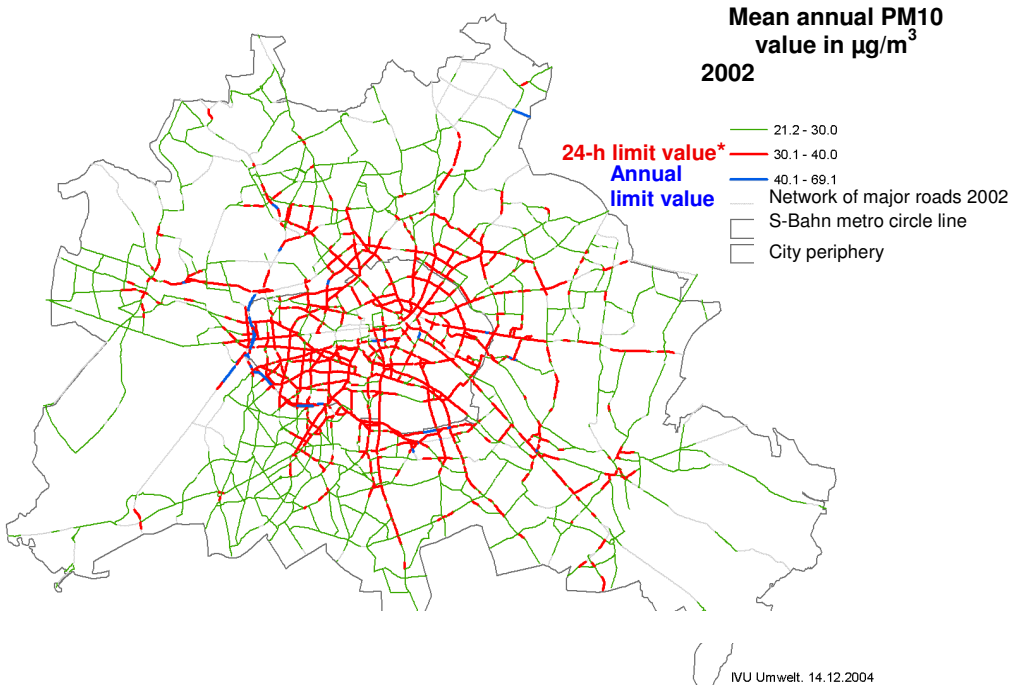


Diagram 3.3 Number of days with daily mean PM10 values exceeding 50 µg/m³ in 2002 (top), 2003 (middle), and 2004 (bottom)



*The 24-hour limit value is statistically equivalent to an annual mean of just under 30 µg/m³

Diagram 3.4 PM10 pollution calculated for the network of major roads in the base year 2002

3.3 Causal analysis

Comprehensive studies have been carried out over the past four years to quantify the origins of pollution from particulate matter and nitrogen dioxide and the contributions from individual source groups.

a) Source apportionment of particulate matter (PM10) pollution:

Studies on the characteristics of PM 10 pollution identified the distribution and origins of PM10 concentrations in Berlin and its surrounding area depicted in Diagram 3.5.

The diagram shows **regional background pollution** (marked in green), which extends over a wide area and is spread relatively evenly outside of the city.

Added to this is the **locally produced** portion of PM10 pollution from emission sources located within Berlin. This segment can be subdivided into:

- the combined contribution of all Berlin-based emissions sources (transport, power plants, industry, domestic heating - see the area in blue in Diagram 3.5) plus the regional background, which is known as **urban background pollution**.
- the additional contribution made by **local emissions** directly at the source, e.g. traffic on Frankfurter Allee (the red peaks in Diagram 3.5).

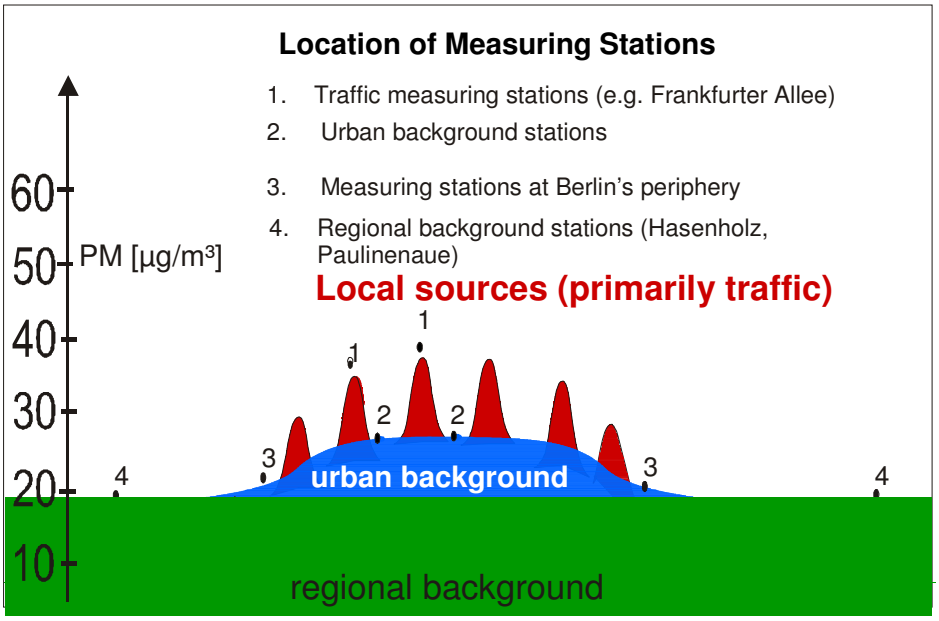


Diagram 3.5 Schematic illustration of the distribution pattern of particulate matter (PM10) pollution in Berlin and the surrounding area

Point II.3 of the Annex contains a detailed description of the findings of the source apportionment analysis as regards traffic-related PM pollution in Berlin's inner city. They can be summarised as follows (see Diagram 3.6):

(i) Just below half of the particulate matter arises from regional background pollution, and thus from sources outside the city. In turn, half of this contribution, which is imported into Berlin and **cannot** be influenced by local measures taken in the city, is attributable to industrial emissions which largely originate in the neighbouring countries to the east. Traffic outside of the city also contributes to PM imports.

(ii) The "home-made" part of the emissions, which can be addressed by local measures taken in Berlin, is composed of the urban background pollution and inner-city sources. Urban background pollution is predominantly caused by road traffic (16% of the total volume of

PM10). The remainder (11%) arises more or less equally from domestic heating, industry / power plants, construction and other city sources.

(iii) Local traffic on a major road accounts for approximately one quarter (26%) of the total PM10 amount measured there. Half of this pollution is caused by exhaust, from diesel vehicles in particular. The other half can be attributed to abrasion from tyres, street surfaces and brakes, as well as the resuspension of road dust by vehicles. Strategies to reduce the traffic volume and, consequently, the abrasion and resuspension of dust, are becoming of increasing importance, particularly since the possibilities for reducing PM pollution through vehicle-related technical measures are mostly limited to exhaust emissions.

(iv) Heavy-duty vehicles (HDV) are responsible for most of the contribution made by local traffic (two thirds).

(v) Dust from natural sources (biogenic particles, resuspended crustal matter, sea salt) accounts for approximately 13-15% of the total and is mainly attributable to the regional background contribution from outside the city. 10% of the PM10 fraction also contains water attached to other compounds.

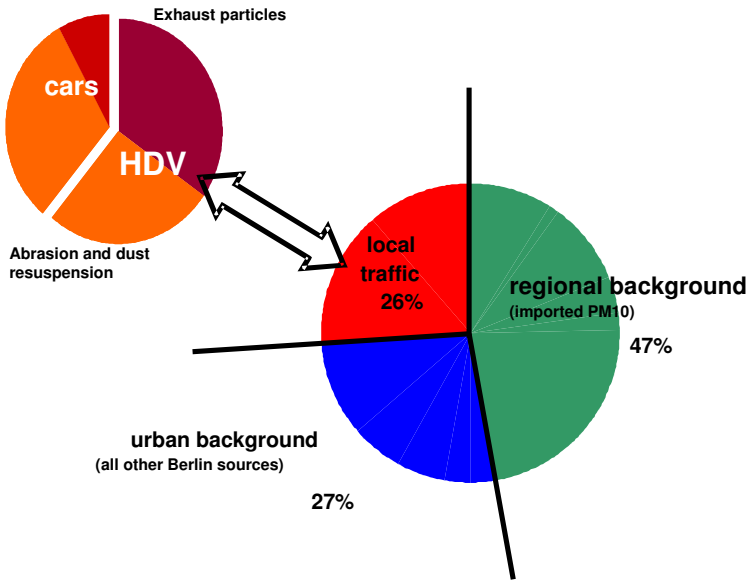


Diagram 3.6 Source apportionment of PM10 pollution on a major road with heavy traffic in Berlin's inner city

The following considerations are important when planning measures to address **exceedances of the daily threshold** of 50 µg/m³of particulate matter:

(i) The share of imported PM pollution tends to be above the statistical mean on days with high peak levels. Such non-compliance situations usually occur in autumn and winter. Inevitably, short-term measures such as smog alerts have built-in delays, occur after the fact, have very little impact and are of limited use for preventing the exceedance of limit values.

