SOOT FREE CITIES

Best practice examples from German and European cities for reducing soot from traffic

A CAMPAIGN BY
Deutsche Umwelthilfe
BUND
NABU
VCD
IMPRINT

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First edition, January 2012

www.sootfreeclimate.org

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Transport policy in German cities has been discussed intensively in the past five years, thanks to the Europe-wide limits on particulate matter (PM10). Restricting diesel vehicles without filters as well as encouraging cycling and public transport were measures taken by many cities to achieve cleaner air for their citizens.

The fact that the NGOs involved in the „Sootfree for the Climate“ campaign are committed to urban traffic policy and support local groups underlines the importance of transport policy in the cities. Cities are the most important actors in the protection of air quality and environmental protection; that both topics are inextricably linked is common knowledge. But new scientific findings show that soot, or Black Carbon, is not only most detrimental to our health but also to our climate: Soot greatly contributes to global warming by heating the atmosphere and by changing the ‘albedo’ (sun reflection) when deposited on snow and ice. Every measure of soot reduction is therefore also a contribution to protecting the climate.

That does not mean, however, that we may cease our efforts to reduce CO₂ or pass this burden on to the next generation. What we badly need is a change in the trend regarding CO₂ emissions because emissions of carbon dioxide remain in the atmosphere for more than a century, which is why the carbon concentrations will continue to increase. Transport as a whole is one of the biggest emitters of CO₂, while diesel engines are by far the biggest source of soot emissions in Europe. The „Sootfree cities“ brochure seeks to demonstrate ways to successfully tackle emissions from sources like cars and lorries, but also from construction machinery, ships and diesel locomotives. The introduction of environmental zones in cities is – to date – the most effective single measure to cut down on soot. Yet technical solutions alone are not enough to achieve compliance with EU limits. Improvements for pedestrians, cyclists, and public transport are equally important to reduce soot and promote alternatives to the car. The brochure contains positive examples from a number of European countries.

Such best practices will hopefully get stakeholders and initiatives involved in making their cities more livable by improving air quality and protecting the climate. Indeed, good examples are the best motivators for further action. We have the opportunity for change in the years ahead of us, so let’s get down to it!

Yours sincerely

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What has soot got to do with climate protection?

There is now a very broad scientific consensus behind anthropogenic global warming, with carbon dioxide (\( \text{CO}_2 \)) being the main contributor. Reducing \( \text{CO}_2 \) emissions by at least 80% by 2050 is the current official government position in Germany – even though there is still much too little being done to achieve this goal. The sooner the \( \text{CO}_2 \)-reductions begin, the greater the effect on climate protection. The half-life of \( \text{CO}_2 \) is 100 years, i.e. the effects of today’s emissions will still be felt more than 100 years from now. However, Short-Lived Climate Forcers, such as particulate matter (i.e. Black Carbon) are also very significant contributors to global warming.

Climate effects of Black Carbon

Soot particles influence global warming in three ways. They

- absorb the sun’s radiation due to their dark surface and therefore heat the surrounding area,
- are deposited on the Arctic ice, reducing its potential to reflect sunlight by 40%, thereby contributing to an acceleration of ice melt\(^1\),
- affect cloud formation and therefore regional precipitation patterns\(^3\).

The harmful effect of soot is particularly evident in the Arctic, where temperatures are rising dramatically, twice as high as the global average temperature rise. \( \text{CO}_2 \) alone cannot fully account for this rapid increase\(^4\). The accelerated melting of the Arctic ice is considered one of the tipping points (points at which observed changes in the local climate have a decisive influence on the world climate). This is why our primary aim must be to stop the melting process in the Arctic immediately.

The climate effects of the so-called short-lived climate forcers (soot, among others), which only stay in the atmosphere for days or weeks, are not yet high on the agenda of European scientists and politicians. This is unlike the situa-

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\(^1\) Dennis Clare (2009): „A Quick Look at Black Carbon“ Präsentation auf www.rußfrei-fuers-klima.de
\(^2\) Particulate Matter – German Environmental Agency (UBA)
\(^3\) Ramanathan V. et al. (2005): „Atmospheric brown clouds: Impacts on South Asian climate and hydrological cycle“
\(^4\) Drew Shindell, Greg Faluvegi (2009): “Climate response to regional radiative forcing during the twentieth century“
\(^5\) AMAP (2008): „The Impact of Short-Lived Pollutants on Arctic Climate“

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**Contributions of emissions to global and Arctic temperature increases**

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tion in the United States, where it is now beyond dispute that soot is contributing considerably to global warming. They are only debating whether black carbon is the second- or third-leading cause of climate change after CO₂. Due to the short atmospheric lifetime of soot, it has a stronger climate effect than CO₂, but the longer-lived CO₂ accumulates in the atmosphere. If we curtail CO₂ emissions today, we will not start seeing temperature differences quickly.

Reducing particulate matter – and with it soot – will not only help the climate but will also protect humans from the harmful effects of pollutants with emission limits set by the EU. The tiny and ultra-fine particles in particulate matter (PM2.5 and smaller) penetrate the lungs and enter the circulation system, which may lead to inflammations. In addition, they help carcinogenic compounds find their way into the bloodstream. The soot particles deposited on Arctic surfaces are also relatively small, and they are transported at high altitudes mainly from Europe (see Fig. 2).

Why large cities?

Half the world’s population lives in large cities, and the figures are rising. This is where up to 80% of greenhouse gases are emitted. Therefore, cities have to become particularly active in health and climate protection. At the same time they are hot spots with the greatest potential for progress on these issues. The small travel distances in urban environments as well as the existence of good infrastructure – at least in major European cities – encourage a higher use of cleaner modes of transport: walking, cycling, using buses and trains. Whether a city is considered livable depends, among other things, strongly on its air quality. As a result, sustainable transport policy that focuses on ecomobility (walking, cycling, use of public transport - including buses, trams, and suburban rail services) has become an indicator representing a city’s quality of life.

When examining the cities, we looked at technical and non-technical mitigation measures. Even though the modernisation of cars, lorries, and buses resulting from the introduction of environmental zones is the most important of all the mitigation measures, alone it does not suffice. The modal share of
cycling, walking and public transport has to rise significantly. So far restrictions for cars and trucks have received most public attention. But measures to reduce the emissions of soot from buses, ships, locomotives and construction machinery must also be taken into account to achieve sufficient soot reduction.

Diesel engines are not only an important source of particulate matter, but at the same time also the main emitters of nitrogen oxides (NO\textsubscript{x}). This pollutant is also detrimental to human health and leads to premature deaths. And as a precursor of ozone (O\textsubscript{3}) it contributes to global warming as well.

All the measures proposed are not only good for the climate, but are also an important step towards making our cities more livable.

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**What else advocates the reduction in emission values?**

As early as 1999, the EU Directive 1999/30/EC has set limits for particulate matter (both PM10 and PM2.5) and nitrogen dioxide (NO\textsubscript{2}). In 2008 the Air Quality Directive 2008/50/EC updated the limits to the currently applicable values. The air quality limits as of January 2010 are:

- the daily mean of 50 \(\mu g/m^3\) for PM10 is not to be exceeded more than 35 times a year.

- the limit of 200 \(\mu g/m^3\) NO\textsubscript{2} per hour is not the be exceeded more than 18 times a year.

- the annual means to be observed are 40 \(\mu g/m^3\) for PM10 and 40 \(\mu g/m^3\) for NO\textsubscript{2}.

Cities that do not meet these values and fail to show that all appropriate measures were taken to reach the ceilings will face sanctions worth millions of Euros. Time extensions granted to cities by the EU Commission on application ended on the 11th of June 2011. Since then every city has to maintain the PM10 limits.
To comply with the EU emission limits, long-term reduction strategies must be developed combining both technical approaches (installation of particulate filters) and the promotion of sustainable transport. The objective must be to...

- Filter out soot particles from the exhaust fumes from lorries, cars, buses, trains, inland water vessels and diesel locomotives,
- Encourage more people to make sustainable transport choices rather than to rely on their cars and thus reduce motorised traffic in the city, for example through improved mobility management.

The measures to improve air quality and climate can be divided into these categories:

- **Technical measures**: Installation of filter systems to decrease soot and nitrogen dioxide
- **Regulatory measures**: Laws, ordinances, directives
- **Pricing measures**: Economic incentives to change people’s behaviour resulting in choices for clean vehicles or increased demand for environmentally-friendly modes of transport
- **Organisational measures**: Restructuring administration, for example integrated rather than sectoral approaches
- **Infrastructural measures – reallocation of road space**: Measures aiming to redesign road space in favour of sustainable modes of transport or to initiate and implement new projects, for example rebuilding trams and cycle lanes
- **Marketing**: Information, advertisement, communications and events supporting ecomobility
The measure descriptions in the respective category include three steps:

• a brief outline of the concepts and their implementation,
• two or three examples to illustrate how it works in practice,
• an evaluation from the point of view of the environmental associations (strengths and weaknesses)

This brochure aims to describe the effectiveness and mitigation potentials of every measure as concretely as possible. If quantitative data on soot reduction is available, it is provided in the text. Unfortunately, measurements of soot emissions are available only in a handful of cases. In these cases you will find details on fine dust reductions or on changes in the modal split. For a few measures, we were not able to find any data.

Technical measures

Particulate filter

Technical abatement measures, particularly for new cars with diesel engines, are the most effective and cost-efficient way to cut soot emissions. Installing closed filter systems can help reduce soot emissions (by mass and number of fine particles) by up to 99%. Since 1 September 2009, Euro 5 standards have applied to all new cars with PM emissions restricted to 0.005 g/km, which can only be achieved with the use of closed particulate filters. This is a fourfold decrease in particulate matter compared to Euro 4 standards (valid for all new cars from 1 January 2005). The vehicles on our roads, by contrast, can only be retrofitted with open filters, raising the cost by EUR 500 to 600 for each vehicle. Particulate matter is reduced by 30 to 50% on average.

The German government temporarily grants a one-time credit of EUR 330 for retrofitting diesel vehicles. In May 2010 the tax allowance was extended to light commercial vehicles up to 3.5 t.\textsuperscript{7} In September 2014 Euro 6 enters into force which cuts down nitrogen oxide emissions (NO\textsubscript{x}) of diesel passenger cars to a level which petrol cars have reached since 2005.

1 Operating principle of closed filters
2 Operating principle of open filters

\textsuperscript{7} “Förderung von Dieselpartikelfiltern geht weiter”, Press Release 2010, Federal Environment Ministry (german)
New Light commercial vehicles like buses and lorries are usually fitted with the **CRT particulate filter** (Continuous Regenerating Trap) as emission control technology, combining an oxidation catalyst with a ceramic or sintered metal filter. CRT filters are capable of eliminating about 90% of particulate emissions. As they cannot reduce NO\textsubscript{2} emissions, the CRT filter is completed by the so-called SCR technique (Selective Catalytic Reduction). The SCR deNO\textsubscript{X} technology has the potential to reduce the NO\textsubscript{2} emissions by up to 80%.

**Retrofitting the public vehicle fleets**

Most of the buses of transport companies and the commercial vehicles of municipal building yards, as well as the vehicles of utilities and street cleaning companies have diesel engines and gather high mileage within the cities and towns; thus they account for relatively high emission levels. In addition, the municipal governments have to be role models and are therefore particularly responsible for retrofitting their vehicle fleets with effective filters. It is unacceptable for them to rely on exemptions for their own diesel vehicles while enforcing the retrofitting of private cars.

**Oxfordshire**

Oxfordshire is reviewing the costs and effects of introducing an emissions protocol into a quality bus partnership agreement (and other approaches to regulating emissions from commercial bus fleets). Any regulatory approach is likely to remain technology neutral meaning that emission reductions may be achieved via retrofits or vehicle replacement. Also within Oxfordshire, the Oxford Bus Company has placed air quality and emission control centrally within its commercial strategy. It has undertaken a benchmarking exercise to ensure that its fleet is among the best in the UK in controlling PM, NO\textsubscript{x} and other emissions. All vehicles have CRTs retrofitted as a minimum requirement and the fleet average age is currently six years old and vehicles are now replaced by ones that are Euro V standard or better.

**Zurich**

For new vehicles the city of Zurich requires the strictest Euro standards available on the market. Those manufactured after 2006 need to be equipped with exhaust treatment systems according to best available techniques (BAT). All existing vehicles were required to be retrofitted by the end of 2010. As part of its CO\textsubscript{2} reduction targets, the city has also set a 2% fuel consumption reduction target per year (between 2006 and 2015). The municipal authorities use carpooling and car sharing services on business trips and for local use they have 140 bikes at their disposal.