(ii) Longer-term traffic-related measures are more effective at reducing PM levels and achieving compliance with the 24-hour limit value of 50 µg/m³in locations in which the 24-hour mean values are only slightly above the threshold. In unfavourable years with high pollution, such as 2003, this applies to residential areas, but even to traffic-exposed measuring stations in favourable years such as 2004 (and 2001).

The preference for medium and long-term measures to reduce PM pollution is also supported by the assessment of the latest research into the effects of particulate matter conducted by the World Health Organisation (WHO) on behalf of the European Commission. It found that a lasting decline in PM pollution is of much greater benefit than a strategy comprised of measures directed at combating short-term concentration peaks, whose effectiveness is necessarily limited.

b) Source apportionment of nitrogen dioxide (NO_2) pollution:

The results of the studies conducted to quantify the relative contributions by emission sources can be summarised as follows:

- The imported share of pollution from nitrogen dioxide amounts to less than 10%.
- The contribution from non-traffic sources is also less than 10%. Measures must be applied first and foremost to vehicle exhaust emissions.
- The total traffic-related contribution accounts for approximately 80%, with local traffic comprising over half of this amount. Diesel vehicles, and heavy-duty vehicles in particular, are also the main polluters in this context.

4 Future trends and measures

4.1 Measures already introduced and their effect on air quality

4.1.1 Emission trends in Berlin, Germany and Europe as a result of measures already introduced (trend scenario 2010)

A trend scenario compiled for 2010 considered progress made throughout Europe as a result of implementing European regulations, not only because this is a legal requirement, but also because of the significance of the interregional, long-distance PM transport. The trend scenario makes necessary assumptions regarding the anticipated emission reduction across Europe on the basis of information provided by the European Commission.

To give an example, the EU Accession Treaty with the neighbouring country of Poland requires industrial plants to comply with exhaust emission standards only as of 2010/2015. Therefore, undoubtedly, the emissions from these foreign plants will decrease more markedly than those in Berlin, where industrial facilities have been meeting the strict exhaust emission standards for years.

In Germany – just as in other countries – the output of particulate matter will decrease by approximately 14% in relation to 2000. The trend for nitrogen oxides indicates a decrease in emissions of almost 30%.

Despite increased motor vehicle traffic, the Greater Berlin area can expect reductions in traffic-related emissions of 10% for particulate matter and 40% for nitrogen oxides by 2010.

Separate estimates have been made of the projected future reductions in the emissions of industrial installations, power plants and domestic heating in Berlin.

Industrial plants in Berlin, e.g. power and heating plants, some large facilities such as waste incinerators, coffee-roasting establishments, and asphalt and construction waste processing plants, are already using state-of-the-art technology, and, consequently, no justifiable and hence proportionate bases exist to require further emission reductions. An example is the installation of cloth and fibrous filters, which represents the currently available state-of-the-art technology. Even the requirements of the *Großfeuerungsanlagen-Verordnung* (13. *BImSchV*) [Ordinance on Large Combustion Plants - 13th Ordinance to the Federal Immission Control Act], which will enter into force in 2007, are already being met or surpassed. Nonetheless, further reductions in emissions can be expected, as has been seen in recent years, due to switches in fuel types and the continued optimisation of combustion engineering technology.

In the field of domestic heating, the replacement of old systems (e.g. in accordance with the *Energieeinsparverordnung* [Energy Saving Ordinance]) and the continued move away from solid fuels should reduce nitrogen oxide emissions by 7 to 9% and particulate matter emissions by up to 35% by 2010.

Due to the replacement of equipment in the trade and industry sector (e.g. timber industry, dry mortarless construction) PM and NOx emissions will decrease by another 5% and 33% respectively in the next few years.

As older vehicles are gradually phased out, emissions of nitrogen oxides and particulate matter from motor vehicles exhaust will both decline by about 30% by 2010.

Consequently, the measures described above will lead to a total reduction of 6% for particulate matter emissions and of 20% for nitrogen oxides in Berlin by 2010.

4.1.2 Improvements of ambient air quality under the trend scenario 2010

Mathematical modelling can be used to estimate the extent to which Berlin's air quality, i.e. its ground level pollution, will improve due to the emission reduction measures described in the previous section. As the mathematical models also cover large parts of Europe, a projection can be

made of how the regional background level of PM10 will decrease as a result of the measures included in the EU-wide trend scenario.

According to these models, the level of particulate matter transported into the city from outside sources will decrease by approximately 10% in 2010 compared with 2002.

The locally produced share of urban background PM pollution will show a slightly smaller reduction of about 7% by 2010, based on the assumptions in the trend scenario. This will result in a mean decrease in urban background pollution of between 7 and 10% in the inner city area by 2010.

The projected improvement in PM levels is sufficient to ensure compliance with the mean annual limit value for particulate matter even in years with unfavourable weather conditions.

However, the decrease predicted by the trend scenario in 2010 will be insufficient for meeting the 24-hour PM limit value. The graph on the left in Diagram 4.1 illustrates the length of the road sections exceeding the 24-hour limit value for the base year of 2002 and for 2005 and 2010 respectively, assuming the same environmental conditions and the decrease in emissions predicted by the trend scenario. Taking the approximately 450 km of road sections in 2002 as the starting point, approximately 350 km of road in 2005 and about 200 km in 2010 will still exceed the limit values despite marked improvements, which will have a direct impact on 140,000 (2005) and 80,000 (2010) people respectively.

A 25% reduction in concentrations will be needed to ensure full compliance with the 24-hour limit value for particulate matter. However, as stated at the outset, an improvement of this magnitude is unlikely to occur for either the locally produced or the external contribution to the PM burden.

Consequently, additional abatement measures must be taken in Berlin, and also at the national and European levels, to achieve further reductions in the contributions from both segments.

Similar conclusions can be drawn for the projected trend in nitrogen dioxide pollution (see the graph on the right in Diagram 4.1). The measures already implemented under the trend scenario will lead to a significant reduction in the length of road sections with limit value exceedances and the number of residents affected. However, supplementary measures - primarily local measures in Berlin - are also required in this context, to relieve the burden on the remaining 60 km of roads and 20,000 residents affected.

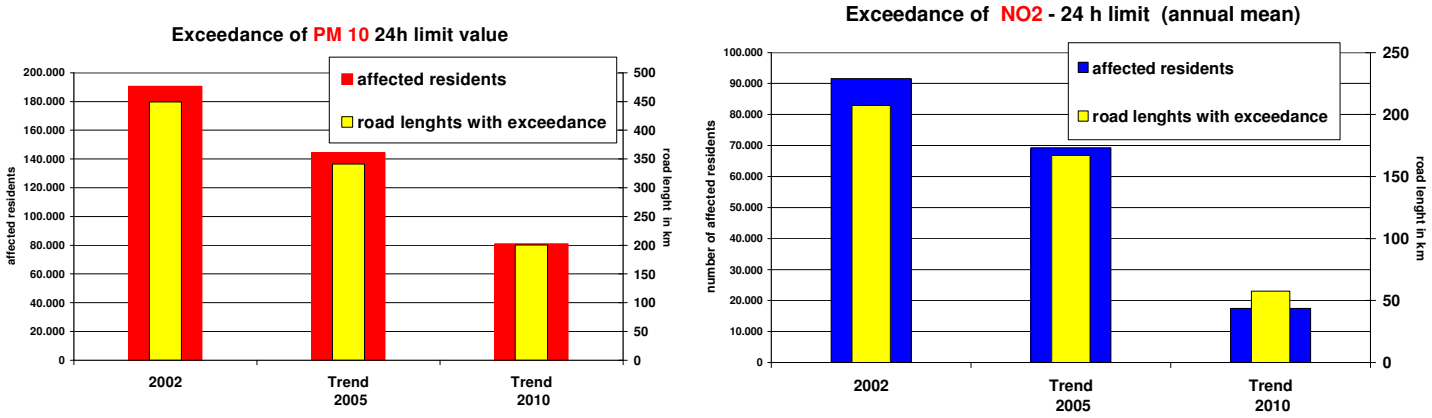


Diagram 4.1 Changes in the lengths of the road sections exceeding the 24-hour PM10 limit value (left) and the NO_2 limit value (right) and the residents affected in the base year of 2002 and in the trend scenario for the entire urban area

Summary:

- A trend scenario was used to investigate the future effects on air quality of the measures already introduced in Berlin and at the national and European levels to reduce the pollution load.
- The measures that have already been implemented or introduced should result in a 7-10% decrease in urban background pollution from particulate matter by 2010. A precondition is that the PM pollution load brought into Berlin from outside sources will actually decrease by 10% as projected.
- Consequently, the annual mean limit value for particulate matter would be attainable even in years with unfavourable weather conditions.
- The length of the road sections exceeding the 24-hour limit value for particulate matter and the annual limit value for nitrogen dioxide, along with the number of residents affected, will more than halve by 2010 under the trend scenario.
- Additional measures to reduce particulate matter and nitrogen oxide emissions must be introduced to end the remaining exceedances of the limit values.

4.2 Potential additional measures and their effect on air quality

A broad range of different measures to further reduce atmospheric pollution are currently the subject of public and specialist discussion.

These measures differ widely in terms of the intensity and the timing of their effect, and are of varying applicability based on practical and legal considerations. Therefore, the following sections will begin by presenting additional measures that are potentially available and outlining the framework conditions for their implementation.