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8 UK, Department for Environment, Food and Rural Affairs, Local Air Quality Management, Practice Guidance 4
Construction machinery

Construction machinery and vehicles are responsible for about 14% of PM10 emissions (cf. analyses of the Environmental Ministry of the state of Baden-Württemberg). According to the Federal Environmental Agency (Umweltbundesamt: UBA) and IFEU Heidelberg, construction machinery causes about a quarter of the transport sector’s particulate matter emissions.

To achieve significant reductions in soot, measures targeted at construction machinery are very important. For this reason, in Switzerland, construction machinery with a power over 37 kW has been required to be fitted with a particulate filter since 1 January 2009, machinery with less power since 1 January 2010. In addition, machinery manufactured between 2000 and 2008 have to be retrofitted. In Vienna, as well, similar provisions have already been put into effect.

Retrofitting inland water vessels

Ship owners still find it difficult to fit particulate filters on their passenger and commercial vessels, even though the technology could help to filter out 95 to 99% of all soot particles, provided that low-sulphur fuel is used. Though both the EU and the German government have set mandatory emission requirements for ship engines (Directive 2004/26/EC: Stage IIIA and IIIB from 1 January 2010), it is quite difficult and expensive to retrofit inland water vessels. That is because those vessels are generally built in small quantities and filters therefore usually must be custom made or built in very small numbers. Certain government programmes cover a proportion of the costs, for example by paying subsidies for new engines and new vessels. In most cases, however, the programmes fall short of providing for sufficient incentives for the ship owners to retrofit their vessels.

Amsterdam

The city of Amsterdam offers subsidies for retrofitting older passenger tour ships with newer and cleaner engines. The exchange of Diesel against electric or hybrid engines is supported in particular. The measure explicitly addresses improvements in air quality and the protection of historic heritage in the inner city area. Many cruise boats already use electric, hybrid or hydrogen engines.

CONCLUSION

Particulate filters are the easiest and most cost-effective way to decrease soot emissions. Since there are as yet no nation-wide requirements for mandatory particulate filters, cities have to find ways to promote the filters indirectly. They should set a good example, for instance, by retrofitting their own vehicle fleets or including municipal provisions in tenders and public procurement. Diesel engines can only be considered clean if they reduce both particles and nitrogen oxides at the same time. Otherwise nitrogen dioxide concentrations could even rise.

9 see Federal Environmental Agency (2007), Measures to reduce fine dust and nitrogen dioxide, Dessau, p. 121
**DEMANDS**

Requirement to retrofit vehicles of the public transport fleet, i.e. vehicles with a life expectancy of more than two years and if it is technically feasible.

Building planning stipulates that the planned construction measures be carried out by low-emission machinery or machines equipped with efficient filters.

Tenders for construction of public buildings must include rules for the use of low-emission machinery or machines equipped with efficient filters – for instance by means of specific or additional contractual conditions.

Effective and sufficient subsidies, compensation payments, and other incentives for retrofitting inland water vessels.

Incentives to make ships soot-free.

**Regulatory measures**

**Environmental zone**

Low Emission Zones (LEZ) or „environmental zones“ (Umweltzone in Germany, UWZ) is the most talked about measure in the transportation sector in Germany. Since the first environmental zones were introduced in 2008, more than 40 German cities have adopted them so that vehicles with very high fine particle emissions are restricted from entering parts of the inner city or even all parts of the city. Taking this step, the cities hope to reduce the particulate matter levels and thus bring themselves into compliance with the EU limits for PM10 and NO\(_2\) (nitrogen dioxide). Meanwhile LEZs have been introduced in eight European countries.

**Berlin**

Berlin launched the first environmental zone on 1 January 2008, as did Hanover and Cologne. After allowing all vehicles with a red, yellow, and green sticker to enter the environmental zone, Berlin made green stickers (at least Euro 4-standard) mandatory for vehicles travelling within the S-Bahn ring line on 1 January 2010. After only one year, the environmental zone reduced the diesel exhaust particulates by 24% and NO\(_2\) emissions by 14%. It has also led to a modernisation of the vehicles on Berlin's roads. The number of cars that did not qualify for a sticker because of the level of pollutants they emitted went down by 70%, that of lorries by 55%. In 2008 88% of the cars registered in Berlin met at least the Euro 4 emission standards\(^{10}\).
CONCLUSION

Environmental zones are essential in cities and urban agglomerations as they are the most effective short-term measure to mitigate soot emissions in urban areas. The local reduction potential in terms of BC and nitrogen dioxide in an LEZ is about 10 to 12%, according to calculations by the Federal Environmental Agency (UBA). The preconditions for guaranteeing the effectiveness of environmental zones are that the third implementation stage (green sticker) is introduced quickly, and that there are few exemptions and effective controls. Since environmental zones apply to all cars and lorries that enter a city, regardless of where they are registered, they provide an incentive to equip new cars with efficient filters and promote the retrofitting of the vehicle fleet with filter systems. Therefore, this measure will reduce pollutant emissions throughout the country. Environmental zones help especially to reduce the smallest particles that are particularly harmful to public health and the climate. The reduction in NO\textsubscript{2} emissions is another good reason to set up an environmental zone. It is very important to introduce a separate sticker for the cleanest cars meeting the euro 5- and euro 6-standard.

London

London installed a LEZ for heavy goods vehicles with of 3.5 t or more in most of Greater London. In this zone, heavy goods vehicles are required to meet Euro 3 standards. Euro 4 standard for PM is now slated be introduced in 2012, as the introduction of the third phase was postponed from 2010. The LEZ is monitored and enforced by the same system as the congestion charge (automatic number plate recognition system by camera).

Stockholm

The city of Stockholm has had a low emission zone for heavy goods vehicles since 2006. The zone covers the entire city centre, and diesel trucks and buses older than 6 years are required to meet at least Euro 2 standards. Diesel trucks less than 8 years old need to meet either Euro 2 or 3. Euro 4 vehicles will be phased out in 2016 and Euro 5 trucks can be driven until 2020.
DEMANDS

When limits for PM10 are exceeded: immediate introduction of an environmental zone.

The environmental zone should cover all parts of the city as well as major traffic hubs (i.e. ports and freight stations).

Existing environmental zones have to make high standards (euro 4 at least) mandatory as soon as possible.

Nation-wide exemptions for two- and three-wheeled vehicles as well as non-road mobile machinery should be abandoned; local exemptions should be omitted.

Stricter rules should be introduced with Euro 5 being the minimum standard for the green sticker and Euro 6 the next emission standard (a blue sticker, for example).

Further Links

Low Emission Zones in Europe Network
www.lowemissionzones.eu

German Federal Ministry for the Environment, Nature Conversation and Nuclear Safety – Information on low emission zones & emissions-control windscreen stickers
www.bmu.de/english/air_pollution_control/general_information/doc/40740.php

City of Berlin - Berlin’s Environmental Zone from 2008 – What drivers need to know
Speed limits

Speed limits should be a standard tool when it comes to improving the climate in cities. Limiting the speed of vehicles will not only save fuel, it will also reduce differences in vehicle speed and minimize braking and acceleration and thus reduce PM10 emission from brakes, tyres and lower re-suspension of dust from the street surface\textsuperscript{11}. It is relatively easy and cheap to indicate speed limits, which is why they have long been introduced in inner-city areas to reduce traffic noise and improve road safety. The precondition is, however, that measures are taken to secure a high level of compliance, for example via mobile speed cameras. In addition, the cities should adopt the „green wave“ scheme on roads regulated by traffic lights to make motorists obey the speed limit. They could also discourage the use of adjacent side streets through structural measures.

Berlin

In most German cities, traffic planners seem to be happy to implement 30-km/h (about 19 mph) zones in side streets. As part of the Europe-wide „HEAVEN“ pilot project, the city of Berlin went one step further. 16 stretches of main roads have been slowed down with a speed limit of 30 km/h since 2005, making this measure even more effective as these roads carry up to 80\% of the urban traffic. As such regulations can only apply in exceptional cases, the city has to present convincing arguments: increased traffic safety and lower exhaust and noise emissions. In the Schildhornstraße, the average speed fell by 25 km/h (about 15 mph). The concentrations of PM10 sank by 7\%, those of nitrogen oxides by 13\%. The number of accidents even dropped by more than half. Comparable roads without speed limit enforcements only showed a 3\% decline of those pollutants\textsuperscript{12}.

Graz

Between December 2008 and October 2009, the city of Graz had been lowering the speed limit from 130 to 100 km/h (about 62 mph) on the motorways surrounding the Austrian city by using a flexible traffic control system. Although the high amount of lorry traffic and speeding affected the reduction potential of the measure, it still helped eliminate 450 kg of PM10 and 16,000 kg of nitrogen oxides during the test period\textsuperscript{13}. Therefore, speed limits on urban motorways can contribute to bringing down the background levels of fine particles in urban areas.

\textsuperscript{11} German environmental agency – Speed limits (german)

\textsuperscript{12} City of Berlin, EU-environmental project – HEAVEN (german)

\textsuperscript{13} „Großraum Graz hat 450 Kilo Feinstaub eingespart“, Kleine Zeitung, 29.10.2009, (german)
CONCLUSION
A speed limit combines several advantages: it can be easily implemented, it reduces pollutant levels and noise significantly, and it increases traffic safety. For these reasons, speed limits are a must when drawing up a package of measures to mitigate soot emissions. However, their reduction potential on motorways is still highly underestimated. A series of tests conducted on Swiss motorways revealed that a speed limit of 80 km/h (about 50 mph) decreased exhaust gases by 27%! Yet here too, its reduction potential very much depends on how it is implemented. Berlin, for instance, witnessed declining concentrations of fine particles both in street sections with and without fixed speed control systems. In street sections with speed control systems they were twice as high.

DEMANDS
Expanding 30-km/h zones in European city centres, including on main roads.

- Maximum speed limit of 80 km/h on suburban motorways.
- Strict enforcement of speed limits.

Driving ban for lorries
Lorries are the largest soot emitters in road traffic and are responsible for considerable amounts of transport-related particulate matter pollution in cities. Driving bans for lorries, such as those implemented in several German cities, ensure that local emissions drop quickly and contribute to health protection and noise reduction. Driving bans for lorries usually apply in road stretches with high concentrations of PM10 and NO₂ and are limited solely to heavy goods vehicles. This measure only has a limited local impact and total emissions are not affected. However, driving bans need to be installed wherever there are high local levels of particulate matter caused by lorries.

Stuttgart
The city of Stuttgart imposed a driving ban for lorries from January 2006 to March 2008 - the most extensive of its kind in Germany. Vehicles weighing more than 3.5 t were not permitted to drive through any part of the inner city. As a result, particulate matter emissions fell by 9%. The reduction in emissions of black carbon, however, was not measured. Studies indicate emissions were likely to have decreased by up to 11%14. Traffic census data conducted on the outskirts of the city showed a decline in lorry traffic by 36%15.

As part of the introduction of the LEZ in 2008, Stuttgart ended the driving ban for lorries. This proved to be a mistake! The low emission zone alone proved unable to prevent exceeding PM10 rates. On 1 March 2010 they had to reintroduce the driving ban for lorries from 3.5 t.
Vienna
In 2008 Vienna introduced an inner city ban for trucks manufactured before 1992. The ban sets a limit for high polluting vehicles, which is nevertheless somewhat weakened by several exemptions for commercial vehicles that have to enter the city for deliveries. These exemptions are relatively broad and cover a large amount of the otherwise banned vehicles. Also, the ban addresses only very old vehicles, and changing vehicle status by retrofitting is not supported by the measure.

CONCLUSION
Driving bans are appropriate measures to reduce local soot emissions in the short term. The actual mitigation effects vary according to the proportion of lorries in the area under the ban and on consistent enforcement of the ban. Authorities must bear in mind that lorries making detours may cause increased emissions. Another disadvantage is that a general driving ban - unlike an environmental zone - excludes clean lorries as well. Thus it does not encourage the purchase of new vehicles or the retrofit of old ones.

DEMANDS
- Compulsory driving bans for lorries in areas with very high concentrations of pollutants.
- Ensure consistent enforcement of these driving bans.
- Indicate reasonable alternative routes to avoid detours.

Pricing measures

Congestion charge

Congestion charge, road pricing, congestion toll, road toll – the charges for using the inner-city street network have many names. Originally introduced to finance road construction, public transport or consolidating the public budget, they can also be effective in reducing soot emission levels in cities. Setting a price on the use of roads could convince many people to leave their cars and switch to public transport in the inner-city. An emissions-based toll scheme can reduce emission pollution even further. If the toll varies depending on the peak times, it will also improve traffic flow and avoid congestion.