This will be followed by a summary of the measures suited to a clean air strategy in Berlin and an assessment of their impact (Chapter 4).

4.2.1 Potential local measures

4.2.1.1. Measures at stationary sources

A Industry, power plants and domestic heating

The previous chapter described the measures already introduced for stationary emission sources and indicated possible supplementary activities. The answer to the question of whether additional improvements could be achieved in this area using proportionate means can be summarised as follows:

- No further justifiable measures can be implemented in industry and power plants to reduce emissions of particulate matter and nitrogen oxides. The emission levels are already well below the limit values to be attained in 2007. However, when the refurbishment needs of old plants are being explored with regard to implementing the new legal regulations, checks will be made in each individual case to study whether further improvements are possible to avoid fugitive particulate emissions, while at the same time taking into account the principle of proportionality.
- Fewer than 5% of all households still use coal for domestic heating. The legal measures planned for the rehabilitation of small heating installations suffice to achieve additional reductions in this sector.

Summary:

- Industry, power plants and domestic heating account for only a small share of ambient air pollution, due to their advanced level of technology. Therefore, the reduction potential of additional measures is very limited.

B Dust emissions from construction, small business and private individuals

The other causes of particulate matter emissions include the many large-scale construction sites in Berlin, which were and still are a source of increased pollution. However, building permit requirements limit the emissions to the extent allowed by modern technology. Smaller building sites, and especially private ones, do not always use the latest technology. Consequently, in future, building project clients should receive even more information about the possibilities that exist for dust avoidance.

A corresponding provision has been incorporated in the new *Landes-Immissionsschutzgesetz* [*Land* Immision Control Act] planned to enter into force in 2005, which creates a legal obligation to take measures to curtail dust emissions from building and private activities. Another clause will facilitate the regulation of dust emissions from plants that do not require licensing as well as from other activities.

Summary:

Currently, the following measures are being implemented:

1. Providing information to builders about potential dust abatement measures on construction sites
2. Exploring the possibility of requiring building sites in heavily polluted areas to use dust control equipment, along with the criteria that should be applied.
3. Reducing dust emissions from construction sites under the new *Land* Immission Control Act

4.2.1.2 Transport sector measures

As the causal analysis revealed (Chap. 3.3), transport is a major contribFutor to air pollution in Berlin. The lion's share is produced by diesel vehicles exhaust emissions of particulate matter and nitrogen oxides.

The use of technical measures for lowering exhaust emissions must be complemented by decreases in abrasion emissions (from brakes, tyres and road surfaces) and the resuspension of road dust. However, emissions from abrasion and resuspension can only be curtailed if the volume of traffic is reduced and traffic flows are stabilised at low speeds. This requires traffic organisation and planning measures.

Street cleaning occupies a special position among the technical measures. At first glance, it appears to be the quickest and simplest way of reducing the resuspension of road dust, especially during spells of dry weather.

A Technical measures

(i) Increased street cleaning

Previous studies on the effect of conventional cleaning using street sweeping vehicles failed to reveal any positive outcomes. A six-week trial in autumn 2003 and a further trial from June to October 2004, which involved wet cleaning Frankfurter Allee twice a day prior to each rush hour, also failed to generate any measurable reduction in ambient PM concentrations.

The information currently available thus indicates that (increased) wet cleaning is not an effective control option for the resuspension of road dust, as it serves only to collect and wash away coarse dust.

(ii) Vehicle-based emission abatement

Emissions can be substantially reduced at the source, i.e. the vehicle, using improved exhaust technology and low-emission fuels. The European legislation on exhaust emissions (Table 4.1) has established a framework under which the attrition of old vehicles and the replacement with new ones will lead to a significant medium to long-term improvement in ambient air quality, as projected in the trend scenario (see Chapter 4.1.2). However, this trend is insufficient for shorter-term air pollution abatement. An assessment of the individual Euro standards in Table 4.1 reveals that making the leap to the Euro II standard results in an improvement of over 50%. Euro I vehicles are already currently 11 to 13 years old.

Equipping Euro II or III diesel vehicles with a soot filter, where this is possible, results in a further substantial reduction in particle emissions. Manufacturers claim that the retrofitting of cars and light duty vehicles with PM traps would cut particle emissions by an extra 50%, while the retrofitting of a continuously regenerating particle trap of the type already being used in 1000 *BVG* buses can bring about an emission control of as much as 80 to 90%. Some manufacturers already have retrofit kits for cars on the market, with the retrofitting procedure currently costing between 500 and 600 euros.

According to the manufacturers of diesel exhaust particulate filters, retrofit kits will be available for all current models of light duty vehicles under 7.5 t by the end of 2005. Retrofitting costs range from 2500 to 4500 euros, depending on the complexity and efficiency of the filter system. However, in the future mass production should lead to a reduction in price of up to 20%. Retrofit kits for medium to heavy-duty vehicles will reach the market in 2006, with costs ranging from 4000 to 7000 euros, depending on the vehicle and filter system.

Switching to natural gas during the retrofitting procedure makes even Euro IV emission standards attainable. New vehicles that are designed to use natural gas ex works can be eligible for Euro V or the EEV standard (e.g. public buses or garbage trucks). Natural gas is also an economical alternative, because it will remain at least 50% below the standard tax rate set for oil until 2020. Moreover, natural gas has far quieter combustion, lowering the vehicle's noise emissions by 2 to 3 dB(A).

Euro standard	Valid from...	Vehicles aged over...in 2008	PM exhaust emission limit value		
			Passenger cars in g/km	Light duty vehicles II in g/km	Heavy-duty vehicles g/kWh
I	1992/93	11-13 years	0.18	0.22	0.40
II	1996-98	8-12 years	0.08	0.12	0.15
III	2000/1	3-8 years	0.05	0.07	0.10
IV	2005/6	1-3 years	0.025	0.04	0.02
V/EEV	2008	0 years	*0.005**	-	0.02

*Probable value in a future proposal by the European Commission

Table 4.1 European standards for particle emissions from diesel vehicles

B General traffic organisation

(i) Logistical reductions in traffic (logistics on large construction sites, "city logistics")

Efficient logistics on the large construction sites at Potsdamer Platz and Lehrter Bahnhof involved transporting large freight volumes by rail and ship, ensured that each means of transport was used to full capacity, and consequently only placed a moderate strain on the city in the form of additional heavy vehicle traffic to the building sites. Moreover, there is a host of individual daily transports making deliveries to shops, businesses, offices and households in the city, some of which are using very little of their loading capacity. This indicates that the logistics could be optimised with a view to reducing the number of journeys ("city logistics").

The tools mentioned should be used more often or trialled in Berlin in the future.

The decline in building activity, including large projects, is reducing the scope for application and the willingness of private actors to engage in (voluntary) logistical cooperation. Large companies, department stores, retail chains, etc. are already optimising their transport flows for reasons of cost. Coordinating the remaining delivery traffic is difficult as it is based on the willingness of many individual firms to participate. Efforts in the field of logistics are important, as they lead to tangible reductions in traffic in high-pollution areas. However, the true potential of reducing emissions through improvements to logistics is very limited.

(ii) Traffic Management

Even once the additional anti-pollution measures take effect, the exposure situation in Berlin's network of major roads will continue to be characterised by isolated pollution hot spots at major traffic hubs or heavily polluted sections of arterial roads. In these cases, air pollution can be reduced by intermodal traffic management.

The focus is on local traffic control measures and on stabilising traffic flows. Encouraging the steady flow of vehicles at low speeds reduces braking and acceleration, which in turn cuts PM emissions from abrasion and resuspension. It also lowers exhaust emissions.

However, the technical infrastructure available for traffic management is not yet sufficient to guarantee effective traffic regulation in the agglomeration, and especially as regards specific sections of the inner city area. In the upcoming years, substantial investment will be required in this field. The establishment and launch of the Berlin Traffic Management Centre have already laid the foundations for this approach.

Research projects are expected to demonstrate the effect of the management systems as early as 2006, including their positive impact on the environment.

C Transport planning

The measures incorporated in the Berlin Urban Development Plan – Transport (Stadtentwicklungsplan (*StEP) - Verkehr*) can provide effective support for accomplishing emission abatement objectives. Launched in 2003, *StEP – Verkehr* takes into account the interactions between the environment, transport and urban development in its strategic plan and corresponding action programme.

Nonetheless, implementing transport planning measures can make only a limited contribution to reducing overall pollution, since, without a change in existing conditions, motorised road traffic will continue to increase until 2015.

Generally speaking, however, transport planning measures are not effective in the short term, but rather in the medium to long term.

The following planning tools of the Urban Development Plan – Transport, which are primarily addressed in the partial strategies on "eco-mobility modes of transport", "inner city", "health and safety" and "trade and industry", also help to reduce air pollution:

(i) Limiting the increase in traffic through integrative planning for the city and region

An integrated transport and settlement policy ("compact city development" and a rail-oriented urban and regional settlement policy) is slowing the trend towards increased commuting. However, there are only limited possibilities of managing the regional development processes that generate traffic, and hence road traffic will continue to increase on major radial roads between the city and surrounding area until 2015, despite countermeasures.