London
In 2003, the biggest city in the EU introduced a congestion charge covering 38 square kilometres in the city centre. Drivers are obliged to pay GBP 8 per day
for entering the charging zone (from 7 am to 6.30 pm on weekdays only). The charge is enforced by a network of number plate recognition cameras placed at the zone boundaries. The congestion charge was intended to finance the renovation of the underground system. Air pollution control and noise reduction were just secondary benefits of this measure. It also provides environmentally beneficial incentives, for example by exempting electric cars from the charge\(^\text{16}\). The charge has led to decreased emissions of PM10 (down 6%) and NOx (down 7%). Inner-city traffic went down by 15%, with up to 60% of motorists changing to public transport services\(^\text{17}\). Despite all these benefits, London had to also launch a low-emission zone for lorries and buses in February 2008 because they had failed to meet pollution standards. The commitment of Ken Livingstone, Mayor of London at that time, to tackle congestion has been decisive for the acceptance and implementation of this costly measure (EUR 280 million).

Stockholm
The Swedish capital launched a congestion charge in 2007 after a seven-month trial period. According to the charging system, motorists have to pay different rates to enter the central zone depending on the time of day. As Stockholm charges the congestion fee every time a vehicle enters or leaves the zone, they have introduced a maximum daily charge (around EUR 6.65). Although the congestion charge was not exactly popular with the citizens, it was publicly accepted in a referendum. The objectives of the congestion tax are air pollution control and improvements to public transport services\(^\text{18}\). The evaluation of the trial period showed a decline in PM10 emissions by 7% and in NOx emissions by 8%. The vehicle kilometres of traffic in the inner city fell by more than 15%\(^\text{19}\).

**CONCLUSION**
A congestion charge brings threefold benefits: **less soot – less traffic – more money to fund public transport.** On the other hand, the control and paying systems associated with the charge have so far been quite complex and expensive. Furthermore, critics are saying that it is unfair to low-income motorists. This criticism can be countered with the argument that those without a car benefit from congestion charging revenues being used for public transport.
DEMANDS

A congestion charge should be introduced in addition to the environmental zone if the regulated area still exceeds limits for PM10 and NO2 with all emission standards fully implemented.

The revenues raised by the scheme should be used for improving public transport.

Fees should depend on the car’s exhaust emissions, allowing the share of clean vehicles to grow.

Further Links and Literature

London Congestion Charge


Parking management

The availability of reasonable parking spaces at every destination has a key impact on people’s decisions to choose a particular mode of transport over others. That is why parking management, i.e. fewer spaces for cars and parking pricing, can encourage a considerable number of motorists to change to sustainable transport modes. It decreases inner-city traffic (especially commuter traffic) and relieves residential areas of traffic. Parking restrictions and regulations have to be enforced to reduce the amount of vehicles contributing to pollution and traffic congestions.

Vienna

In 1993, Vienna started a pilot project to charge parking fees in a central district; at that time more than half of the inner city roads were congested by parked vehicles. Since then, the areas with parking fees have been extended to cover Vienna’s entire city centre. With no free parking space available in side roads, the Austrian capital ensured a consistent management of parking across the city. Motorists within the parking sector can park their vehicle for two hours at the most (60 cent for 30 min). Short-term parking (less than 10 min) is free; residents can buy an annual parking permit (about EUR 200). Some of the revenues have been earmarked for public transport services. The modal share of public transport has risen from 29 to 35% since 1993, whereas individual motorised transport has dropped by 7% to 33%19.

Alternatives in Vienna
CONCLUSION
A pricing approach like the parking management in inner cities is crucial to developing a soot reduction strategy because it makes driving cars less attractive. It may be equivalent to the congestion charge, provided it is enforced consistently. The primary target group would be commuters who will use public transport if parking charges are introduced. A parking management concept has an immediate impact on people’s parking behaviour, providing additional benefits when the revenues are used for improvements of public transport. Short-term parking will cause more traffic because drivers will no longer be able to park longer than permitted. In addition, the parking management plan could be thwarted by privately owned car parks, in which case the city has to make adjustments.

DEMANDS

- Implement parking management throughout the city centre.
- Reduce parking space within the parking management area.
- No discounts or exemptions for short-term parkers.
- System with several zones across the city (e.g. via zone codes).

Further Links

City of Vienna – Parking Management (German)
www.wien.gv.at/stadtentwicklung/parkraumbewirtschaftung
Organisational measures

Improved traffic management also helps decrease soot-emissions. In particular, telematic services (information and communications technology) can be a valuable tool, for instance, to promote ecomobility, avoid congestion, and deflect of traffic.

Ramp metering in Frankfurt/Main

Ramp metering is a highly-effective traffic management technique that controls the rate at which vehicles are allowed to merge into the flow of traffic by modifying the amount of time for which the red and green lights are on. It aims to deflect traffic onto alternative routes, preventing flow breakdown and easing congestion and emissions in city centres. In the Friedberger Landstraße in Frankfurt, such a ramp meter was installed in 2006 after the area exceeded emission limits. Ramp metering reduced traffic on this stretch by 5%, and compliance with limits was achieved. In 2009, however, emission concentrations returned to slightly above EU limits. This was also caused by unfavourable weather conditions that year that caused pollution levels to rise.

Public transport priority

Inductive loop sensors signal approaching trams before they reach a traffic intersection, and priority switches give them the necessary priority over car traffic. Not only does it make public transport above ground faster, it also avoids expensive construction of underground lines. Zurich, for example, has implemented a highly-effective transport system after the Zurich voters approved the priority initiative in a popular vote. Since the 1990s, Zurich has been an excellent example of sustainable, low-cost and customer-friendly local traffic policy.
Munich

Munich has taken a comprehensive approach to attracting more passengers by delivering better public transport. Along with other measures, the city renovated bus and tram stops and redesigned rail tracks. Between 1994 and 2004, there were improvements to the tram network, changing traffic signals to give the trams high priority and make them faster. Results of an evaluation showed that the journey times and reliability of trams improved considerably. The city was able to reduce the number of tram vehicles needed and saved EUR 4.2 million in operating costs. The Munich citizens have acknowledged these efforts, with passenger numbers on some tram lines rising by up to 26%. In 2006, the city issued a 10-year plan for buses, one of the most important parts of which is separate bus lanes. Bus lanes enable buses to run independently of other traffic, as well as being easy to implement and relatively cost-efficient.

CONCLUSION

The effectiveness of organisational measures varies widely. Even though faster public transport requires additional investment, lower operating costs and more passengers can fund a large part of the cost. By contrast, a ramp meter, for example, can only reduce soot levels when it ensures the smooth flow of traffic and increases the modal share of public transport. Another benefit results from ramp meters deflecting car traffic away from roads shared with trams.

DEMANDS

Schemes for making public transport faster have to be integrated in urban traffic policies.

Ramp metering should become part of a traffic policy that not only causes congestion but also encourages more people to use public rail and bus services, for example buses bypassing traffic congestion on separate lanes.

Further Links

Ramp metering in Frankfurt/Main (German)
www.frankfurt.de/sixcms/detail.php?id=28028_ffmpar_id_inhalt=17311

Public transport acceleration in Munich (German)
www.muenchen.de/Rathaus/kvr/strverkehr/verkehrssteuerung/opnv/189589/index.html
Individual motorised transport today is still a dominant part of the everyday mobility patterns of urban populations. If it is possible to influence those patterns in mobility behaviour, we have the opportunity to make traffic more efficient, more environmentally friendly, and more socially acceptable. This is what mobility management (MM) is about. It seeks to convince the decision-makers to provide such a highly-effective transport infrastructure that it is able to get more people out of their cars and onto public transport or intermodal/multimodal forms of transport. Mobility management also encourages a change in behaviour towards more sustainable modes of transport or to avoid unnecessary habits.

Municipalities (e.g. Munich)
The city of Munich developed a comprehensive approach to its mobility management concept Gscheid mobil (a word play conveying two connotations of „gscheid“ meaning „travel smart“ and „proper or excellent supply of infrastructure“) including all services provided under this brand. A mobility manager, intensive public relations efforts (e.g. via various marketing measures designed to target both city inhabitants and companies, an internet portal to offer information on mobility in Munich and a cycling campaign), as well as consistent monitoring and other improvements have been key to the successful mobility management programme. The mobility consulting programme for new citizens was particularly successful and created a 7.6% rise in public transport use for this target group.
Stockholm
The city of Stockholm has a mobility management strategy that promotes multi-modal and sustainable transport. It has a carpooling programme with almost 170 vehicles that is scheduled to be expanded. Furthermore, the city has recently improved the information services for travel planning, including online campaigns and free trial tickets for public transport. Also, it offers travel plans to schools and businesses. In its mobility management strategy, the municipality aligns the implementation of its congestion charging zone with well-managed public parking spaces and the promotion of sustainable transport. As a result, the share of individual mobilised transport among all forms of transport decreased by 14% between 2004 and 2010.

CONCLUSION
Intelligent mobility management aims to avoid the generation of traffic and does not restrict itself to managing existing flows of traffic. Mobility management may also provide economic benefits, for example for companies spending less money for parking facilities as a result of a growing number of people switching to public transport or cycling. It is very difficult to estimate the soot reduction potential of mobility management as it depends on the extent of the measures taken and, above all, on their implementation. Furthermore, evaluations have only recently been started.

DEMANDS
Mobility management should become an integral part of urban and traffic planning, i.e. it should be integrated in the air quality management and health plans as well as in regional climate protection programmes.

- Local companies should become role models for mobility management.
- Municipalities should put more effort into developing mobility management projects with private companies (operational mobility concepts) by providing positive political framework. Private companies must be involved as the behaviour of their employees determines a large part of the traffic flow.
- Successful mobility management is based on a holistic approach that includes all mobility options and implements both infrastructural and marketing measures.

Further Links

- DENA – Action plan for mobility management – “Gscheid Mobil” The region of Munich
- City of Stockholm – Stockholm action plan for climate and energy 2010 – 2020
Infrastructural measures: reallocation of road space

Tram

In addition to the measures described so far, strengthening public transport is essential to meeting the air pollution limits in major cities and to ensure „mobility for everyone“. An increasing number of cities are relying on an above-ground tram system because it is more cost-effective and flexible to operate than, for example, an underground line or a light-rail system. Unlike the average bus, the tram runs much more efficiently and with fewer emissions. A number of new lines (such as in Munich or Karlsruhe) clearly indicate that a modern and attractive tram has the potential to make more car owners switch to public transport. Trams can be used both for inner city transit and for connecting city centres with suburbs.

Reintroducing or developing the tram network

Until the 1960s/70s, the tram was a long-standing part of the street scene in almost every European city. But with the rise of the car, both urban and transit planning began creating auto-centric urban landscapes (under the slogan car-oriented city). The tram vanished from many streets (e.g. in West Berlin in 1967, in Hamburg in 1978). However, this trend has reversed since the mid-1980s: throughout Europe, especially in France and Spain, cities have reintroduced trams (or are planning to do so) to tackle problems like traffic jams, noise, and air pollution.

Strasbourg

In Strasbourg, there have been plans for a new public transport infrastructure since as early as the 1970s. However, for a long time, the city could not decide whether to build a city railway, a metro, or a tram. The tram finally prevailed over the other options and has rolled through the inner city since 1994. So far there are 5 tram lines with 33 kilometres of tracks. With a price of EUR 23.5 million per kilometre, the Strasbourg tram is comparatively expensive. However, during the construction work, the city used the opportunity to implement a series of measures to reshape the city. Major roads in the city centre were closed to car traffic, central roads were made into pedestrian zones, and bus services were limited to the outskirts, among other things. The result of this visionary traffic project is quite impressive: car traffic declined by 17%, the volume of public transport rose by 43%, and pedestrian traffic rose by 20%.

Regional tram

Generally, tram networks are limited to the urban districts, but it is especially the commuters flocking into the cities from the suburbs that cause congestion.

Zurich’s good example

In the 1950s, the urban planners wanted to build a two-storey road system for the cars. The citizens who needed to approve the project rejected it. They also rejected a proposal for an underground system. Instead the citizens chose to improve the tram network above ground. Today Zurich is a role model for modern urban traffic planning. The modal share of cars being under one-third of the modal split and the compliance with EU limits for PM10 and NO2 reflect this success.

22 Wikipedia – Strasbourg tramway

23 Christoph Groneck (2003): „Neue Straßenbahnen in Frankreich“ (german)
So-called regional trams fill the gap between urban public transport and the surrounding municipalities by connecting the urban transit system with the regional transit. Trams and trains use the same rail system and thus enable travelling into the city without the need for changing transport means or price systems. Thus they are an attractive alternative to car commuting. A further advantage is that the existing rail network is used to provide the regional transport services. A tram-train network, even though difficult to implement, can be an effective solution improving access to areas with ineffective transport infrastructure and high commuter activity.