(ii) Consistent promotion of non-motorised transport

Due to Berlin's compact urban structure, almost 50% of all journeys made within the urban area are under 5 kilometres. Given the right conditions, in many cases trips can be made by bus or bike instead of by car. For this reason, the Urban Development Plan – Transport includes a bicycle strategy (plus supplementary measures to improve conditions for pedestrians) with the aim of increasing the modal-split share of bicycle travel from 10 to 15% by 2010. This is a good way of avoiding superfluous motor vehicle traffic and controlling air pollution, particularly in the densely populated inner city areas.

Even in the short term, the initial implementation of the bicycle strategy is projected to have an, albeit limited, effect in the city centre. However, the main pollution control will only occur in the medium to long term.

(iii) Retaining an effective local public transport system by increasing its appeal

Given the relatively favourable conditions for motor vehicles in Berlin, offering an effective public transportation system is a precondition for curtailing the growth of individual motorised traffic. Opportunities should be used to make the local PT system more attractive, by making it faster, improving the connections and optimising the available fixed route services. However, the cost of implementing measures to promote public transport is high, which is difficult to reconcile with the current need to substantially cut public funding for the system.

(iv) Gradual extension of Parking Management Concepts

Parking management concepts curb air pollution by reducing the large number of vehicles searching for a parking space and encouraging commuters to switch to "eco-mobility modes of transport" (reduction in inbound motor vehicle traffic). Consequently, the Urban Development Plan – Transport considers the gradual extension of paid parking to all areas of the city with high demand but limited parking to be necessary, along with differentiated levels of pricing. The new parking fee scale and the guidelines on parking management provide the foundation for this measure. Further extending these paid parking areas will require cooperation from the districts, which have sole responsibility for this task.

(v) Diversion of inner city through traffic onto bypass roads

The transport planning concept of diverting through traffic onto bypass roads supplements and complements any potential modal shift from individual motor vehicle to public transport. Primarily, traffic organisation and management measures will be used to redistribute some of the motor vehicle traffic currently transiting through the inner city area onto new bypass routes and the city motorway. However, as bypass routes of this kind are already under considerable strain in many (but not all) cases, the prerequisites for implementing this concept are that:

- the diversion routes will be designed to cover a very wide area (extending at times beyond the city boundaries) and
- the shift to other modes of transport will reduce motor vehicle traffic (see paid parking and traffic management) and create limited extra capacities.

New road infrastructure contributes to easing pressure when traffic from densely populated urban areas is redistributed to less densely populated areas (examples are the A 113, and also the Tiergartentunnel, the Köpenick western bypass and some other street projects integrated in StEP's catalogue of measures). Road capacity will be reduced in the urban areas relieved of traffic. The current stage of planning has shown this strategy to be feasible, but under the same

infrastructural requirements as for traffic management, namely modernised traffic light systems, the creation of a system of radio-controlled variable message signs and other complementary infrastructure.

D Traffic control and regulation (road law measures)

(i) Additional speed limits in the network of major roads (generally 30 kph zones):

The introduction of speed limits on heavily polluted roads has only a marginal abatement effect on these roads, due to the decrease in abrasion and the resuspension of particulate matter by motor vehicle traffic. However, speed limits also cause traffic to move to other roads. Given the limited contribution made by this measure to air pollution control, changing the speed limit to 30 kph on a heavily polluted major road with this sole aim would usually be disproportionate. However, such a measure would be conceivable in situations where there is an urgent need to reduce other traffic-related pollution as well, e.g. noise pollution, and improve road safety.

(ii) Closure of heavily polluted roads or road sections in the network of major streets and diversion of traffic:

While closing a heavily polluted major road, for instance to heavy vehicle traffic, reduces pollution in the restricted areas, its broader effect is solely to redirect traffic to other roads, which – in Berlin's case – are usually equally unsuitable (an example is Frankfurter Allee and its parallel streets). For this reason, road closures are generally not appropriate as a standard measure for curbing air pollution.

Very few suitable roads, i.e. bypass or diversion routes with light exposure that are capable of absorbing higher loads, exist due to the intensive mixture of uses in Berlin's urban structure (Beusselstrasse is an example, see also the annex to Chap. III.2.1.3). Within the framework of the traffic management measure (B (ii)), this option is nonetheless being studied and implemented on the few suitable road sections that exist.

In April 2005, the daily mean limit value for PM10 of 50 µg/m³was exceeded for the 36th time since the beginning of the year on Silbersteinstrasse (Berlin Neukölln), thereby exceeding the limit value set down in the 22nd Ordinance to the Federal Immission Control Act (*BImSchV*). Shortly afterwards, the *Verkehrslenkungsbehörde Berlin (VLB*) [Berlin Traffic Control Authority] agreed to prohibit heavy-duty vehicle through traffic access to this street, using traffic signs and rerouting signage for the A 100 motorway that runs parallel to it.

(iii) Closure of heavily polluted urban space (road network segments)

The limit values are being exceeded in Berlin across almost the entire network of major roads in the inner city area bounded by the metro circle line [S-Bahn]. This is due primarily to the concentration of traffic on the network of major roads, a measure designed to protect the residents. For this reason, the possibility of closing the inner city to the segment of motor vehicle traffic responsible for much of the pollution (all diesel vehicles) should be explored. According to the causal analysis, this would apply above all to heavy-duty vehicles (contributing approximately two thirds). However, the majority of heavy vehicle traffic in the inner city is inbound, outbound or locally generated within an urban area that covers around 100 square kilometres and contains approximately 1 million residents and 700,000 workers. Such heavy vehicle traffic brings deliveries and supplies to the city centre and is also responsible for waste disposal. Without it, the inner city area would not be viable. Heavy vehicle traffic in the inner city cannot be shifted to lower emission modes of transport, such as ships and the railway, to the extent required. A total closure of the inner city would thus not strike a proportionate balance between the consequences of such a restriction and the projected benefits. A temporary closure (of the entire inner city area) during peak hours is completely ineffective as a general measure because the emission levels are computed as a 24-hour or annual mean, with the result that any temporary shifts during these intervals would show no result whatsoever.

Consequently, given the conditions prevailing in Berlin, general driving bans - even temporary ones – are unsuitable as measures.

(iv) "Low emission zones" and the creation of a "user benefit"

An appropriate variant on (iii) is the closure of the inner city to motor vehicles whose emission standards exceed a defined limit value for exhaust or particulate matter. Different options are conceivable in this context but all compliant motor vehicles would have unrestricted access to this designated "low emission zone". This is a far less intense restriction, which only discourages the use of a very small proportion of the vehicle fleet and can be avoided by retrofitting exhaust equipment or acquiring low-emission vehicles. A deterrence of diesel cars and heavy-duty vehicles would be justified to combat pollution from particulate matter in Berlin, as these vehicles are the largest contributors to this problem in terms of overall traffic. However, older petrol-fuelled vehicles without a catalytic converter also contribute to non-attainment of the relevant limit values, especially due to their nitrogen oxide emissions, making it advisable to also include vehicles of this type in an low-emission zone regulation.

Designating Berlin's inner city as a "low emission zone" will not reduce traffic per se. However, it can significantly increase the pressure to use environmentally friendly vehicles. Providing a tax incentive to install or convert to modern exhaust technology will not be enough by itself to accelerate the take-up rate of this equipment in the vehicle fleet. Changes in the regulatory framework should also be considered to supplement this process.

The establishment of a low-emission zone is dependent on certain framework conditions, which will be discussed in Chapters 5 and 6.

(v) Network of HDV routes

In some cities that have urban area roads less sensitive to traffic, heavy-duty vehicles may travel to their destinations via designated routes within the major road network. The increased concentration of heavy vehicle traffic on this network of HDV routes relieves the pollution load in many other parts of the city.

With this objective in mind, a multi-level network of heavy-duty vehicle routes has also been developed for Berlin, and its potential effects evaluated.

Effect analyses show that while the number of residents impacted by noise pollution could be reduced considerably in the event of broad compliance with the designated routes, air pollution would largely remain unaffected. In fact, the sections of the route network containing densely packed buildings on both sides would experience a further increase in their already high pollution levels from the greater concentration of heavy vehicle traffic. Berlin's urban structure contains a great many mixed use zones with small-scale residential and commercial clusters, as well as a high proportion of city streets with buildings on both sides located within the major roads network. Given these circumstances, a network of HDV routes whose sole aim is to concentrate such traffic on the main roads will not make any relevant contribution to curbing air pollution.

E Increasing the share of environmentally sustainable transport in urban freight traffic

In Berlin, as in other cities, rail and shipping have consistently and considerably declined in importance as modes of transportation. This has been caused by the drastic structural change in trade and industry since 1990, the switch in energy supply and different logistical needs. Furthermore, deliveries account for a very large proportion of inner city freight traffic, which must necessarily be conveyed by road due to the spatial distribution of the sources and destinations.

The city is nonetheless maintaining the infrastructure (railway connections with freight transfer points, waterways and the necessary ports) required to convey goods to and from locations in the inner city using environmentally friendly modes of transport.

F Inner city landing stages for ships

The increasing use of the landing stages and moorings along the waterways in Berlin's urban space by passenger boats, pleasure craft and other tourist activities is causing additional ambient air pollution problems. Along with the potential noise pollution by people and engines, the output of marine diesel exhaust emissions and diesel exhaust particles generates considerable atmospheric

pollution. The cause, namely captains continuing to run their ship's engines while moored, can be avoided in most instances by having them connect to Berlin's readily available power grid. Use of Berlin's electricity supply is a suitable contribution to air pollution abatement.