Karlsruhe
Karlsruhe was the first city to introduce an urban, regional tram, this new system is known as the Karlsruhe model. The idea was born in 1961. The city linked its narrow gauge railways to the inner-city tram network to offer passengers seamless travel. In 1992, the city revived this idea and combined the existing railway lines and tram network so urban trams could also run on the mixed rail network. The aim was to connect the suburban areas with the city centre since the central station is somewhat further away from the city centre. Encouraged by the success of their Karlsruhe model, the city has continued to expand the network with tram-train vehicles operating on 470 kilometres of tracks. As a result, the amount of passengers has increased sixfold\(^4\).

CONCLUSION
Trams are efficient, flexible, relatively cost-effective, and clean, particularly when they run on renewable energy. In addition, their construction also creates the opportunity to reshape the urban space. Urban trams can even provide transport services to the suburban and rural areas, making public modes of transport more accessible to commuters. With all these benefits, trams are not only a modern invention but have proved their effectiveness in the past. A tram network is relatively costly, just like all infrastructural measures. It has to be implemented carefully and should be an integral part of urban planning. It needs to be supported by extensive public-relations activities. Very importantly, the public should be involved in such projects from the start to ensure they approve them.

DEMANDS

- Maintain and improve tram networks in small cities.
- Reintroduce tram systems in large cities on appropriate lines where trams have disappeared.
- Create new tram-train systems.
- Use renewable energies.
Walking

Anyone who wants to walk more than the few steps is reliant on good walking conditions. These conditions should not only include adequate footpaths, but also other factors like perceived security in terms of both traffic and crime, or clean air. If car traffic is reduced, people are increasingly likely to walk or cycle short distances. People use convenient modes and expand their mobility. Urban planners and politicians must collaborate on these issues.

Shared Space

The idea of the „Shared Space“-approach is that people and cars use the space in a city on equal terms. Traffic behaviour so far has followed traffic signs and rules; the shared space concept replaces traffic signs by social behaviour. Evaluations of Shared Space projects revealed several positive effects: smoother flow of traffic, slightly decreasing traffic volumes and positive feedback from the residents. The scheme has also led to fewer accidents. The idea, concept, and pilot projects were developed in the Netherlands.

MEASURES

- Removal of traffic signs
- Central reservations
- Structural separations
- Functional layouts

CONSEQUENCES

- Disconcerting effect
- Social behaviour
- Eye contact
- Speed reduction
- Shared use

OBJECTIVES

- Quality of life
- Identity
- Infrastructure capacity
- Traffic flow
- Accidents
- Land use

Hamburg

Hamburg is set to introduce shared space areas in 2010, making it the Germany’s first large city to implement several shared space projects. The city passed the main hurdle after a report gave the green light to shared space. In the financial year 2009/2010 alone, Hamburg provided over EUR 7 million to the project. However, it seems to be difficult to specify suitable roads. „Hamburg was able to pass the necessary legislation after an assessment approved shared spaces in Hamburg“.
Pedestrian plan (London)
London was the first major city to develop a strategy for urban walking, the „Walking Plan for London“, in 2004 as it saw pedestrian numbers decline. The goals are, among others, to improve pedestrian access to the public transport network, promote accessibility, strengthen the local economy, and improve the urban environment. The Walking Plan is designed to make London the most walking-friendly city. In quantitative terms, the amount of walking for trips under two miles (about 3 kilometres) should increase by 10% compared to other forms of transportation, as should the number of trips made per person per year. The walking improvements include soft policies, such as promoting the benefits of walking, as well as improving the street environment and considering the needs of walkers in future urban planning. The plan integrates the walking as a long term objective. However, there has not been an evaluation since its approval.

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DEMANDS

Major cities should develop walking strategies to encourage walking across the city and ensure pedestrian safety.

Implement alternative urban design concepts like Shared Space where appropriate, especially in residential quarters.
Cycling strategies

No car, no pollutants! This simple logic means that providing alternatives to the car will contribute to reducing soot emissions in cities. The benefits of cycling: no exhaust, bicycles are affordable, healthy, great for short trips, need little space, and create jobs in manufacturing, sales, services, etc.

The development and implementation of cycling strategies or plans are the most successful steps to increase the modal share of cycling in cities. They include a package of comprehensive measures that have to be implemented over several years; most of them are developed by the municipalities themselves and, ideally, supported by all interest groups. An approach like this must be an integral part of traffic development plans recognising that bicycles and cars are equal road users.

Münster
Münster has been thought of as the unofficial cycling capital in Germany for years, and rightly so. The modal share of cycling is 37.6% (12% on average in German cities). There are a number of reasons, amongst others a high share of students and flat topography. Also, Münster is an old town with narrow streets that discourages the use of cars. The crucial factor, however, was that Münster developed its first cycling concept as early as 1994. A network of cycle lanes, 30-km/h zones, cycle-friendly traffic signals, sufficient bike parking and bicycles being allowed on public transport were parts of the cycling plan. The revised concept (2004 to 2010) incorporates the results of BYPAD (Bicycle Policy Audit), shifting the focus to traffic safety in cycle traffic, information, communications and services.

Copenhagen
Perhaps the most prominent example of a cycling city is the Copenhagen. Cycling has been part of the municipal mobility strategy for a long time. As a result, the infrastructure for biking is very well developed with 35,000 bike racks and 360km of bike lanes. The city is continuously expanding its network, including a network of ‘bicycle superhighways’ and cycle and footbridges. Also, a row of promotion measures are motivating citizens to cycle, for example handing out chocolate for good cycling behaviour. Finally, cycles are prioritised at many crossings, bikes can be brought on all metros and trains (except for a few restrictions) and the city ensures high information supply to the citizens.
CONCLUSION

With cycling becoming increasingly popular in urban traffic, cities cannot avoid creating a cycling strategy and have to take into account the needs of cyclists in new developments.

The main benefits of a cycling strategy are that it coordinates the measures to promote cycling more efficiently and helps to assess the role of cycling in public transport trips, provided that transport planning stipulates their implementation. Accepting bicycles on public transport is a key element of a cycling concept in order to avoid competition between public transport and cycling.

DEMANDS

Every city should develop a cycling strategy.

Adequate funding for cycling promotion and cycling infrastructure, with bicycles being unique among the transport modes (cheap and cost-efficient).

Public transport and cycling have to complement each other and must not compete with each other; bicycles can be carried on public transport free of charge or at a small extra charge.

Further Links

German federal ministry of transport, Cycling
Copenhagen – City of Cyclists, Bicycle Account 2010

Pedelecs

are bicycles with an electric motor that assists pedalling. The motor generally provides about half the pedal power, enabling cyclists to reach higher speed levels with less physical effort and as a result to cover longer distances. Pedelecs with an integrated electric motor use rechargeable batteries and have a range of 50 to 100 kilometres. They encourage cyclists to use them for longer trips (over 5 km) as well as in hilly terrain.
Promoting EcoMobility

The choice of the transport mode is only to some extent the result of rational decision-making. Car advertising makes a clear statement: The car is not only a vehicle, it is an expression of your personal lifestyle and image. Why should those involved in EcoMobility - i.e. transport services, the bicycle industry, or municipalities - not make use of these successful marketing techniques? The „future“ eco-mobile users will respond when these actors address their emotional needs in a creative and innovative way.

Climate Heroes in Essen

In 2007, the local transport company, Essener Verkehrs-AG (EVAG), promoted itself by launching the unusual image campaign „Climate Heroes“. The pivotal point of the campaign was to take up climate protection and link it to people's mobility behaviour, conveying the key message: Using public transport makes a major contribution to climate protection. During the campaign, public vehicles with the slogan „Carpooling for the climate“ or „(E)MISSION (IM)POSSIBLE“ had been running on the streets of Essen, along with leaflets and flyers delivered to homes across the city. EVAG also invited people to take free „test drives“ on its vehicles on seven Sundays. A comprehensive website providing information on climate change with a CO\textsubscript{2} calculator completed the campaign. The costs amounted to EUR 80,000. The evaluation showed that as a result of the campaign, 10% of the citizens wanted to use public transport more often.

CONCLUSION

Image is (almost) everything. Let's take cycling as an example. Cycling is „in“, trendy and accepted. In fact, it is so accepted that we can even see managers in suits getting on their bikes. The growing amount of cycling compared to other transit modes mirrors this trend. EcoMobility should be modelled on cycling campaigns and place more emphasis on better marketing. Multimodal transport should be the guiding principle, i.e. the combination of several modes. However, it is difficult to measure the effectiveness of efforts to promote EcoMobility and the associated long-term improvements. Ecomobility programmes therefore need to place emphasis on good evaluation and long-term marketing support.

DEMANDS

The Association of German Transport Companies and the German Association of Cities should inform their members of exemplary marketing concepts and innovative activities on a regular basis.

Cooperating with inventive advertising agencies, forming local alliances, and the organising of local events can boost the popularity of EcoMobility.
Ineffective measures

Municipalities are under increasing pressure to meet air quality targets. The cities face hefty fines if they fail to do so and fail to take steps to prevent exceeding of limits. It is obvious that one measure alone will not eliminate air pollution. Insufficient knowledge of the effectiveness of existing measures adds to the problem. The measures outlined below should help prevent municipalities from putting resources into ineffective measures that are hardly promising. They are often expensive and difficult to implement, but their effectiveness is close to zero. On the contrary, building bypasses, for instance, even has a considerable negative impact.

Application of Calcium Magnesium Acetate (CMA)

Some cities seek to reduce particulate matter pollution using “fine-dust glue” as a dust-binder. Calcium Magnesium Acetate (CMA) has to date been used mainly as a de-icing agent in Scandinavia. In 2008/2009, Halle, a city in East Germany, had been applying CMA on roads with heavy traffic for three months in an effort to reduce re-suspension of particulate matter. Yet the study showed very little impact on fine particle levels. Similar results were reported by a study carried out in Stuttgart between January and March 2010. They had also tested the use of CMA1. The application of CMA is very difficult, expensive and quite ineffective, treating the symptoms rather than the causes2.

Improved street cleaning machinery

A study conducted in Berlin aimed to test the mitigation potential of improved street cleaning machinery to reduce PM10 pollution. In 2006/2007, street cleaners equipped with particulate filters cleaned a very busy stretch in Berlin for five months. Data analyses found no lower PM10 concentrations and thus no difference in performance between street cleaners with or without particulate filters1.

Road construction

Building bypasses is no cure-all for fine dust. Studies show that the – limited – reduction in pollutant emissions on roads relieved of heavy traffic is offset by a considerable rise in pollutant emissions on newly built roads. The NO₂ emissions are even higher due to speed increases. Municipalities usually do not redesign thoroughfares to make them more compatible with the residential surroundings or urban environment, they accommodate the cars with more road space and additional roads. However, more roads usually generate more car traffic.
Conclusion

With the examples from European cities that have been outlined here, we do not seek to nor can we offer magic formulas. There is no simple way nor any single measure to meet the EU limits. What is needed is a combination of approaches for each individual city: technical air quality measures (on cars, lorries, construction machinery, buses, trains, etc.) and measures to reduce individual motorised transport, for example through improvements of cycling and public transport. Environmental zones, which lead to a modernisation of vehicle fleets, are the most effective single measure, but they alone will not suffice. Therefore, every city has to develop its own action plan and consistently implement it.

However, without comprehensive measures to bring down the background exposure to fine dust, most cities are fighting a losing battle. This is why the „Sootfree for the climate“ campaign is involved with tougher emission limits for vehicles, construction machinery, locomotives, ships, etc. The NGOs involved in this campaign lobby the decision-makers, who are responsible for regulating the relevant limits: the national government, the European Union and, in the case of ship emissions, international organisations such as the International Maritime Organisation (IMO) as well.

Black carbon is a significant contributor to global warming. Along with the argument for health protection that helped achieve the existing European emission standards, climate protection is now a matter of concern as well. This is one more reason to be consistent in our actions and reduce soot emissions to zero as soon as possible. The reduction measures outlined in this brochure are very cost-efficient, create additional jobs, and generate secondary benefits: cities with less car traffic will become more attractive to their inhabitants and are „livable cities“ in the truest sense of the word.
The „Soot free for the climate“ campaign aims to raise awareness of the negative climate effects of soot emissions from diesel engines in order to stimulate political and social discussion; it calls for measures that can help reduce soot emissions significantly. Decreasing soot emissions has an immediate benefit on the climate and on public health.