Summary:

Currently, the following measures are being implemented:

1. Providing information to skippers on accessing electricity from the grid.
2. Exploring the possibility of making the use of Berlin's electricity supply mandatory for moored vessels.
3. Reducing ambient air pollution levels by applying the provisions in the planned *Land Immissionsschutzgesetz* [Land Immission Control Act], especially §§ 2, 9 and 15.

4.2.2 Necessary measures at the national and European level

A Passing an Ordinance on the Labelling of Low-Emission Vehicles in accordance with §40 para. 3 of the *Bundes-Immissionsschutzgesetz* [Federal Immission Control Act - *BImSchG*] and Amendment of the *Straßenverkehrsordnung* [Road Traffic Regulations]

A low emission zone with traffic restrictions on high-emission vehicles can only be implemented effectively and unbureaucratically by labelling low-emission vehicles. Berlin has repeatedly called on the Federal Government in the *Bundesrat* [Federal Upper House of Parliament] and in the *Umweltministerkonferenz* [Conference of Environment Ministers] to table a proposal in accordance with the power to issue statutory instruments under § 40 para. 3 of the *BImSchG*. The Federal Ministry of the Environment tabled an initial draft bill for an ordinance on the labelling of low-emission vehicles (34th Ordinance to the Federal Immission Control Act) in May 2005, and undertook consultations with the relevant associations and supreme *Land* authorities. Regulating the corresponding requirements to retrofit diesel vehicles with particle filters and introduce road signage to indicate the pertinent roads or zones will require the respective amendment of the *Straßenverkehrszulassungsordnung* [Road Traffic Licensing Regulations - *StVZO*] and *Straßenverkehrsordnung* [Road Traffic Regulations - StVO]. As the EU must be notified of the ordinance, a 3 month waiting period will apply once it has been passed by the German legislature (Federal Government, *Bundestag*, *Bundesrat* [Federal Lower and Upper Houses of Parliament]), meaning that the Ordinance can only enter into force by the end of 2006 at the earliest.

Actor: Federal Government

B Tightening European vehicle emission standards

The current EU exhaust emission standards are in urgent need of adaptation to reflect technological developments. More stringent particle emission standards must be introduced for diesel vehicles that match the efficiency of soot filters. The emission value of 5 mg of particles per kilometre contained in a European Commission working paper would be suitable.

The European Commission should adopt a corresponding proposal for cars and heavy-duty vehicles as soon as possible. In this context, the problem posed by the increasing share of NO_2 emissions in the NOx output of diesel vehicles should also be considered.

In June 2004, Berlin called on the Federal Government to create tax and economic incentives for passenger cars, heavy-duty vehicles and buses in a *Bundesrat* initiative. In response, the Federal Government announced in February 2005 that a merit pricing system for motor vehicle tax would be launched by the summer of 2005 to promote the introduction and retrofitting of particle traps in motor vehicles. In the interim, the federal cabinet has discussed a draft ordinance amending the taxation on motor vehicles with particle filters. However, this will not suffice.

As heavy-duty vehicles are the most significant source group of soot emissions, Berlin launched another initiative in the *Bundesrat* requesting that the Federal Government also create tax or economic incentives for low-emission buses and heavy-duty vehicles. These incentives should be

available to both new vehicles and retrofits, for example through revenue neutral tax exemptions for motor vehicles with particle filters or equivalent technology.

A corresponding resolution was passed by the *Bundesrat* as a joint initiative with the *Land* of Berlin on 26 May 2005.

Actors: Federal Government, European Commission

C Stricter exhaust control regulations for mobile machinery and equipment, supported by economic incentives

New studies have identified mobile machinery and equipment as an increasingly significant emission source, since no limits were placed on the pollution from, e.g. construction machines, until 2004, and their exhaust emission regulations are less stringent than those for motor vehicles. The particles emitted by off-road machinery have already reached 80% of the exhaust levels from motorised road traffic in Germany, with a continuing upward trend.

Given this order of magnitude, the limit values for exhaust emissions must be made stricter, to the extent that particle filters are required for operation of these machines. This is especially important for construction machinery, due to its frequent use in residential areas. The necessary technology already exists, and, therefore, countries like Switzerland have already introduced rigorous exhaust emission regulations to this effect.

The introduction of stricter limits should occur at the European level, and be supplemented by economic incentives such as tax concessions at the national level.

Actors: European Commission, Federal Government

D Reducing emissions from stationary sources in neighbouring states

Research into the causes of PM pollution has identified cross-border transports of PM10 from neighbouring countries to the east, especially from southern Poland and the Slovak Republic. A clear connection between high PM10 levels, and sulphate in particular, and the origin of the air pollution in the above-named regions can be derived from the models used in the Clean Air Plan to calculate the extensive dispersion of air pollutants. The correlation between wind direction and levels of PM10 and other components during exceedances of the 24-hour value of 50 µg/m^3 also indicates that pollution increases when the wind is coming from the east or south-east. The increase in sulphate concentrations observed in this context is an indication of sulphur dioxide sources from the power plant and industrial sector.

The Federal Government is already undertaking consultations with Poland to cut down the environmental pollution in the area near the border, for example by preparing an interregional Clean Air Plan. However, this will not suffice, as many other Polish power plants, which are located far from the border and for which transitional periods for compliance with the Large Combustion Plant Directive (2001/80/EC) have been negotiated until the end of 2017, also contribute to background pollution in Berlin.

In May 2005, an initiative launched by Berlin, aimed at reducing the background pollution from large combustion plants in other European Union member states, prompted the Conference of Environment Ministers to urge the Federal Government to advocate the idea at forthcoming talks with the European Commission that all EU member states should meet ambitious and harmonised emission standards.

Actors: European Commission, Federal Government

4.2.3 Summary

The content of this chapter can be summarised as follows:

- Not all of the measures discussed during public consultation are suited to reducing air pollution under the conditions prevailing in Berlin.
- No measures exist that are simultaneously effective and proportionate in the short term, and which would strike a reasonable balance between intervention and air pollution abatement. Individual actions taken by the road authorities, such as road closures, are unsuitable as they only result in a spatial displacement of the problem.
- The measures to reduce air pollution at the source (vehicle), which have been in place for some time, are already showing an effect, but can and must be intensified.
- As air pollution will remain a critical problem for years to come, additional regulatory measures ("low emission zone") will be needed to further reduce the burden on the residents affected.
- Transport planning measures have also already been introduced and are contributing to clean air. However, their main effect will only be noticeable in the medium to long term.
- The objective of reducing atmospheric pollution will only be achieved by a combination and strategic orientation of all appropriate measures in the short, medium and long term.
- The local measures in Berlin must be supplemented by measures at the national and European levels and correspondingly adapted to their outcomes to achieve a dramatic improvement in air quality.

5 The abatement strategy and its impact on air quality

An abatement strategy was developed on the basis of the various measures described in the previous section. The actions considered to be suitable and practicable in Berlin were ranked according to the time frame for their potential implementation and analysed individually in terms of their emission reduction potential.

The effect analysis started by discussing the implementation of the trend scenario measures for 2010 described in Section 4.1.

Three elements in the abatement strategy attainable in the short, medium and long term were identified and analysed. The pollution reduction expected from their implementation will come in addition to that forecast under the trend scenario:

A Reducing emissions through improved motor vehicle exhaust technology

(i) Use in local government vehicles and large haulage firms

The Senate's voluntary initiatives in recent years to promote the installation of particle traps and use of natural gas as a fuel in local government fleet vehicles have been instrumental in encouraging industry to make this technology available and develop it further. These measures (see Section 4.2.1.2 A ii) have also contributed to controlling soot exposure (Diagram 3.1). The **Senate** will continue to set an example, thereby also demonstrating the viability of the measures.

The continued modernisation of the large fleets of vehicles that account for much of the traffic output in the urban area should lead to additional reductions. Along with the *BVG*, *BSR* and the Senate's car pool, these fleets also include large haulage and courier firms as well as taxis. *BVG* vehicles alone consume around 6% of the diesel fuel supplied to Berlin.

Another GASAG natural gas filling station was opened on the premises of the HARU-Reisen coach company in Berlin-Spandau in June 2005, and 9 of the company's natural gas-fuelled buses were simultaneously put into service on *BVG* scheduled routes.

This measure will be particularly effective in further reducing black carbon emissions at pollution hot spots in the major roads network where the above-mentioned fleets of vehicles are concentrated. However, the overall effect of these measures will depend on the extent to which this technological potential can be actually realised in the short term. Given that most of the *BVG* bus fleet has already been equipped with soot filters in recent years, only a limited reduction in total road traffic emissions is projected.

Upgraded exhaust technology must be extended to all cars and goods vehicles to enable low-emission vehicle technology to improve air quality. In Berlin, there is major potential for modernising light duty vehicles in particular, as over half of the existing fleet consists of old vehicles with practically no abatement technology. Old vehicles with spark ignition engines, which emit large amounts of nitrogen oxides, should also be replaced more rapidly by low-emission vehicles. This will help to achieve compliance with the nitrogen dioxide limit values prior to the expiry of the transitional period in 2010.

The following concept was prepared to encourage the more widespread use of low-emission vehicle technology:

(ii) Two-stage plan for a low emission zone in Berlin

Section 4.2.1.2 D describes the idea of creating a low emission zone with user benefits for low-emission cars. Several variations on this approach were subsequently evaluated in terms of their emission reduction potential (see Annex III.2.1.2.3 for the findings). This evaluation was based on the assumption that the technical options for retrofitting diesel vehicles with particle traps, which are mentioned in Section 4.2.1.2, are available at acceptable costs for a large proportion of the existing vehicle fleet.

The findings of the study indicate that:

- a regulation covering both diesel passenger cars and diesel HDV leads to substantially higher emission reductions than a concept that is limited to heavy-duty vehicles;
- the main reduction occurs in the inner city area ("*Großer Hundekopf*"), as the population density and hence the number of residents affected by limit value exceedances is greater;
- a much larger decrease can be achieved by accelerating the implementation of the plan (e.g. start in 2008). Diagram 5.1 shows the projected reductions in traffic emissions in addition to those under the trend scenario for the example of a low emission zone which requires HDV, buses and taxis to meet at least the Euro II exhaust emission standard and be fitted with a particle trap. However, due to the normal replacement rate of old vehicles, the abatement diminishes rapidly if the transitional period is extended for another two years (2010);
- in case of a longer transitional period (e.g. 2010), the exhaust emission criterion must be more ambitious (at least Euro III standard plus a retrofit diesel exhaust particle trap) to achieve any worthwhile reductions.

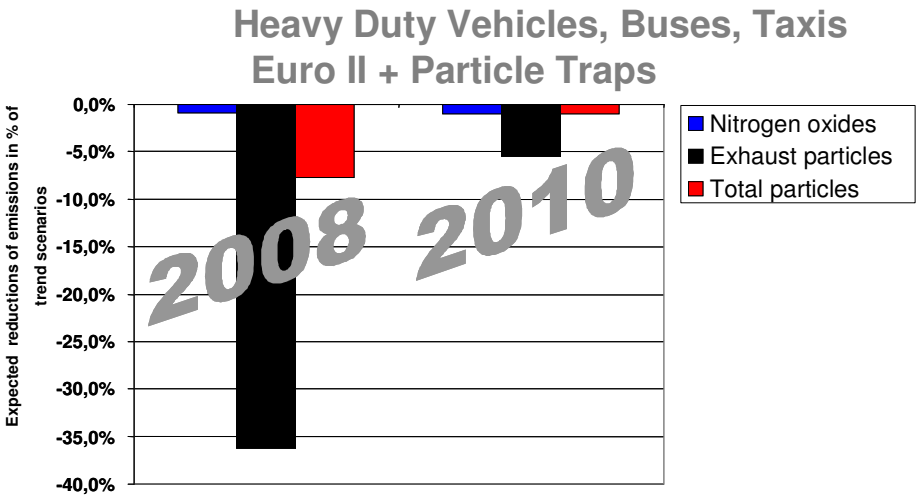


Diagram 5.1 Projected emission reductions (in per cent) from motor vehicle traffic in the "Hundekopf" area in relation to the trend scenario, if only heavy-duty vehicles, buses and taxis that meet at least Euro II and are equipped with particle traps are permitted as of 2008 (columns on the left) or 2010 (columns on the right)

Diagram 5.2 illustrates the projected reduction for the residents of a hypothetical low emission zone in the "*Großer Hundekopf*" area, in which all diesel vehicles must meet at least the Euro III exhaust emission standard and be retrofitted with a soot filter by 2010.

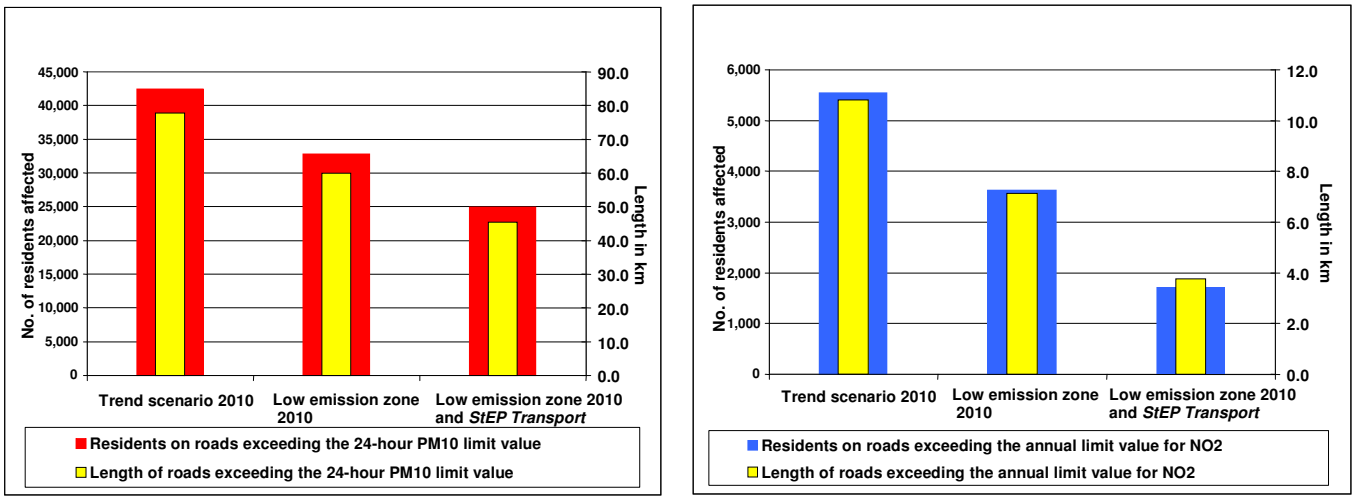


Diagram 5.2 Sections of road in the inner city ("Großer Hundekopf" area) exceeding the 24-hour PM10 limit value (left) and the mean annual value for nitrogen dioxide (right), plus the number of residents affected in different reduction scenarios

The left bar graph illustrates the trend of the length of the road sections in the major roads network in the "*Hundekopf*" area with non-attainment of the 24-hour PM10 limit value, and the number of residents who are directly affected. The trend scenario (column on the left) is followed by the scenario of the low emission zone variant explained above (middle column). The lower-emission exhaust technology required for diesel vehicles in the "*Hundekopf*" area will decrease the number of residents affected by 10,000 and reduce the length of the road sections with limit value exceedances by almost 20 km. Compared with the trend scenario, this is a 23% decrease. Taken in conjunction with the measures under the Urban Development Plan – Transport (*StEP Verkehr*), the number of people affected can be reduced by around 16,000.

The incentive to use emission abatement technology in vehicles also has a positive effect outside the low emission zone. An additional 2,000 residents, or 10%, will also enjoy the air quality benefits outside the zone.

The diagram on the right applies the same information to the annual limit value for nitrogen dioxide. The low emission zone results in around 2000 fewer residents being affected in this context, which corresponds to a reduction of about one third compared with the trend scenario.

Despite the substantial reductions, many road sections will undoubtedly continue to exceed the limit values in 2010. Given the legal situation outlined in Section 3.1, possibilities should be investigated for making additional improvements more rapidly while still observing the principle of proportionality.

For this reason, a low emission zone should be operated which would only allow low emission diesel vehicles access in the future. At the same time, old vehicles with spark ignition engines that emit large amounts of nitrogen oxides should be replaced more quickly, to enable timely compliance with the limit values for nitrogen dioxide prior to the expiry of the transitional period in 2010. In this respect, the following two-stage plan has been developed:

Stage 1 from 2008: Diesel vehicles in Berlin's inner city area ("*Großer Hundekopf*") must meet at least the Euro II emission standard.

Of the approximately 1.5 million motor vehicles registered in Berlin in 2003, around 70,000 diesel passenger cars and approximately 40,000 HDV were classified as Euro I or lower. The natural vehicle stock renewal cycle will reduce the number of vehicles affected to approximately 40,000 diesel cars and 30,000 HDV by 2008. As these vehicles will be over 12 years old in 2008, it can be reasonably expected that they will be replaced, especially if the Federal Government provides a tax incentive.

Stage 2 from 2010: Diesel vehicles in Berlin's inner city area ("*Großer Hundekopf*") must attain at least the Euro III emission standard and be equipped with a particle trap. Vehicles with a spark ignition engine must be upgraded to at least the Euro II standard.

In 2003, this would have impacted an additional 43,000 diesel passenger cars and 15,000 heavy-duty vehicles. After stock replacements, this will still apply to 20,000 diesel vehicles and 10,000 heavy-duty vehicles in 2010. These vehicles will be more than 10 years old in that year. A compulsory soot filter retrofit would upgrade Euro III vehicles and make them more or less capable of meeting the new Euro IV PM emission standard that will be mandatory as of 2005/6.
The restriction on vehicles – mainly passenger cars - with spark ignition engines would involve around 1300 vehicles in 2010 that are already at least 18 years old and do not comply with any of the Euro standards ("Euro 0"). A further 6500 Euro I cars with spark ignition engines would be affected, which would already be older than 15 years at the time.

As shown in Diagram 5.2, stage 2 should result in fewer violations of the PM10 limit levels and therefore greater air quality benefits achieved for around 10,000 residents by 2010 in the "*Großer Hundekopf*" area. The restrictions on high-emission diesel vehicles should also ensure that the number of residents affected by annual limit value exceedances of nitrogen dioxide will drop by 2000. The accelerated renewal of old vehicles with spark ignition engines by more modern vehicles will further reduce nitrogen dioxide concentrations along heavily polluted sections of road.

The additional stage 1 of the plan envisaged for 2008 will result in a reduction by half that will be noticeable a few years sooner, as its early introduction will extend the requirements to more old, high-emission vehicles.

Uncertainty currently exists regarding
- the timely availability of retrofit technology for all conventional diesel vehicle models and
- tax incentives to promote retrofitting and the purchase of new vehicles, especially with respect to heavy-duty vehicles.

However, retrofitting remains an indispensable and simultaneous requirement, at least in stage 2, as the emission reduction would otherwise be substantially diminished.

The most recent signals from vehicle and soot filter manufacturers indicate the high probability that retrofit kits will be available for Euro III vehicles by 2010. However, it is still not sure whether retrofit kits for Euro II vehicles will be offered in time for the launch of stage 1 in 2008. This will depend inter alia on the rapid introduction of the Federal Government's planned tax incentive scheme and the approval procedure for particle traps.
In light of future developments, the possibility is currently being investigated of requiring these vehicles to be retrofitted with a soot filter during stage 1, in addition to meeting the minimum Euro II criterion.

Furthermore, the framework conditions outlined in 4.2.2 must also be fulfilled.

In addition to the modernisation of vehicle exhaust technology, a dramatic improvement in PM10 pollution control will imply a reduction in PM10 emissions from abrasion and dust resuspension. Abrasion and resuspension can be decreased by stabilising traffic flows at low speeds. However, the most important measure is traffic reduction, as it simultaneously limits exhaust emissions, abrasion and the resuspension of dust. London City is a good example of the positive effects of traffic reduction measures on ambient air quality, as it was able to reduce traffic volume by 15% and air pollution by 12%.

B Implementing traffic reduction measures under the Urban Development Plan - Transport (*StEP Verkehr*)

Traffic reduction is a traffic organisation and planning task. The relevant measures are described in Section 4.2.1.2 in Points B, C and E, and are being implemented as part of the Urban Development Plan – Transport. This document presented by Berlin addresses medium to long term courses of action, whose objectives also include reducing atmospheric pollution.

The priorities are to reduce traffic originating and terminating in the "*Großer Hundekopf*" area by consistently promoting eco-mobility modes of transport (local public transport, cycling and pedestrians) and extending parking management. The latter is also an effective way of decreasing the number of passenger vehicles searching for a parking space. The rerouting of through traffic to bypass roads around the inner city complements the traffic reduction effect of paid parking schemes.

Most actions require considerable investments in infrastructure, and are thus effective only in the medium to long term. For this reason, it will be even more crucial to accelerate the implementation of the measures described in the previous section in order to achieve an additional reduction by 2010. This would supplement the vehicle-technology element of the emission abatement strategy (Point A), which is effective in the shorter term.

The column on the right in Diagram 5.2 shows the reduction expected in 2010 from the simultaneous implementation of the technical exhaust measures in A plus the traffic reduction measures reflected in the Urban Development Plan − Transport. Compared with the trend scenario, the PM10 exposure will decrease for more than 15,000 residents and approximately 30 km of major roads.

The abatement achieved by vehicle technology can be almost doubled when combined with transport planning measures in the "*Großer Hundekopf*" area.

However, it is unlikely that transport planning measures will result in translating the predicted (moderate) increase in motor vehicle traffic into a traffic decrease for the entire city. Consequently, transport planning measures alone cannot be expected to contribute to reducing air pollution throughout the entire urban area by 2010.

In fact, the traffic may potentially increase on some major radial roads linking the city and the region, making the simultaneous use of low-emission vehicle technology even more important.

For this reason, another possibility is being investigated, namely that of diminishing pollution by rerouting local traffic in these areas and at specific inner city hot spots in Berlin's network of major roads. This element forms the third pillar of the reduction strategy.

C Reducing pollution at hot spots through local traffic management

Local traffic management includes various measures, such as traffic diversion, dynamic traffic control, stabilisation of traffic flows and temporary speed restrictions.

These measures can be implemented in the short to medium term, depending on the investments required in necessary technical infrastructure, and can thus coincide with the introduction of technical vehicle-related measures (Point A) and be coordinated with the traffic organisation measures (Point B).

The rerouting of particular types of traffic (e.g. heavy-duty vehicles) from certain road sections does indeed result in a perceptible reduction in air and noise pollution (see Section 4.2.1.2 D). However, this measure depends on the availability of low-pollution bypass and diversion routes with only a few residential buildings which is not commonly found in Berlin. This requires detailed planning that considers the specific circumstances of each case.

Based on the effect analyses conducted in this context, areas are being identified in which local traffic management could form a meaningful complementary measure for reducing peak levels. Heavy vehicle through-traffic has been banned from Silbersteinstraße since May 2005. The pollutant readings taken at the roadside measuring station will be analysed to evaluate the effectiveness of this measure.

Frequently, the only appropriate measure at many main traffic arteries is to encourage the steady flow of vehicles at low speeds, which must be evaluated and implemented in conjunction with noise abatement planning.

Summary:

- The measures implemented or introduced under the trend scenario for 2010 (including the emission contribution from outside sources) will result in a 7-10% decrease in urban background pollution from particulate matter. Nonetheless, exceedances of limit values can be expected to occur on many major roads in the future, primarily in the inner city area.
- The impact of a cleaner local government fleet of vehicles will be particularly noticeable at pollution hot spots in the major roads network where these fleets tend to be concentrated.
- The effect analyses show that further abatement measures are needed. The creation of a low emission zone would have the greatest effect, as it could achieve reductions across a wide area.
- The evaluation has resulted in a two-stage plan. Its implementation will culminate in air quality benefits achieved for around 10,000 residents along major roads of the inner city by 2010 (almost 25%). Air pollution will also decrease in inner city residential areas. More than 5,000 residents will enjoy the benefits from an early launch of stage 1 in 2008. The additional use of particle filters in 2008 will significantly enhance this effect.
- Technical vehicle-related measures will also lead to improvements outside the city centre.
- The implementation of the measures described under the Urban Development Plan - Transport will lead to benefits for another approximately 8000 residents by 2010.

6 Summary

The Clean Air Plan's medium-term objectives are, until 2010, to remain consistently below the mean annual limit value for particulate matter as well as to maintain the urban background pollution below the 24-hour PM10 limit value in the short term. In the medium term, the Plan also seeks to stay below the 24-hour PM10 limit value along roads.

The measures have been designed to address source groups' contributions and to be proportionate in their consequences.

Transregional and natural sources account for a significant share of local particulate matter concentrations in many German and European cities, and the *Bundesrat*, on the initiative of Berlin, has called for consideration of this matter when reviewing the EU directive.

Trend modelling has demonstrated an approximately 10% decline in the share of non-locally generated PM10 by 2010, in particular due to measures implemented in the large combustion plants of the EU accession countries. In conjunction with the adoption of state-of-the-art technology in industrial facilities, additional energy savings in buildings, and the modernisation of Berlin's vehicle fleet, the result will be a 7-10% reduction in air pollution in Berlin's urban area.

This will ensure compliance with the mean annual value for PM10 even in years with unfavourable weather conditions.

Compliance with the 24-hour PM limit value and the mean annual NO2 value will remain of critical importance. Consequently, the strategy focuses on the principal source group in Berlin, namely traffic, even though the output of pollutants by cars and heavy-duty vehicles has declined considerably in recent years.

The Senate will continue its successful strategy of promoting the installation of particle traps and the use of natural gas-fuelled vehicles to further reduce exhaust emissions from diesel engines. The *BVG*, *BSR* and fleet of government vehicles in Berlin will upgrade their stocks accordingly.

The possibilities for extending this strategy to the private sector were explored in a discussion group initiated by the Senate Department of Urban Development, involving the automotive industry and representatives from the Chamber of Industry and Commerce, the Chamber of Crafts, and the road transport and haulage sectors. This dialogue is continuing.

General driving bans, e.g. when the 24-hour limit value for PM10 has been exceeded on more than 35 days, do not adequately differentiate between polluters. On one hand, this is because, on days with heavy pollution, up to 70% of the PM emissions arise from outside sources. On the other hand, it is essential to continue to supply the city and to remove urban waste. Consequently, this measure is not proportionate.

However, the gradual implementation of restrictions on high-emission vehicles within the boundaries of the metro circle line in Berlin's inner city ("*Großer Hundekopf*") would constitute a proactive measure. Evaluations of the effects of the Clean Air Plan have resulted in the following two-step approach, dubbed the "two-stage plan for Berlin's low emission zone":

Stage 1, effective 2008: Diesel vehicles in the "*Großer Hundekopf*" area of Berlin's inner city must, at a minimum, meet the Euro II emission standard.

Stage 2, effective 2010: Diesel vehicles in the "*Großer Hundekopf*" area of Berlin's inner city must, at a minimum, comply with the Euro III emission standard, as well as be equipped with a particle trap. Vehicles with a spark ignition engine must, at a minimum, meet the Euro II standard.

Given that soot filters should be widely available by 2008, the possibility is currently being investigated whether, in addition to meeting the minimum Euro II criterion, these vehicles should also be required to be retrofitted with particle filters during Stage 1.

By 2010, the two-stage plan is expected to result in air quality benefits for about 10,000 residents in the "*Großer Hundekopf*" area.

Another condition that will play a decisive role in the practical implementation of the two-stage plan in Berlin's inner city is a nationwide system for labelling vehicles by pollutant category (windshield sticker). To this end, the Federal Government must pass a corresponding ordinance; however, several of Berlin's previous initiatives in the *Bundesrat* and Conference of Environment Ministers were unsuccessful. Traffic signs are also needed to designate low emission zones which will require an amendment to the *Straßenverkehrsordnung* [Road Traffic Regulations] by the Federal Government. In May 2005, the Federal Ministry of the Environment presented a draft bill for an ordinance on the labelling of low-emission vehicles (34th Ordinance to the Federal Immission Control Act - *34. BImSchV*) and organised a hearing with the relevant associations and highest *Land* authorities.

The Senate has also repeatedly called for a revenue-neutral tax incentive to include heavy-duty vehicles and buses with low exhaust emissions, since heavy-duty vehicles and buses are major contributors to air pollution. On the initiative of Berlin, the Federal Government presented a draft bill for such an ordinance in April 2005 which is, however, limited to passenger cars.

In addition to vehicle-related measures, the emissions from abrasion and the resuspension of dust by traffic must also be reduced. This can be achieved by with measures designed to stabilise the traffic flow and to reduce traffic volumes, especially in Berlin's heavily polluted city centre. To this end, Berlin's transportation policy must integrate a host of different measures.

Berlin is already well-prepared. The Senate adopted the Urban Development Plan - Transport in July 2003, whose aims take account of the new legal situation with regard to the reduction of air pollutants and noise abatement. Its strategic approach and action plan take the interactions between the environment, transport and urban development into consideration.

Environmental policy can – and must – receive effective support from a suitable transport policy and transport planning.

Of critical importance are efforts to curtail the increase in motor vehicle traffic in the city and region, and an integrated transport and settlement policy can make a major contribution in this area. Berlin consistently focuses on "compact city development" and has been cooperating with Brandenburg in the pursuit of a responsible, rail-oriented settlement policy on the outskirts of Berlin.

Cars are, and will remain, indispensable in the city and region. Nonetheless, for reasons of urban and environmental policy, the Urban Development Plan –Transport seeks to place greater emphasis on the "eco-mobility" modes of transport. To increase their traffic share, the new bicycle strategy will consistently promote bicycle use in the future, while a whole range of measures will be introduced to make the local public transport system more appealing.

Improved parking management in the city centre, and especially paid parking schemes, can provide considerable support for efforts to reduce air and noise pollution by decreasing the numbers of vehicles searching for a parking space and encouraging commuters to switch to local public transport. For this reason, the Senate supports and encourages the district authorities to continue to gradually extend paid parking to all areas with a severe parking shortage.

To supplement the measures outlined above, the Senate is preparing to reorganise priority traffic flows in all areas of the road network where, currently, limit values are exceeded due to heavier traffic volume. This affects the entire network of main roads in the inner city, but also, e.g., the network in the old town area of Köpenick. In the future, the Senate will achieve traffic reductions by making changes to the organisation of traffic or, in exceptional cases, by diverting traffic onto different roads.

Supplementing the package of measures described above, which will primarily be effective in the medium term, will be additional measures from the new road safety programme. Stricter observance of existing speed limits and more speed restrictions wherever necessary for purposes of noise abatement and road safety will also result in a reduction in air pollutants.

Traffic avoidance and redirection measures will reduce inbound, outbound and through-traffic in Berlin's inner city area which will lead to an additional reduction in pollutants, primarily the PM10 concentrations. This will further decrease the exposure of more than 8,000 residents of the inner city area.

Pollutant concentrations along the remaining heavily polluted road sections will be reduced through traffic management and traffic flow stabilisation measures. However, some infrastructure-related work is needed first. Some of it will have been completed by early 2006 within the framework of research projects.

Necessary as supplements to the measures introduced in Berlin are initiatives for more stringent exhaust emission standards and for a reduction in cross-border air pollution, both at the German federal and European levels

The following tables provide a summary of the measures contained in the Clean Air Plan.

Measure	Effect	Framework Conditions, Comments	Period of Implementation
Gradual installation of soot filters in the *BVG* bus fleet Gradual conversion of the *BVG* bus fleet to the EEV[2] standard (local transport plan)	Perceptible effect on roads with high bus traffic density	• Model for other sectors • Berlin has already made more progress here than other European cities	By 2008 By 2012
Gradual installation of soot filters or replacement by natural gas vehicles in Berlin's government vehicle fleet	Perceptible effect in areas with high pollution Minor in comparison to total traffic	• Model for other sectors • Berlin is already leading the way in this area	By 2008
Gradual installation of soot filters in the *BSR's* vehicle fleet or replacement by natural gas vehicles			50% of the fleet by 2008, the entire fleet by 2012
Negotiations on similar conditions for other waste disposal companies			
Continued promotion of natural gas vehicles as taxis and in driving schools within the framework of the *TUT* programme			Continuous
Continued promotion of natural gas-fuelled heavy-duty vehicles within the framework of the TELLUS programme			Continuous until 2006

Table 6.1 Current measures

Measure	Effect	Framework Conditions, Comments	Period of Implementation
Speed restrictions	Minor	• Synergies with noise abatement planning and road safety	Immediately/ continuous
Information campaign for building site operators on options for avoiding dust	Moderate, local only		Continuous from the end of 2005
Reducing dust emissions from building sites under the *Landes-Immissionsschutzgesetz*	Major, local only	• Building sites must be monitored	End of 2005
Possibility is being investigated of requiring construction equipment designed to reduce particle emissions to be used in heavily polluted areas	Moderate		End of 2005
Local traffic control and stabilisation measures to reduce pollution hot spots	Minor to major, depending on the particular case	• Displacement of traffic to other areas must be avoided • High cost of evaluating each case • Financing must be guaranteed	6-12 months, depending on the measure

Table 6.2 Measures with a short-term effect

[2] EEV: Most rigorous environmental standard (Enhanced Environmentally Friendly Vehicle)

Measure	Effect	Framework Conditions, Comments	Period of Implementation
Low emission zone in the "*Grosser Hundekopf*" area (Traffic restrictions in the "*Grosser Hundekopf*" area on high-emission diesel vehicles that do not comply with the relevant environmental criteria)	Major Greater air quality benefits achieved for at least 5,000–10,000 residents in streets with exceedances; has an additional effect on residential areas Initial reductions occur in the short term and increase until the introduction of the low emission zone	Necessary prerequisites for implementation: • Federal Government ordinance on labelling • Amendment of the *StVO* (traffic sign for the low emission zone) • Tax incentive for low-exhaust vehicles (including heavy-duty vehicles and buses) • Retrofitting technology available for all vehicle models • Adequate lead time In light of future developments, the possibility is being investigated of also requiring retrofit for Euro II during stage 1	Stage 1 in 2008: The Euro II exhaust emission standard is the minimum criterion for diesel vehicles Stage 2 in 2010: Minimum criteria for diesel vehicles are the Euro III exhaust emission standard and a soot filter; Euro II is the minimum standard for vehicles with a spark ignition engine

Table 6.3 Measures with a medium-term effect

Measure	Effect	Framework Conditions, Comments	Period of Implementation
Diversion of through traffic in the city centre onto bypass roads	Major in the "*Hundekopf*" area due to traffic reduction; also reduces abrasion and resuspension of PM10	• Priority implementation of the plan necessary • Guarantee the necessary funding	Medium term
Gradual extension of paid parking		• Accelerated implementation necessary by the competent district authorities	Short, medium to long term
Consistent promotion of non-motorised transport (local public transport, bicycle plan)		• Financing must be granted for the extension and maintenance of infrastructure	Short to medium term
Maintaining / increasing the appeal of the local public transport system in the long term		• Balance must be struck between fares, income levels and motor vehicle usage (parking fees) • Implementation of the bicycle plan	Medium to long term

Table 6.4 Measures with a medium to long-term effect (transport planning) under the Urban Development Plan - Transport (*Stadtentwicklungsplan Verkehr)*

Measure	Actor	Framework Conditions, Comments	Period of Implementation
Passing of a Labelling Ordinance (§40 para. 3 *BImSchG*) and amendment of the *StVO* (traffic sign)	Federal Government	• Berlin renewed its initiative in the *Bundesrat*	Immediately
Tightening of the European emission standards for motor vehicles and mobile machinery / equipment	EU	• Rapid adoption by the EU • Creates the possibility of tax incentives for low-exhaust technology	Bill tabled in 2005 Entry into force in 2010
Tax incentives for low-exhaust vehicles and retrofitting; including for heavy-duty vehicles and buses	Federal Government		In 2005
Encouraging neighbouring Eastern European countries to more rapidly reduce particulate matter-related emissions from industry and power plants	EU, Federal Government	• Limited ability to exert influence	Immediately
Proposal to review the EU directives on air quality	European Commission	• The aim is to harmonise the EU's regulatory framework conditions for emission reduction with the pre-set limit values for air quality	In the short term

Table 6.5 Need for external action